ENVIS CENTER
on
ENVIRONMENTAL BIOTECHNOLOGY

Abstract Vol. XXVII

Sponsored by

MINISTRY OF ENVIRONMENT, FORESTS AND CLIMATE CHANGE
GOVERNMENT OF INDIA
NEW DELHI

Department of Environmental Science
University of Kalyani
Nadia, West Bengal
December, 2015

Published by:
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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.

This ENVIS Centre is established in the focal theme area - Environmental Biotechnology at the Department of Environmental Science, University of Kalyani, Nadia-741235, West Bengal in the year 2002.

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 fifteen sub-heads. 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 27th 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 in last six months upto December, 2015. In this issue, various topics like Bioenergy, 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 author's 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 16 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.

Nano Biotechnology: Bionanotechnology, nanobiotechnology, and nanobiology are terms that refer to the intersection of nanotechnology and biology. Given that the subject is one that has only emerged very recently, bionanotechnology and nanobiotechnology serve as blanket terms for various related technologies.

This discipline helps to indicate the merger of biological research with various fields of nanotechnology. Concepts that are enhanced through nanobiology include: nanodevices, nanoparticles, and nanoscale phenomena that occurs within the disciple of nanotechnology. This technical approach to biology allows scientists to imagine and create systems that can be used for biological research

Biomimicry: Biomimicry is an applied science that derives inspiration for solutions to human problems through the study of natural designs, systems and processes. Biomimicry on the other hand, which is not a science, is a more subtle way which we can benefit from nature. It is the modern, often high tech, equivalent of the

historical practices of emulating nature. . The science of biomimicry is a newly developing field but the application of biomimicry has been around since the beginning of man. The biomimetic technologies (flight controls, bio-robotics, ventilation systems, etc.) and potential technologies (fin geometry, nacre materials, etc.) improve performance. The use of biomimicry as an approach to sustainable engineering, specifically the environmental components.

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

Karina Krzciuk[a] & Agnieszka Gałuszka[a*]. ([a] Geochemistry and the Environment Division, Institute of Chemistry, Jan Kochanowski University, Kielce,Poland). Prospecting for hyperaccumulators of trace elements: a review. Critical Reviews in Biotechnology, Volume 35(4) (2015): 522-532

Specific plant species that can take up and accumulate abnormally high concentrations of elements in their aboveground tissues are referred to as "hyperaccumulators". The use of this term is justified in the case of enormous element-binding capacity of plants growing in their natural habitats and showing no toxicity symptoms. An increasing interest in the study of hyperaccumulators results from their potential applications in environmental biotechnology (phytoremediation, phytomining) and their emerging role in nanotechnology. The highest number of plant species with confirmed hyperaccumulative properties has been reported for hyperaccumulators of nickel, cadmium, zinc, manganese, arsenic and selenium. More limited data exist for plants accumulating other elements, including common pollutants (chromium, lead and boron) or elements of commercial value, such as copper, gold and rare earth elements. Different approaches have been used for the study of hyperaccumulators – geobotanical, chemical, biochemical and genetic. The chemical approach is the most important in screening for new hyperaccumulators. This article presents and critically reviews current trends in new hyperaccumulator research, emphasizing analytical methodology that is applied in identification of new hyperaccumulators of trace elements and its future perspectives.

Keywords: Hyperaccumulators, hyperaccumulator sampling, hyperaccumulator sample treatment, plant sample analysis, trace elements

Xiaoli Tang[ab], Xingmin Mu[cd*], Hongbo Shao[acde*], Hongyan Wang[ab] & Marian Brestic[af]. ([a] Key Laboratory of Coastal Biology & Bioresources Utilization, Yantai Institute of Coastal Zone Research (YIC), Chinese Academy of Sciences (CAS), Yantai, China, [b] University of Chinese Academy of Sciences, Beijing, China, [c] Institute of Soil and Water Conservation, Northwest A&F University, Yangling, China, [d] Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resources, Yangling, China, [e] Institute for Life Sciences, Qingdao University of Science & Technology (QUST), Qingdao, China, and [f] Department of Plant Physiology, Slovak Agricultural University, Nitra, Slovak Republic). Global plant-responding mechanisms to salt stress: physiological and molecular levels and implications in biotechnology. Critical Reviews in Biotechnology, Volume 35(4) (2015): 425-437

The increasing seriousness of salinization aggravates the food, population and environmental issues. Ameliorating the salt-resistance of plants especially the crops is the most effective measure to solve the worldwide problem. The salinity can cause damage to plants mainly from two aspects: hyperosmotic and hyperionic stresses leading to the restrain of growth and photosynthesis. To the adverse effects, the plants derive corresponding strategies including: ion regulation and compartmentalization, biosynthesis of compatible solutes, induction of antioxidant enzymes and plant hormones. With the development of molecular biology, our understanding of the molecular and physiology knowledge is becoming clearness. The complex signal transduction underlying the salt resistance is being illuminated brighter and clearer. The SOS pathway is the central of the cell signaling in salt stress. The accumulation of the compatible solutes and the activation of the antioxidant system are the effective measures for plants to enhance the salt resistance. How to make full use of our understanding to improve the

output of crops is a huge challenge for us, yet the application of the genetic engineering makes this possible. In this review, we will discuss the influence of the salt stress and the response of the plants in detail expecting to provide a particular account for the plant resistance in molecular, physiological and transgenic fields.

Keywords: Antioxidant system, eco-environment, genetic engineering, photosynthesis, salinization, SOS pathway

Santosh Kumar Karn[a, b,]. ([a] Department of Biotechnology, National Institute of Technology, Raipur 492001, CG, India, [b] Bioremediation Laboratory, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China). **Arsenic (As) contamination: A major risk factor in Xinjiang Uyghur autonomous region of China. Environmental Pollution, Volume 207(2015): 434–435**

Xinjiang province is one of the unhealthiest region in China due to natural as well as man-made activities. Here soil and water having high concentration of multi-metals especially arsenic content in the soil and water is a major threat to the peoples which suffers regularly from arsenic contamination therefore multiple diseases and illness is the common phenomenon. Therefore this area urgently needed a comprehensive assessment by governmental and nongovernmental organization to cope up with this problem and find a miracle solution which can remediate soil and water quality. There peoples suffers much for the above mentioned reason.

Keywords: Industries; Xinjiang; Mine tailing; Metal contamination; Arsenic; Peoples

Liwen Qiang[a], Xiaomei Shi[a], Xiaoyu Pan[b], Lingyan Zhu[a], Meng Chen[a], Yuwei Han[a]. ([a]College of Environmental Science and Engineering, Tianjin Key Laboratory of Environmental Remediation and Pollution Control, Key Laboratory of Pollution Processes and Environmental Criteria, Ministry of Education, Nankai University, Tianjin, 300071, PR China, [b] College of Marine Science of Engineering, Tianjin Key Laboratory of Marine Resources and Chemistry, Tianjin University of Science and Technology, Tianjin, 300457, PR China). **Facilitated bioaccumulation of perfluorooctanesulfonate in zebrafish by nano-TiO_2 in two crystalline phases. Environmental Pollution, Volume 206(2015): 644–651**

Zebrafish were placed in the upper layer of aquariums to investigate the impacts of anatase and rutile nano-TiO_2 on perfluorooctanesulfonate (PFOS) bioaccumulation in zebrafish. Both variations of particle hydrodynamic size and concentration in water column suggest that anatase was better dispersed than rutile. PFOS could be significantly adsorbed on nano-TiO_2 to form TiO_2-PFOS complexes, leading to reduced concentration of PFOS in upper layer. Due to enhanced exposure to PFOS by ingestion and adhesion of TiO_2-PFOS complexes, the whole-body PFOS concentration in zebrafish was enhanced by 59.0% (95% CI: 55.9%, 61.9%) and 25.4% (95% CI: 24.8%, 25.6%) in the presence of anatase and rutile nano-TiO_2 after equilibrium compared with the control with PFOS alone. The bioaccumulation of PFOS was much more promoted by anatase, which was attributed by greater adsorption capacity of PFOS to anatase, slower migration of their complex in water column, and slower elimination rate of anatase from fish.

Keywords: Anatase nano-TiO_2; Rutile nano-TiO_2; PFOS; Bioaccumulation; Zebrafish

E. Barón[a], J. Giménez[b], P. Verborgh[c], P. Gauffier[c], R. De Stephanis[d], E. Eljarrat[a, ,] , D. Barceló[a, e]. ([a]Institute of Environmental Assessment and Water Research Studies (IDAEA), Spanish Council for Scientific Research (CSIC), Jordi Girona 18-26, 08034 Barcelona,

Spain, [b] Doñana Biological Station (EBD-CSIC), Department of Conservation Biology, Avenida Americo Vespucio s/n, 41092 Sevilla, Spain, [c] Conservation Information and Research on Cetaceans (CIRCE), Cabeza de Manzaneda 3, Algeciras-Pelayo, 11390 Cádiz, Spain, [d] Fundación Rosetta, Cabeza de Manzaneda 3, Algeciras-Pelayo, 11390 Cadiz, Spain, [e] Catalan Institute for Water Research (ICRA), H_2O Building, Scientific and Technological Park of the University of Girona, Emili Grahit 101, 17003 Girona, Spain). Bioaccumulation and biomagnification of classical flame retardants, related halogenated natural compounds and alternative flame retardants in three delphinids from Southern European waters. Environmental Pollution, Volume 203(2015): 107–115

Occurrence and behaviour of classical (PBDEs) and alternative (HNs, HBB, PBEB, DBDPE and HBCD) flame retardants, together with naturally produced MeO-PBDEs, were studied in short-beaked common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*) and long-finned pilot whale (*Globicephala melas*) in two sampling locations from Southern European waters. PBDEs, Dec 602, Dec 603, DP, α-HBCD and two MeO-PBDEs were detected in all three species. ∑PBDEs were between 17 and 2680 ng/g lw; ∑HNs were between 1.1 and 59 ng/g lw; α-HBCD levels ranged between 3.2 and 641 ng/g lw; ∑MeO-PBDEs were between 34 and 1966 ng/g lw. Bottlenose dolphins were the most contaminated species and some individuals could present health risk for endocrine disruption since levels found were above the reported threshold (1500 ng/g lw). Stable isotope analysis was used to evaluate the biomagnification capacity of these compounds. PBDEs, MeO-PBDEs and Dec 602 showed a significant positive correlation with trophic position.

Keywords: Bioaccumulation; Biomagnification; Cetaceans; Dechloranes; Emerging BFRs; Gulf of Cádiz; Strait of Gibraltar; MeO-PBDEs; PBDEs

Amalie Thit' , Gary T. Banta , Henriette Selck. (Dept. of Environmental, Social and Spatial Change, Roskilde University, Roskilde, Denmark). Bioaccumulation, subcellular distribution and toxicity of sediment-associated copper in the ragworm *Nereis diversicolor*: The relative importance of aqueous copper, copper oxide nanoparticles and microparticles. Environmental Pollution, Volume 202(2015): 50–57

The sediment-dwelling ragworm, *Nereis diversicolor* was exposed to sediment spiked with aqueous Cu (Cu_{Aq}, $CuCl_2$), CuO nanoparticles (CuO_{NP}) or CuO microparticles (CuO_{Micro}) at 150 µg Cu g^{-1} dw sediment for 10d. Exposures to Cu_{Aq} and CuO_{Micro} caused mortality (62.5 and 37.5%, respectively), whereas mean burrowing time increased during exposure to Cu_{Aq} and CuO_{NP} from 0.12 h (controls) to 19.3 and 12.2 h, respectively. All Cu treatments bioaccumulated, especially Cu_{Aq} (up to 4 times more than the other treatments). Cu was roughly equally distributed among the five subcellular fractions in controls and worms exposed to CuO_{NP} or CuO_{Micro}. In contrast, ≈50% of accumulated Cu in Cu_{Aq} exposed worms was found in metal rich granules and significantly more Cu was present in heat-denatured proteins and organelles than in worms exposed to CuO_{Micro} or in controls. Our results suggest that Cu form affects its bioaccumulation and subsequent toxicity and detoxification in a polychaete like *N. diversicolor*.

Keywords: Cu body burden; Burrowing behaviour; NP; Polychaete; Sediment exposure

Lamin Daddy Massaquoi, Hui Ma, Xue Hui Liu, Peng Yu Han, Shu-Mei Zuo, Zhong-Xian Hua, Dian-Wu Liu. (Shijiazhuang School of Public Health, Hebei Medical University, Shijiazhuang Center for Disease Control and Prevention, School of Public Health, Hebei Medical University, Shijiazhuang Center for Disease Control and Prevention, Center for Disease Control and Prevention). Heavy metal accumulation in soils, plants, and hair samples: an assessment of heavy metal exposure risks from the consumption of vegetables

grown on soils previously irrigated with wastewater. Environmental Science and Pollution Research, Volume 22(23) (2015): 18456-18468

It is common knowledge that soils irrigated with wastewater accumulate heavy metals more than those irrigated with cleaner water sources. However, little is known on metal concentrations in soils and cultivars after the cessation of wastewater use. This study assessed the accumulation and health risk of heavy metals 3 years post-wastewater irrigation in soils, vegetables, and farmers' hair. Soils, vegetables, and hair samples were collected from villages previously irrigating with wastewater (experimental villages) and villages with no history of wastewater irrigation (control villages). Soil samples were digested in a mixture of $HCL/HNO_3/HCLO_4/HF$. Plants and hair samples were digested in $HNO_3/HCLO_4$ mixture. Inductive coupled plasma-optical emission spectrometer (ICP-OES) was used to determine metal concentrations of digested extracts. Study results indicate a persistence of heavy metal concentration in soils and plants from farms previously irrigated with wastewater. In addition, soils previously irrigated with wastewater were severely contaminated with cadmium. Hair metal concentrations of farmers previously irrigating with wastewater were significantly higher ($P < 0.05$) than farmers irrigating with clean water, but metal concentrations in hair samples of farmers previously irrigating with wastewater were not associated with current soil metal concentrations. The study concludes that there is a persistence of heavy metals in soils and plants previously irrigated with wastewater, but high metal concentrations in hair samples of farmers cannot be associated with current soil metal concentrations.

Keywords: Heavy metals; Risk assessment; Daily metal intake; Wastewater; Agriculture; Health hazard; Bio-concentration; Geo-accumulation

Jialong Sun, Xiao Zou, Tangfu Xiao, Yanlong Jia, Zengping Ning, Min Sun, Yizhang Liu, Tao Jiang. (School of Resources and Environmental Engineering, Guizhou Institute of TechnologyGuizhou Institute of Environmental Science and DesignState Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences , Institute of Fungal Resources, Guizhou University, State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, School of Resources and Environmental Engineering, Guizhou Institute of TechnologyState Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences). Biosorption and bioaccumulation of thallium by thallium-tolerant fungal isolates. Environmental Science and Pollution Research, Volume 22(21) (2015): 16742-16748

Little is known about the biosorption and bioaccumulation capacity of thallium (Tl) by microorganisms that occur in Tl-polluted soil. The present study focused on characterizing the biosorption and bioaccumulation of Tl by Tl-tolerant fungi isolated from Tl-polluted soils. Preliminary data showed a positive correlation between the biomass and the biosorbed Tl content. The Tl-tolerant strains were capable of bioaccumulating Tl, up to 7189 mg kg^{-1} dry weight. The subcellular distribution of Tl showed obvious compartmentalization: cytoplasm $\gg$ cell wall > organelle. The majority of Tl (up to 79 %) was found in the cytoplasm, suggesting that intracellular compartmentalization appeared to be responsible for detoxification. These findings further suggest the applicability of the fungal isolates for cleanup of Tl in Tl-polluted water and soil.

Keywords: Thallium; Biosorption; Bioaccumulation; Fungal isolates; Subcellular distribution

Bioremediation

A.M. Braud, M. Hubert, P. Gaudin, T. Lebeau. ((IRSTV, LPGN UMR CNRS 6112, Nantes, France. Correspondence: Armelle M. Braud, IRSTV/Laboratoire de Planétologie et Géodynamique de Nantes, 2 chemin de la Houssinière, BP 92208, 44322 Nantes Cedex 3, France. E-mail: armelle.braud@laposte.net). A quick rhizobacterial selection tests for the remediation of copper contaminated soils. Journal of Applied Microbiology, Volume 119(2) (2015): 435–445

The main objective of the study is to develop and improve quick bacterial tests to select the best candidates for the bioaugmentation of metal-contaminated soil, coupled with phytoextraction. Bacteria isolates (181) were selected from a collection originated from a Cu-contaminated sediment, on the basis of several miniaturized biochemical tests adapted to the copper contamination. Amongst them, we used a growth soil based-medium to select metal-tolerant bacteria, and their ability to grow and mobilize metals by mean of metabolites (siderophores, organic acids) was also assessed.

The result of the bacterial selection tests showed differences in presence or absence of copper, especially for phosphate-solubilizing strains which ability decreased by 53% in the presence of copper hydroxide phosphate as compared to the standard tricalcium phosphate test. A promising *Pseudomonas putida* was selected from the collection. The study underlined the importance of choosing significant selection tests regarding the nature of the metal occurring in the soil to be cleaned-up to assess the real potential of each bacterial strain for subsequent soil bioaugmentation purposes.

U. Ishaq, M.S. Akram, Z. Iqbal, M. Rafiq, A. Akrem, M. Nadeem, F. Shafi, Z. Shafiq, S. Mahmood, M.A. Baig. (Institute of Pure and Applied Biology, Bahauddin Zakariya University, Multan, Pakistan, University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan, Institute of Chemical Sciences, Bahauddin Zakariya University, Multan, Pakistan). Production and characterization of novel self-assembling biosurfactants from *Aspergillus flavus.* Journal of Applied Microbiology, Volume 119(4) (2015): 1035–1045

This work was conducted to produce, purify and characterize biosurfactants from *Aspergillus flavus* AF612 isolated from citrus fruit. Biosurfactant named 'Uzmaq' was isolated from *A. flavus* AF612. The chemical characterization of the biosurfactant was conducted. Biosurfactant Uzmaq produced by *A. flavus*, was composed of methoxy phenyl oxime glycosides. Two molecular forms of the biosurfactant, Uzmaq-A and Uzmaq-B were isolated. Biological properties (antifungal activity) were evaluated. The fractions of the biosurfactant were isolated and their surface properties were analysed. Uzmaq-A and Uzmaq-B had critical micelle concentration (CMC) around 170 and 80 mg l^{-1}, and lowered surface tension of water up to 20 and 25 m Nm^{-1} respectively. The biosurfactants were stable at pH 3–12 and temperature up to 80°C. Growth and biosurfactant production kinetics were also analysed.

Novel biosurfactant Uzmaq was produced from *A. flavus*, which was composed of methoxy phenyl oxime glycosides. The surface activity of Uzmaq was better than the maximum values of synthetic chemical surfactants. The biosurfactant showed antifungal activity and self-assembling

properties. *Aspergillus flavus* AF612 can be used for commercial production of Uzmaq that may be employed for controlled drug release applications and bioremediation.

G. Płaza, J. Chojniak, K. Rudnicka, K. Paraszkiewicz, P. Bernat. (Department of Environmental Microbiology, Institute for Ecology of Industrial Areas, Katowice, Poland. Correspondence: Grazyna Płaza, Institute for Ecology of Industrial Areas, Department of Environmental Microbiology, Kossutha Street 6, 40-844, Katowice, Poland. E-mail: pla@ietu.katowice.pl, Laboratory of Gastroimmunology, Department of Immunology and Infectious Biology, Faculty of Biology and Environmental Protection, University of Lodz, Lodz, Poland, Department of Industrial Microbiology and Biotechnology, Faculty of Biology and Environmental Protection, University of Lodz, Lodz, Poland). Detection of biosurfactants in *Bacillus* species: genes and products identification. Journal of Applied Microbiology, Volume 119(4) (2015): 1023–1034

To screen environmental *Bacillus* strains for detection of genes encoding the enzymes involved in biosurfactant synthesis and to evaluate their products e.g. surfactin, iturin and fengycin. The taxonomic identification of isolated from the environment *Bacillus* strains was performed by Microgene ID *Bacillus* panel and GEN III Biolog system. The polymerase chain reaction (PCR) strategy for screening of genes in *Bacillus* strains was set up. Liquid chromatography–mass spectrometry (LC-MS/MS) method was used for the identification of lipopeptides (LPs). All studied strains exhibited the presence of *srfAA* gene and produced surfactin mostly as four homologues (C13 to C16). Moreover, in 2 strains (KP7, T'-1) simultaneous co-production of 3 biosurfactants: surfactin, iturin and fengycin was observed. Additionally, it was found out that isolate identified as *Bacillus subtilis* ssp. *subtilis* (KP7), beside LPs co-production, synthesizes surfactin with the efficiency much higher than other studied strains (40·2 mg l^{-1}) and with the yield ranging from 0·8 to 8·3 mg l^{-1}.

We showed that the combined methodology based on PCR and LC-MS/MS technique is an optimal tool for the detection of genes encoding enzymes involved in biosurfactant synthesis as well as their products, e.g. surfactin, iturin and fengycin. This approach improves the screening and the identification of environmental *Bacillus* co-producing biosurfactants—stimulating and facilitating the development of this area of science. The findings of this work will help to improve screening of biosurfactant producers. Discovery of novel biosurfactants and biosurfactants co-production ability has shed light on their new application fields and for the understanding of their interactions and properties.

Lucélia Cabral, Claúdio Roberto Fonsêca Sousa Soares, Admir José Giachini, José Oswaldo Siqueira. (Research Center for Chemistry, Biology and Agriculture – CPQBA, University of Campinas – UNICAMP Affiliated withDepartment of Microbiology, Immunology and Parasitology (CCB/MIP), Center of Biological Science, Federal University of Santa Catarina, Institute of Technology Sustainable Development). Arbuscular mycorrhizal fungi in phytoremediation of contaminated areas by trace elements: mechanisms and major benefits of their applications. World Journal of Microbiology and Biotechnology, Volume 31(11)(2015): 1655-1664

In recent decades, the concentration of trace elements has increased in soil and water, mainly by industrialization and urbanization. Recovery of contaminated areas is generally complex. In that respect, microorganisms can be of vital importance by making significant contributions towards the establishment of plants and the stabilization of impacted areas. Among the available

strategies for environmental recovery, bioremediation and phytoremediation outstand. Arbuscular mycorrhizal fungi (AMF) are considered the most important type of mycorrhizae for phytoremediation. AMF have broad occurrence in contaminated soils, and evidences suggest they improve plant tolerance to excess of certain trace elements. In this review, the use of AMF in phytoremediation and mechanisms involved in their trace element tolerance are discussed. Additionally, we present some techniques used to study the retention of trace elements by AMF, as well as a summary of studies showing major benefits of AMF for phytoremediation.

Keywords: Arbuscular mycorrhizal fungi, Contaminated soils, Morphological and genetic mechanisms, Trace elements, Phytoremediation

T. P. H. van den Brand, K. Roest, G. H. Chen, D. Brdjanovic, M. C. M. van Loosdrecht. (KWR Watercycle Research Institute, Hong Kong University of Science and Technology, UNESCO-IHETU Delft, TU DelftKWR Watercycle Research Institute). Potential for beneficial application of sulfate reducing bacteria in sulfate containing domestic wastewater treatment. World Journal of Microbiology and Biotechnology, Volume 31(11) (2015): 1675-1681

The activity of sulfate reducing bacteria (SRB) in domestic wastewater treatment plants (WWTP) is often considered as a problem due to H_2S formation and potential related odour and corrosion of materials. However, when controlled well, these bacteria can be effectively used in a positive manner for the treatment of wastewater. The main advantages of using SRB in wastewater treatment are: (1) minimal sludge production, (2) reduction of potential pathogens presence, (3) removal of heavy metals and (4) as pre-treatment of anaerobic digestion. These advantages are accessory to efficient and stable COD removal by SRB. Though only a few studies have been conducted on SRB treatment of *domestic* wastewater, the many studies performed on *industrial* wastewater provide information on the potential of SRB in domestic wastewater treatment. A key-parameter analyses literature study comprising pH, organic substrates, sulfate, salt, temperature and oxygen revealed that the conditions are well suited for the application of SRB in domestic wastewater treatment. Since the application of SRB in WWTP has environmental benefits its application is worth considering for wastewater treatment, when sulfate is present in the influent.

Keywords: Sulphate reducing bacteria; Heavy metal removal; Decreased sludge treatment; Low growth yield; Pathogen removal; Domestic wastewater

M. Azizur Rahman, Ben Hogan, Elliott Duncan, Christopher Doyle, Mohammad Mahmudur Rahman, T. V. Nguyen, Richard P. Lim, William Maher, Ravi Naidu, Rick Krassoi, S. Vigneswaran, Christel Hassler. (Centre for Environmental Sustainability, School of the Environment, University of Technology Sydney, Ecochemistry Laboratory, Institute for Applied Ecology, University of Canberra, Ecotox Services Australasia Pty. Ltd., Global Centre for Environmental Remediation (GCER), Faculty of Science & Information Technology, University of NewcastleCooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC-CARE), Faculty of Engineering and IT, University of Technology Sydney, Global Centre for Environmental Remediation (GCER), Faculty of Science & Information Technology, University of NewcastleCooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC-CARE), Ecotox Services Australasia Pty. Ltd., Centre for Environmental Sustainability, School of the Environment, University of Technology SydneyInstitute F. A. Forel, University of Geneva). Ecotoxicological Effects of an Arsenic

Remediation Method on Three Freshwater Organisms—*Lemna disperma, Chlorella* sp. CE-35 and *Ceriodaphnia* cf. *dubia.* Water, Air, & Soil Pollution, Volume, 226(2015): 411

Chemical methods have been used for the remediation of arsenic (As)-contaminated water; however, ecological consequences of these methods have not been properly addressed. The present study evaluated the effects of the Fe-oxide-coated sand (IOCS) remediation method on As toxicity to freshwater organisms (*Lemna disperma*, *Chlorella* sp. CE-35, and *Ceriodaphnia* cf. *dubia*). The As removal efficiency by IOCS decreased substantially with time. The IOCS remediation method was less effective at suppressing the toxicity of As^{V} than As^{III} to *L. disperma* but was highly effective in reducing both the As^{III} and As^{V} toxicity to *C.* cf. *dubia*. The growth of *Chlorella* sp. was significantly higher ($p < 0.05$) in remediated and pre-remediated water than in controls (non-As-contaminated filtered Colo River water) for As^{III}, while the opposite was observed for As^{V}, indicating that As^{V} is more toxic than As^{III} to this microalga. Although the IOCS can efficiently remove As from contaminated water, residual As and other constituents (e.g. Fe, nitrate) in the remediated water had a significant effect on freshwater organisms.

Keywords: Arsenic, Fe-oxide-coated sand (IOCS), Remediation, Ecotoxicological effect, Freshwater organisms

Sezar Gülbaz, Cevza Melek Kazezyılmaz-Alhan, Nadim K. Copty. (Civil Engineering Department, Istanbul University, Institute of Environmental Sciences, Boğaziçi University). Evaluation of Heavy Metal Removal Capacity of Bioretention Systems. Water, Air, & Soil Pollution, Volume, 226(2015): 376

Bioretention is one of the most common low-impact development (LID) types but there is lack of knowledge in the capacity and local behavior of bioretentions. In this study, laboratory-scale experiments are conducted in order to investigate the heavy metal removal capacity of bioretentions. Batch sorption experiments were first performed to determine the sorption parameters and retardation factor of copper (Cu), lead (Pb), and zinc (Zn) on various bioretention media, namely mulch, turf, vegetative soil, sand, and gravel. Reaction kinetics of Cu, Pb, and Zn were determined in order to assess the sorption equilibrium time of these metals for the five different bioretention media. The results of the batch tests show that turf has the highest sorption capacity followed by mulch and vegetative soil. For the range of concentrations considered in this study, linear sorption isotherm was found to best represent the metal sorption for all bioretention media. Metal removal percentages were highest for Pb and lowest for Zn. The time required to reach equilibrium ranged from 1 to 6 h depending on the type of bioretention media and metal. In addition to batch sorption experiments, column sorption experiments were also conducted in order to investigate effects of soil textures and organic content on removal of heavy metal in bioretention columns. For this purpose, four bioretention columns with different vegetative soil, turf, and sand ratios were prepared. The column tests were conducted for a period of 127 days under continuous boundary source, i.e., constant flow rate is supplied to each column with a concentration of 5 mg/L for each metal. Results show that different local soil types in bioretention design affect removal of heavy metal concentration considerably. Breakthrough analysis indicates that the removal of Zn reaches almost zero in about 127 days, while Cu and Pb are almost fully retained in all columns until the end of the experiment.

Keywords: Bioretention; Sorption; Column test; Batch test; Heavy metals; Low impact development

Fernanda Schmidt Silveira, Marisa Azzolini, Armando Molina Divan Jr. (Laboratório de Fitorremediação, Centro de Ecologia, Instituto de Biociências, UFRGS, Laboratório de Fitorremediação, Centro de Ecologia, Instituto de Biociências, UFRGS Departamento de Plantas de Lavoura, Faculdade de Agronomia, Laboratório de Bioindicação Vegetal, Centro de Ecologia). Scanning Cadmium Photosynthetic Responses of *Elephantopus mollis* for Potential Phytoremediation Practices. Water, Air, & Soil Pollution, Volume, 226(2015) : 359

Photosynthetic process is a good approach to discriminate cadmium-tolerant species, because it is reported as one of the most sensitive processes. Our goal was to measure *Elephantopus mollis* Kunth (Asteraceae) tolerance, determining the interference of Cd on the photosynthetic process. For this, a hydroponic experiment design was conducted in nutrition solution with concentrations of 0 (control), 10, 50, and 100 μM of cadmium (Cd). Measures of photosynthesis performance were obtained, for example, gas exchange, photosystem integrity, chlorophyll content, leaf growth rate, root length, and dry weight. In addition, cadmium and zinc concentrations were measured. Furthermore, results were linked to phytoremediation potential. Our specific questions were as follows: (1) Can the photosynthetic apparatus of *E. mollis* deal with cadmium stress? (2) Is *E. mollis* able to accumulate cadmium and maintain zinc level? (3) Is *E. mollis* a tolerant or sensitive species? (4) Can any phytoremediation practice be suggested from these results? Our results showed that *E. mollis* can deal with cadmium toxicity up to 10 μM Cd. Moreover, this plant is a potential hyperaccumulator, which can accumulate 248 mg Cd kg^{-1} dry weight. However, at concentrations of 50 and 100 μM Cd, this species was sensitive and cadmium toxicity affected both biochemistry and photochemistry phases of photosynthesis on account of negative changes on gas exchange, fluorescence chlorophyll, and chlorophyll content. Nevertheless, these results did not compromise the research about its tolerance at lower concentrations of cadmium.

Keywords: Cadmium tolerance; Photosynthesis; Hydroponic experiment; Phytoextraction

Sara Concas, Pierfranco Lattanzi, Gianluigi Bacchetta, Meri Barbafieri, Andrea Vacca. (Dipartimento di Scienze Chimiche e Geologiche, Università di Cagliari, Centro Conservazione Biodiversità (CCB), Dipartimento di Scienze della Vita e dell'Ambiente, Università di Cagliari, National Research Council-Institute of Ecosystem Study (CNR-ISE), Pisa Branch). Zn, Pb and Hg Contents of *Pistacia lentiscus* L. Grown on Heavy Metal-Rich Soils: Implications for Phytostabilization. Water, Air, & Soil Pollution, Volume, 226(2015): 340

In this study, we determined the metal (Zn, Pb and Hg) contents in epigean and hypogean organs of *Pistacia lentiscus* L., a Mediterranean native plant grown on heavy metal-rich soils of Iglesiente (southwestern Sardinia, Italy), in view of its perspective use for revegetation and phytostabilization of mine waste piles. Plant samples were collected from four different areas in the district. Metal contents in the different plant tissues are roughly dependent on their total and mobile (diethylene triamine penta acetic acid (DTPA)-extractable) contents in soil and are shown in the following ranges: 48–628 mg kg^{-1} (Zn), 2–354 mg kg^{-1} (Pb) and 13–530 μg kg^{-1} (Hg) and usually decrease in the following order: roots > stems > leaves; the apparent exception for Hg, with an order of leaves > stems, is ascribed to foliar absorption of this element. The biological concentration factors are consistently low (≤0.05) for all metals and support the concept that the strategy of metal tolerance of *P. lentiscus* is based on exclusion. These results

are consistent with most previous literature data, confirming that *P. lentiscus* is well suited for revegetation actions and could decrease metal mobility through the soil stabilization strategy.

Keywords: *Pistacia lentiscus;* Zinc; Lead; Mercury; Iglesiente; Sardinia

G. Hanumanth Kumar, J. Pramoda Kumari. (Department of Biotechnology, Sri Venkateswara University, Department of Microbiology, Sri Venkateswara University). Heavy Metal Lead Influative Toxicity and Its Assessment in Phytoremediating Plants—A Review. Water, Air, & Soil Pollution, Volume, 226(2015): 324

The purpose of this review is to describe how plants take up lead and its distribution to plant parts, morphological, physiological, and biological effects of lead on plants, sequestration strategies, and tolerance mechanisms including detoxification. How lead despite its lack of essential function in plants, causes phytotoxicity by changing cell membrane permeability, by reacting with active groups of different enzymes involved in plant metabolism by reacting with the phosphate groups of adenosine diphosphate (ADP) or adenosine-5′-triphosphate (ATP). Moreover, we also address role of hyperaccumulating plants in lead absorption. How synthetic chelators such as ethylenediaminetetraacetic acid (EDTA) enhances the availability of heavy metal lead in soils and increase phytoextraction efficiency in aboveground harvestable plant parts through enhancing the metal solubility and translocation from roots to shoots, metal tolerance, and future prospectives to decrease lead pollution.

Keywords: Detoxification; Synthetic chelators; Plant metabolism; Hyperaccumulating plants

Dafne Q. Waszak, Ana Cristina B. da Cunha, Marcio R. A. Agarrallua, Cristine S. Goebel, Carlos H. Sampaio. (Mineral Processing Laboratory, Federal University of Rio Grande do Sul, Federal University of Health Sciences of Porto Alegre, Chromatography Laboratory, Center for Technology and Innovation). Bioremediation of a Benzo[a]Pyrene-Contaminated Soil Using a Microbial Consortium with *Pseudomonas aeruginosa, Candida albicans, Aspergillus flavus,* and *Fusarium* sp. Water, Air, & Soil Pollution, Volume, 226(2015): 319

Many studies have been conducted regarding the degradation of PAHs. One of the technologies that has been widely used is bioremediation due to its relatively low cost and greater efficiency for those compounds with structural complexity. Biotechnology has been used in several countries for many years and consists in the use of microorganisms (bacteria and fungi) to transform contaminants into inert substances, which is a result of the microbial activity from biochemical processes. This study aimed to develop a bioremediation methodology for the pollutant benzo[a]pyrene (B[a]P), which belongs to the group of PAHs. The potential use of a microbial consortium with *Pseudomonas aeruginosa, Candida albicans, Aspergillus flavus,* and *Fusarium* sp. for bioremediation was assessed. To confirm the pollutant reduction, quantifications of the samples were performed via gas chromatography–mass spectrometry (GC-MS). The contamination was prepared with a soil previously contaminated with B[a]P at the concentration of 3.74 mg kg^{-1}. The microbial consortium was added (16 μL g^{-1}), and samples were incubated for 42 days in an oven at 35 °C. The microbial growth curves showed representative differences between the samples in the presence and absence of the pollutant, demonstrating the possibility of bioremediation process. The final quantification of soil showed a mean concentration of 1.29 mg kg^{-1}, showed that 65.51 ± 0.95 % of the pollutant was degraded, which is an important and representative performance.

Keywords: Bioremediation; Microbial consortium; Benzo[a]pyrene; Contaminated soil

Sara Yavari, Amirhossein Malakahmad, Nasiman B. Sapari. (Department of Civil and Environmental Engineering, Universiti Teknologi PETRONAS). A Review on Phytoremediation of Crude Oil Spills. Water, Air, & Soil Pollution, Volume, 226(2015): 279

Changes in crude oil production and distribution have increased the incidence of oil spills throughout the world. Oil spills often cause destructive effects on aquatic and land ecosystems. The oil spill cleanup and recovery techniques are challenging and usually involve complex mechanical, chemical, and biological methods. Usually, mechanical removal of free oil is utilized as an effective strategy for cleanup in aquatic and terrestrial environments; however, they are expensive and need specialist personnel and equipment. The other commonly used method is the application of chemical materials such as dispersants, cleaners, demulsifiers, biosurfactants, and soil oxidizers. Nevertheless, these reagents can have potential harmful environmental impacts, which may limit their application. As an alternative, bioremediation can offer reduced environment risk; however, the limitations of microbial activity in the soil can make this option unsuitable. One area of bioremediation is phytoremediation, which offers potential for restoring large areas of contaminated ground. Plants are able to remove pollutants through processes such as biodegradation, phytovolatilization, accumulation, and metabolic transformation. This review presents the fate of crude oil spills in aquatic and land ecosystems and their environmental effects. Furthermore, the paper focuses on crude oil phytoremediation and its applications in polluted ecosystems.

Keywords: Petroleum hydrocarbon; Pollution fate; Environmental effects; Bioremediation; Plant species

Sandeep Panda[a], Jacintha Esther[a, b], Tilothama Bhotra[c], Nilotpala Pradhan[a, b], Lala Behari Sukla[a, b], Barada Kanta Mishra[a, b], Ata Akcil[d]. ([a] Department of Bioresources Engineering, CSIR, Institute of Minerals and Materials Technology (IMMT), Bhubaneswar 751013, India, [b] Academy of Council of Scientific and Innovative Research (AcSIR), CSIR, Institute of Minerals and Materials Technology (IMMT), Bhubaneswar 751013, India, [c] Institute of Life Sciences (ILS), Bhubaneswar 751023, India, [d] Mineral–Metal Recovery and Recycling (MMR&R) Research Group, Mineral Processing Division, Department of Mining Engineering, Suleyman Demirel University, TR32260 Isparta, Turkey). Sequential bioreduction–bioleaching and bioreduction–chemical leaching hybrid tests for enhanced copper recovery from a concentrator ball mill reject sample. Hydrometallurgy, Volume 157(2015): 171–177

Dumping of poor but metal containing industrial waste is associated with several environmental issues. Exposure of these wastes to the natural environment offers serious concerns for the mineral processing industries to utilize them for metal recovery and check environmental pollution. In the present study, a novel sequential bioreduction–bioleaching and bioreduction–chemical leaching route as a hybrid process is compared and discussed for the enhanced recovery of copper from an industrial concentrator plant ball milling unit rejected sample. A mixed consortium of metal reducing bacteria (DMRB) initially adapted to high Fe(III) concentrations was found to cause mineralogical/matrix alteration (possibly silicate weathering) including Fe(III) bioreduction in the sample and dissolute 29.73% copper during the first 35 days under facultative anaerobic conditions. Sequential leaching of the bioreduced waste sample (generated from the first step) using a mixed meso-acidophilic bacterial consortium predominantly *Acidithiobacillus ferrooxidans* showed additional 28.72% copper dissolution

within 2 days using 1 gL^{-1} Fe(II). On the other hand, a comparative chemical leaching of the same bioreduced sample using 0.5 M H_2SO_4 yielded additional 32.17% copper within 4 days of leaching and indicated better performance than the bioleaching tests.

Keywords: Industrial waste; Ball mill reject; Bioreduction; Bioleaching; Chemical leaching; Copper

Tariq M. Bhatti[1]. (Department of Molecular Biology, Umeå University, SE-901 87 Umeå, Sweden, Department of Chemical Engineering, Pakistan Institute of Engineering and Applied Sciences (PIEAS), P.O. Nilore, 45650 Islamabad, Pakistan). Bioleaching of organic carbon rich polymetallic black shale. Hydrometallurgy, Volume 157(2015): 246–255

The present study describes the extraction of metals from organic-carbon rich Kyrk Tåsjö (Sweden) polymetallic black shale using mixed cultures of acidophilic iron- and sulfur-oxidizing microorganisms. Quartz, illite, microcline, calcite, dolomite and pyrite minerals were present in shale matrix. Black shale contained 10.77% organic carbon as kerogen and 1.16% inorganic carbon (graphite). The leaching experiments were performed in shake flasks and stirred tank reactors with and without acidophilic Fe- and S-oxidizing psychrotolerant, mesophile and moderate thermophile strains at 6, 30 and 45 °C. Biological oxidation of pyrite generated sulfuric acid and ferric sulfate in leach solutions during leaching process. Microbial leaching solubilized 80–90% of the total metals (U, Cu, Ni, Mn, Mo, Y and Zn) after 15–20 days of bioleaching at 30 and 45 °C; whereas metal solubilization was slower with acidophilic psychrotolerant bacteria at 6 °C. The biodegradation of kerogen released tetradecane ($CH_3(CH_2)_{12}CH_3$), a long-chain aliphatic hydrocarbon compound and several other un-identified hydrocarbons in leach solutions during bioleaching of black shale. The addition of PO_4^{3-} and NH_4^+ in the growth medium during bioleaching had no effect or decreased the metal solubilization, suggesting that the microorganisms obtained these nutrients from the minerals and kerogen ($C_{100}H_{112}O_9N_2S_5$), a nitrogenous hydrocarbon compound present in the shale matrix. Metal dissolution from black shale was mainly attributed to the acid concentration in leach solution and temperature. The leaching data demonstrate the feasibility of extracting metals from the black shale without additional nutrient supply that constitute a cost saving for commercial scale application of bioleaching process. The bioleaching approach does not appear warranted to view of the low concentrations, albeit relatively high recoveries of valuable metals from the black shale. The leaching data indicate that exposed black shale occurrences, being subject to ambient weather conditions, constitute a long term environmental challenge.

Keywords: Bioleaching; Polymetallic black shale; Kerogen; Uranium; Tetradecane; Acidophilic psychrotolerant

Hong-chang Liu[a, b], Jin-lan Xia[a, b], Zhen-yuan Nie[a, b]. ([a] School of Minerals Processing and Bioengineering, Central South University, Changsha 410083, China, [b] Key Lab of Biometallurgy of Ministry of Education of China, Central South University, Changsha 410083, China). Relatedness of Cu and Fe speciation to chalcopyrite bioleaching by *Acidithiobacillus ferrooxidans.* Hydrometallurgy, Volume 156(2015): 40–46

The relatedness of copper and iron speciation to chalcopyrite bioleaching by acidophilic *Acidithiobacillus ferrooxidans* was analyzed by synchrotron radiation-based X-ray diffraction (SR-XRD) and Cu, Fe K-edge X-ray absorption near edge structure (XANES) spectroscopy, accompanying with the determination of leaching parameters and the observation of chalcopyrite

surface modification by scanning electron microscopy. The results showed that chalcopyrite was leached gradually by *A. ferrooxidans*, with ~ 70.58% of Cu^{2+} dissolution after 30 days of bioleaching when the mineral surface was evidently attacked. During the bioleaching, bornite and chalcocite were detected at day 3 and day 9 when the redox potential was less than 500 mV, but they disappeared at day 18 and day 30 when covellite was detected and the redox potential was about 550 mV. The linear fitting of Cu and Fe XANES spectra quantitatively demonstrated the composition of leaching residue: the copper species comprised ~ 84.8% of chalcopyrite, ~ 10.2% of bornite and ~ 5.0% of chalcocite at day 3, then changed to ~ 90.1% of chalcopyrite, ~ 6.5% of bornite and ~ 3.4% of chalcocite at day 9; the composition became ~ 89.8% of chalcopyrite and ~ 10.2% of covellite at day 18, and ~ 80.3% of chalcopyrite and ~ 19.7% of covellite at day 30. The iron species comprised ~ 26% of chalcopyrite and ~ 74% of jarosite at day 30. Elemental sulfur and jarosite were detected from day 3 but without evident negative effect on the copper extraction.

Keywords: Bioleaching; Chalcopyrite; SR-XRD; XANES; *Acidithiobacillus ferrooxidans*

Shalini Srivastava[a], S.B. Agrawal[a], M.K. Mondal[b]. ([a] Department of Botany, Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India, [b] Department of Chemical Engineering and Technology, Indian Institute of Technology (Banaras Hindu University), Varanasi 221005, Uttar Pradesh, India). **Biosorption isotherms and kinetics on removal of Cr(VI) using native and chemically modified *Lagerstroemia speciosa* bark. Ecological Engineering, Volume 85(2015): 56–66**

The contamination of drinking and irrigation water with Cr(VI) ion is a recurring challenge, especially in developing countries. In the present study, feasibility of the native and chemically modified bark of *Lagerstroemia speciosa* (Pride of India) as biosorbent to remove Cr(VI) from synthetic wastewater was examined. Characterization of the native*L. speciosa* bark (NLSB) and chemically modified *L. speciosa* bark (CLSB) was performed by elemental analysis, SEM and FTIR spectroscopy. The adsorption of Cr(VI) ions was examined with respect to initial pH of the adsorbate, initial Cr(VI) ion concentration, biosorbent dose, biosorbent size and temperature. The applicability of pseudo second order kinetics was indicated by both the biosorbents in the process of Cr(VI) removal. Langmuir, Freundlich, D–R and Temkin isotherm models were studied. The Freundlich and Temkin isotherms showed high correlation coefficient for adsorption of Cr(VI) on NLSB and CLSB, respectively and revealed the presence of multi adsorption mechanism in biosorption process. The negative value of $\Delta G°$ indicated spontaneous nature of the biosorption process and positive value of $\Delta H°$ concluded favorable Cr(VI) ion removal at high temperature.

Keywords: *Lagerstroemia speciosa* bark; Biosorption isotherm; Wastewater treatment; Kinetics; Thermodynamics

Hugo R. Sindelar, Jake N. Yap, Treavor H. Boyer, Mark T. Brown. (Department of Environmental Engineering Sciences, University of Florida, P.O. Box 116450, Gainesville, FL 32611-6450, USA). **Algae scrubbers for phosphorus removal in impaired waters. Ecological Engineering, Volume 85(2015): 144–158**

Algae scrubbers are a developing technology used for nutrient removal from many different impaired waters, including: agricultural runoff, wastewater, and animal operation waste. Algae thrive in environments with high flow velocities, allowing treatment of large volumes of nutrient-rich water. This adaptation helps overcome space issues associated with other biological treatment systems. Although algae scrubbers have shown promise for recovering phosphorus (P), no detailed studies have been completed to research conditions for maximum total P (TP)

removal. Previous studies have suggested that faster flow rates and pulsed inflow conditions are necessary for high biomass production. Studies have also theorized that the calcium-phosphorus (Ca-P) co-precipitation is the driving TP removal mechanism. As a result, the goal of this study was to determine the effect of the following operating parameters on TP removal: (1) flow rate, (2) pulsed versus constant inflow, (3) calcium addition to inflow water, (4) calcium seed addition, and (5) 24-h versus 12-h operation. Results show that 12-h operation significantly increases TP removal in algae scrubber systems from an average of 24 $g/m^2/y$ to 52 $g/m^2/y$. The high TP removal rate can be attributed to the stabilization of Ca-P minerals during 12-h operation. Algal photosynthesis increases daytime pH values (9–9.5) driving Ca-P co-precipitation, and 12-h operation prevents these minerals from re-dissolving at night as the pH decreases back to neutral (7–7.5). The maintenance of an algal seed on the scrubbers significantly decreased the amount of time necessary between harvests, increasing algal productivity.

Keywords: Algae scrubber; Calcium; Phosphorus; Co-precipitation; Biological treatment; Nutrient removal

Reshma A. Chirakkara, Krishna R. Reddy. (University of Illinois at Chicago, Department of Civil and Materials Engineering, 842 West Taylor Street, Chicago, IL 60607, United States). **Biomass and chemical amendments for enhanced phytoremediation of mixed contaminated soils. Ecological Engineering, Volume 85(2015): 265–274**

Pot experiments were conducted to investigate the impact of biomass amendments (biochar, compost and nutrient solution) and chemical amendments (Ethylenediaminetetraacetic acid (EDTA) and Igepal CA-720) on the phytoremediation of soil co-contaminated with organic and metal contaminants by *Helianthus annuus*(sunflower) and *Avena sativa* (oat plant). Mixed contaminated soil was prepared by mixing clean soil with naphthalene, phenanthrene, lead (Pb), cadmium (Cd), and chromium (Cr). To study the biomass amendments, soil was amended with biochar, compost, or a nutrient solution. To study chemical amendments, plants raised in contaminated soils were amended with a solution of EDTA, Igepal CA-720 or both. The combination of biomass and chemical amendments were studied by treating composted soil with either EDTA or Igepal CA-720. The results showed that the biochar and compost amendments improved the growth characteristics and biomass of the plants. Growth improvement was best observed for sunflower plants in composted soil. Average maximum plant height of sunflower in contaminated soil was increased by 115% with the addition of compost. Cd and Pb removal was best in the presence of biochar and compost amendments, but Cr removal was unaffected by the use of amendments. The best removal rate was observed for Pb by oat plant in compost amended soil, with average final Pb concentration decreased by 57.8% with the addition of compost to soil. Nutrient solution amendment did not improve the removal of the metal contamination from the soil. The overall growth and biomass were less for plants grown in soil that was treated with chemical amendments. A combination of compost and chemical amendments also did not provide positive results on the plant growth or contaminant dissipation. Polycyclic aromatic hydrocarbon (PAH) degradation improved in the presence of all of the amendments studied. The results suggest that biochar and compost amendments can improve the plant growth characteristics and enhance phytoremediation of mixed contaminated soils.

Keywords: Phytoremediation; Mixed contamination; Amendments; Biochar; Compost; EDTA; Igepal CA-720

Hugo E. de Jesus, Raquel S. Peixoto, Juliano C. Cury, Jan D. van Elsas, Alexandre S. Rosado. (LEMM—Laboratório de Ecologia Microbiana Molecular–Instituto de Microbiologia Paulo de Góes (IMPG), Universidade Federal do Rio de Janeiro, Molecular Microbiology Laboratory, CSL/Universidade Federal de São João Del Rei, Microbial Ecology Department, University of Groningen). Evaluation of soil bioremediation techniques in an aged diesel spill at the Antarctic Peninsula. Applied Microbiology and Biotechnology, Volume 99(24) (2015): 10815-10827

Many areas on the Antarctic continent already suffer from the direct and indirect influences of human activities. The main cause of contamination is petroleum hydrocarbons because this compound is used as a source of energy at the many research stations around the continent. Thus, the current study aims to evaluate treatments for bioremediation (biostimulation, bioaugmentation, and bioaugmentation + biostimulation) using soils from around the Brazilian Antarctic Station "Comandante Ferraz" (EACF), King George Island, Antarctic Peninsula. The experiment lasted for 45 days, and at the end of this period, chemical and molecular analyses were performed. Those analyses included the quantification of carbon and nitrogen, denaturing gradient gel electrophoresis (DGGE) analysis (with gradient denaturation), real-time PCR, and quantification of total hydrocarbons and polyaromatics. Molecular tests evaluated changes in the profile and quantity of the *rrs* genes of archaea and bacteria and also the *alk*B gene. The influence of the treatments tested was directly related to the type of soil used. The work confirmed that despite the extreme conditions found in Antarctic soils, the bacterial strains degraded hydrocarbons and bioremediation treatments directly influenced the microbial communities present in these soils even in short periods. Although the majority of the previous studies demonstrate that the addition of fertilizer seems to be most effective at promoting bioremediation, our results show that for some conditions, autochthonous bioaugmentation (ABA) treatment is indicated. This work highlights the importance of understanding the processes of recovery of contaminated environments in polar regions because time is crucial to the soil recovery and to choosing the appropriate treatment.

Keywords: Soil; Bioremediation; Antarctica; Diesel

Jie Liu, Shaohua Chen, Jie Ding, Ying Xiao, Haitao Han. (Key Laboratory of Natural Pesticide and Chemical Biology, Ministry of Education, and Lab of Insect Toxicology, South China Agricultural University, Guangdong Province Key Laboratory of Microbial Signals and Disease Control, South China Agricultural University). Sugarcane bagasse as support for immobilization of *Bacillus pumilus* HZ-2 and its use in bioremediation of mesotrione-contaminated soils. Applied Microbiology and Biotechnology, Volume 99(24) (2015): 10839-10851

The degrading microorganisms isolated from environment usually fail to degrade pollutants when used for bioremediation of contaminated soils; thus, additional treatments are needed to enhance biodegradation. In the present study, the potential of sugarcane bagasse as bacteria-immobilizing support was investigated in mesotrione biodegradation. A novel isolate *Bacillus pumilus* HZ-2 was applied in bacterial immobilization, which was capable of degrading over 95 % of mesotrione at initial concentrations ranging from 25 to 200 mg L^{-1} within 4 days in flask-shaking tests. Scanning electron microscope (SEM) images showed that the bacterial cells were strongly absorbed and fully dispersed on bagasse surface after immobilization. Specially, 86.5 and 82.9 % of mesotrione was eliminated by bacteria immobilized on bagasse of 100 and 60 mesh, respectively, which indicated that this immobilization was able to maintain a high degrading activity of the bacteria. Analysis of the degradation products determined 2-amino-4-

methylsulfonylbenzoic acid (AMBA) and 4-methylsulfonyl-2-nitrobenzoic acid (MNBA) as the main metabolites in the biodegradation pathway of mesotrione. In the sterile soil, approximately 90 % of mesotrione was degraded after supplementing 5.0 % of molasses in bacteria-bagasse composite, which greatly enhanced microbial adaptability and growth in the soil environment. In the field tests, over 75 % of mesotrione in soil was degraded within 14 days. The immobilized preparation demonstrated that mesotrione could be degraded at a wide range of pH values (5.0–8.0) and temperatures (25–35 °C), especially at low concentrations of mesotrione (5 to 20 mg kg^{-1}). These results showed that sugarcane bagasse might be a good candidate as bacteria-immobilizing support to enhance mesotrione degradation by *Bacillus p.* HZ-2 in contaminated soils.

Keywords: Sugarcane bagasse; Immobilization; Mesotrione; Metabolites; Bioremediation

Aura O. Nousiainen, Katarina Björklöf, Sneha Sagarkar, Jeppe Lund Nielsen, Atya Kapley, Kirsten S. Jørgensen. (Finnish Environment Institute, Environmental Genomics Division, National Environmental Engineering Research Institute, Department of Chemistry and Bioscience, Aalborg University). **Bioremediation strategies for removal of residual atrazine in the boreal groundwater zone. Applied Microbiology and Biotechnology, Volume 99(23) (2015): 10249-10259**

Strategies for bioremediation of atrazine, a pesticide commonly polluting groundwater in low concentrations, were studied in two boreal nonagricultural soils. Atrazine was not mineralized in soil without bioremediation treatments. In biostimulation treatment with molasses, up to 52 % of atrazine was mineralized at 10 °C, even though the degradation gene copy numbers did not increase. Incubations with radioactively labeled atrazine followed by microautoradiographic analysis revealed that bioremediation strategies increased the relative proportion of active degraders from 0.3 up to 1.9 % of the total bacterial count. These results indicate that atrazine degradation might not solely be facilitated by *atzA*/*trzN*–*atzB* genes. In combined biostimulation treatment using citrate or molasses and augmentation with *Pseudomonas citronellolis* ADP or *Arthrobacter aurescens* strain TC1, up to 76 % of atrazine was mineralized at 30 °C, and the atrazine degradation gene numbers increased up to 10^7 copies g^{-1} soil. Clone libraries from passive samplers in groundwater monitoring wells revealed the presence of phylogenetic groups formerly shown to include atrazine degraders, and the presence of atrazine degradation genes *atzA* and *atzB*. These results show that the mineralization of low concentrations of atrazine in the groundwater zone at low temperatures is possible by bioremediation treatments.

Keywords

Atrazine degradation; Bioremediation; Quantitative PCR; Micro autoradiography; ^{14}C-mineralization

Ying Jiang[a], Mei Lei[b], Lunbo Duan[c], Philip Longhurst[a]. ([a] Centre for Bioenergy & Resource Management, School of Energy, Environment & Agrifood, Cranfield University, Cranfield, MK43 0AL, UK, [b] Centre for Environmental Remediation, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, 100101, China, [c] Key Laboratory of Energy Thermal Conversion and Control, Ministry of Education, School of Energy and Environment, Southeast University, Nanjing, 210096, China). **Integrating phytoremediation with biomass valorisation and critical**

element recovery: A UK contaminated land perspective. Biomass and Bioenergy, Volume 83(2015): 328–339

In the UK, the widespread presence of elemental contaminants such as arsenic and nickel in contaminated sites and more widely release of platinum group metals into the biosphere are growing concerns. Phytoremediation has the potential to treat land contaminated with these elements at low cost. An integrated approach combining land remediation with post-process biomass to energy conversion and high value element recovery is proposed to enhance the financial viability of phytoremediation.

An analytical review of plant species suitable for the phytoremediation of nickel, Arsenic and platinum group metals is reported. Additionally, a preliminary model is developed to assess the viability of the proposed approach. A feasibility appraisal using Monte Carlo simulation to analyse project risk suggests high biomass yield plant species can significantly increase the confidence of achieving financial return from the project. The order of financial return from recovering elements was found to be: Ni > Pt > As.

Keywords: Phytoremediation; Elemental contaminant; Biomass to energy; Monte carlo simulation; Risk analysis

Dae-Jung Kang, Jong-Hyuk Im, Jae-Hoon Kang, Kyoung Heon Kim. ([1]Department of Biotechnology, Graduate School, Korea University, Seoul, 136-713, Republic of Korea). Bioconversion of vitamin D_3 to calcifediol by using resting cells of *Pseudonocardia* sp. Biotechnology Letters, Volume 37(9) (2015): 1895-1904

Resting cells of *Pseudonocardia* sp. KCTC 1029BP were used for the bioconversion of vitamin D_3 to calcifediol which is widely used to treat osteomalacia and is industrially produced by chemical synthesis.

To obtain the maximum bioconversion yield of calcifediol by the microbial conversion of vitamin D_3, a two-step optimization process was used, including the Plackett–Burman and the central composite designs. Six variables, namely agitation speed, aeration rate, resting cell concentration, vitamin D_3 concentration, temperature, and pH, were monitored. Of these, aeration rate, resting cell concentration, and temperature were selected as key variables for calcifediol production and were optimized using the central composite design. Optimal bioconversion conditions obtained were as follows: aeration rate of 0.2 vvm, resting cell concentration of 4.7 % w/v, and temperature of 33 °C.

Using the optimal conditions, 356 mg calcifediol l^{-1} was obtained with a bioconversion yield of 59.4 % in a 75 l fermentor. These are the highest values reported to date.

Keywords: Bioconversion; Calcifediol; Central composite design; Plackett–Burman design; *Pseudonocardia* sp.; Vitamin D_3

Yue Zhao, Gui Fang Zhong, Xue Peng Yang , Xian Mei Hu, Duo Bin Mao, Yu Ping Ma. ([1]School of Food and Biological Engineering, Zhengzhou University of Light Industry, Zhengzhou, 450002, China). Bioconversion of lutein to form aroma compounds by *Pantoea dispersa.* Biotechnology Letters, Volume 37(8) (2015): 1687-1692

To investigate the conversion of lutein, a carotenoid, to aroma compounds by *Pantoea dispersa* Y08, a lutein-degrading bacterium isolated from marigold flower residue. Bioconversion conditions, including substrate concentration, applied co-solvent and reaction time, were optimized.

A maximum biodegradation yield of 80 % for lutein at 10 g/l was achieved. The intermediate, 3-hydroxy-β-ionone, and final β-ionone products were revealed by GC–MS. A bioconversion pathway of lutein is proposed to involve cleavage at the 9–10 double bond position, followed by de-hydroxylation at the 3-hydroxy position.

This is the first report of the ability of a bacterium, *P. dispersa*, to sequentially convert lutein to 3-hydroxy-β-ionone and then β-ionone.

Keywords: Bioconversion; Carotenoids; 3-Hydroxy-β-ionone ; β-Ionone ; Lutein; *Pantoea dispersa*

Festus Anasonye[a] , Erika Winquist[b], Markus Räsänen[b], Jussi Kontro[a], Katarina Björklöf[c], Galina Vasilyeva[d], Kirsten S. Jørgensen[c], Kari T. Steffen[a], Marja Tuomela[a]. ([a]Department of Food and Environmental Sciences, University of Helsinki, P.O. Box 56, FI-00014 University of Helsinki, Finland, [b] Department of Biotechnology and Chemical Technology, Aalto University School of Chemical Technology, P.O. Box 16100, FI-00076 Aalto, Finland, [c] Finnish Environment Institute, P.O. Box 140, FI-00251 Helsinki, Finland, [d] Institute of Physico-chemical and Biological Problems in Soil Science, RAS Institutskaja st., Bldg 2, Pushchino Moscow region, 1422290, Russia). **Bioremediation of TNT contaminated soil with fungi under laboratory and pilot scale conditions. International Biodeterioration & Biodegradation, Volume 105(2015): 7–12**

Bioremediation of contaminated soil involves the utilization of innovative technology such as mycoremediation. The capability of fungi to grow in 2,4,6-trinitrotoluene (TNT) contaminated soil, to produce lignin modifying enzymes and to degrade TNT in soil was studied. White-rot fungi, namely *Gymnopilus luteofolius*, *Kuehneromyces mutabilis*, and *Phanerochaete velutina*, were incubated with TNT contaminated non-sterile soil (1000 mg kg^{-1}). All the fungi produced high amounts of manganese peroxidase (MnP) in TNT contaminated soil, but no laccase. The most efficient fungus, *P. velutina*, degraded 80% of TNT in 2.5 months and was selected for further scale-up experiment with 0.3 t (0.56 m^3) of soil and inoculum soil ratio of 1:30. The degradation of TNT was 70% in 49 days, and production of fungal metabolites, namely 4-amino-2,6-diaminotoluene and 2-amino-4,6-diaminotoluene was only 1% of the original TNT concentration. These metabolites were degraded to less than 0.5% during the following 58 days incubation. Fungal remediation process was scaled-up with *P. velutina*, which tolerated high concentration of TNT and was able to invade the whole mass of soil with only 10 kg of fungal inoculum growing on pine bark. With these parameters the process should be easy to scale-up for soil treatment in field.

Keywords: Bioremediation; Fungi; *Phanerochaete velutina*; Trinitrotoluene; Contaminated soil; Pilot-scale

N. Sakthipriya[a], Mukesh Doble[b], Jitendra S. Sangwai[a]. ([a] Flow Assurance Laboratory, Petroleum Engineering Program, Department of Ocean Engineering, Indian Institute of Technology Madras, Chennai, 600 036, India, [b] Bio Engineering Laboratory, Department of Biotechnology, Indian Institute of Technology Madras, Chennai, 600 036, India). **Action of biosurfactant producing thermophilic *Bacillus subtilis* on waxy crude oil and long chain paraffins. International Biodeterioration & Biodegradation, Volume 105(2015): 168–177**

The study has been carried out to investigate the production of biosurfactant by a thermophilic strain of *Bacillus subtilis* on various hydrocarbon substrates, such as waxy crude oil, model

crude oil and six long chain paraffins ($C_{16}H_{34}$ to $C_{36}H_{74}$) at 35, 50 and 75 °C. Model crude oil represents the mixture of the six long chain paraffins. The maximum biosurfactant production has been found to occur at 50 °C with n-hexadecane ($C_{16}H_{34}$) as a substrate. It has also been inferred that the physico-chemical properties of the biosurfactant is reduced with an increase in carbon number in the hydrocarbon substrate. Biosurfactant production is observed to be higher in the presence of waxy crude oil than the model crude oil, which is due to the presence of short chain paraffins with fewer carbon numbers in the former. *B. subtilis* in the presence of waxy crude oil has been observed to show high microbial adherence, improved surface tension reduction and emulsification activity, production of higher amount of biosurfactant 'surfactin', and improved biosurfactant stability upto 120 °C at 10 MPa, 10% (w/v) salinity and pH 8–14. This indicates the potential of microorganism in tackling oil-spill, wax degradation, flow assurance and enhanced oil recovery.

Keywords: *Bacillus subtilis*; Biosurfactant; Long chain paraffin; Model crude oil; Surface tension; Waxy crude oil

Hirak R. Dash, Surajit Das. (Laboratory of Environmental Microbiology and Ecology (LEnME), Department of Life Science, National Institute of Technology, Rourkela, 769 008, Odisha, India). Bioremediation of inorganic mercury through volatilization and biosorption by transgenic *Bacillus cereus* BW-03($_p$PW-05). International Biodeterioration & Biodegradation, Volume 103(2015): 179–185

A transgenic bacterium *Bacillus cereus* BW-03($_p$PW-05) was constructed by transforming a plasmid harbouring *mer* operon of a marine bacterium *Bacillus thuringiensis* PW-05 into another mercury resistant marine bacterium *B. cereus* BW-03 with mercury biosorption capability. The transformant was able to remove >99% of mercury supplement *in-vitro* by simultaneous volatilization (>53%) and biosorption (~40%). Encapsulation of the transformant increased its mercury removal potential to almost 100%. Additionally, *B. cereus* BW-03($_p$PW-05) could resist wide variations of salinity (5–30 ppt), pH (Brierley et al., 1989; Chung et al., 1989; Chen and Wilson, 1997; Chakraborty and Das, 2014) and mercury (5–50 ppm) and survived in mercury contaminated simulated environment up to 7 days. –SH and –COOH groups were possibly involved for mercury biosorption under laboratory conditions. The potential for application of this transgenic bacterium for *in-situ* bioremediation was demonstrated in a microcosm experiment, where it removed 96.4% inorganic mercury synergistically with the normal microbiota.

Keywords: Transformation; *mer* operon; Inorganic mercury; Biosorption; Volatilization

Erika J. Espinosa-Ortiz[a], Eldon R. Rene[a], Eric D. van Hullebusch[b], Piet N.L. Lens[a]. ([a]UNESCO-IHE Institute for Water Education, P.O. Box 3015, 2601 DA Delft, The Netherlands, [b] Université Paris-Est, Laboratoire Géomatériaux et Environnement (EA 4508), UPEM, 77454 Marne-la-Vallée, France). Removal of selenite from wastewater in a *Phanerochaete chrysosporium* pellet based fungal bioreactor. International Biodeterioration & Biodegradation, Volume 102(2015): 361–369

The performance of a novel fungal bioreactor system containing pellets of *Phanerochaete chrysosporium* was investigated in a continuously operated bioreactor for 41 days to remove selenite (SeO_3^{2-}SeO32−) from synthetic wastewater. These fungal pellets were produced *in situ* under batch conditions during 4 days of incubation in the presence of SeO_3^{2-}SeO32− (10 mg Se L^{-1}, 5 g glucose L^{-1}, pH-4.5). Subsequently, the system was continuously fed with SeO_3^{2-}SeO32− at selenium and glucose loading rates of 10 mg Se $L^{-1}d^{-1}$ and 0.95 g glucose L^{-1} d^{-1}, respectively, and a hydraulic retention time of 24 h. After achieving steady-state

removal profiles (8 days, ∼70% removal from 10 mg Se $L^{-1}d^{-1}$), the biomass was partially removed, once every 4 days, in order to limit the excessive growth of the fungus. Afterwards, the fungal pelletized reactor was tested for its response to an increase in the SeO_3^{2-}SeO32− loading rate from 10 to 20 mg Se $L^{-1}d^{-1}$. During this phase (8 days), although there was a declining trend in the removal of SeO_3^{2-}SeO32−, the bioreactor showed good resilience to the doubled SeO_3^{2-}SeO32− concentration. The bioreactor was further subjected to intermittent spikes of SeO_3^{2-}SeO32− (30–50 mg Se L^{-1}) once every 4 days. The bioreactor showed a good adaptability and flexibility by recovering to every intermittent spike of SeO_3^{2-}SeO32−, achieving ∼70% total soluble Se removal from the continuous Se loading rate (10 mg Se $L^{-1}d^{-1}$). The presence of SeO_3^{2-}SeO32− influenced the morphology of the fungal pellets, and assisted in controlling excess biomass growth. This study shows that fungal bioreactors can handle fluctuating loads of aqueous-phase SeO_3^{2-}SeO32−, while simultaneously offering the possibility to synthesize elemental selenium under long-term operations.

Keywords: Selenium removal; Fungal pellets; Upflow bioreactor; *Phanerochaete chrysosporium*

Ernest Marco-Urrea[1], Inmaculada García-Romera[2], Elisabet Aranda[2, 3]. ([1] Department of Chemical Engineering, School of Engineering, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain, [2] Department of Soil Microbiology and Symbiotic Systems, Estación Experimental del Zaidín, CSIC Granada, Spain). **Potential of non-ligninolytic fungi in bioremediation of chlorinated and polycyclic aromatic hydrocarbons. New Biotechnology, Volume 32(6) (2015): 620–628**

In previous decades, white-rot fungi as bioremediation agents have been the subjects of scientific research due to the potential use of their unspecific oxidative enzymes. However, some non-white-rot fungi, mainly belonging to the Ascomycota and Zygomycota phylum, have demonstrated their potential in the enzymatic transformation of environmental pollutants, thus overcoming some of the limitations observed in white-rot fungi with respect to growth in neutral pH, resistance to adverse conditions and the capacity to surpass autochthonous microorganisms. Despite their presence in so many soil and water environments, little information exists on the enzymatic mechanisms and degradation pathways involved in the transformation of hydrocarbons by these fungi. This review describes the bioremediation potential of non-ligninolytic fungi with respect to chlorinated hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) and also shows known conversion pathways and the prospects for future research.

A. Álvarez, C. S. Benimeli, J. M. Saez, A. Giuliano, M. J. Amoroso. (Unidad de Administración Territorial, Centro Científico Tecnológico (CCT), CONICET-TucumánUniversidad del Norte Santo Tomás de Aquino (UNSTA). **Lindane removal using *Streptomyces* strains and maize plants: a biological system for reducing pesticides in soils. Plant and Soil, Volume 395(1) (2015): 401-413**

Plants and contaminant-degrading microbes are a suitable combination for the remediation of pesticides. The aim of this study was to evaluate the effectiveness of *Streptomyces* strains cultured with maize plants in relation to lindane removal.

Four *Streptomyces* strains were cultured and added as both single and mixed cultures, along with maize plants, to artificially polluted hydroponic systems and soils. The effectiveness of the

resulting soil bioremediation was then evaluated through phytotoxicity testing using lettuce seedlings. In the hydroponic and soil experiments, similar levels of lindane removal were recorded in the inoculated and non-inoculated systems where maize plants were introduced. However, the vigor index (VI) of the maize plants was highest when grown in inoculated and artificially polluted soil. In the phytotoxicity assay, the VI of the lettuce seedlings increased with increasing bioremediation time for the soils, thus indicating the effectiveness of the process.

Similar levels of lindane removal were recorded in both inoculated and non-inoculated planted systems, indicating that pesticide removal was not significantly affected by the bacterial inoculant. However, inoculation an actinobacteria consortium led to an increase in the VI of the maize and protected the plants against the existing toxicity. Furthermore, maize plants may attenuate the transient toxic effects of microbial lindane degradation.

Keywords: Lindane; *Streptomyces* strains; Maize plants; Phytoremediation; Phytotoxicity

Xue Liu[a], Guang-Mei Yang[a], Dong-Xing Guan[a], Piyasa Ghosh[b], Lena Q. Ma[a, b]. ([a] State Key Lab of Pollution Control and Resource Reuse, School of the Environment, Nanjing University, Jiangsu 210023, China, [b] Soil and Water Science Department, University of Florida, Gainesville, FL 32611, United States). **Catecholate-siderophore produced by As-resistant bacterium effectively dissolved $FeAsO_4$ and promoted *Pteris vittata* growth. Environmental Pollution, Volume 206(2015): 376–381**

The impact of siderophore produced by arsenic-resistant bacterium *Pseudomonas* PG12 on $FeAsO_4$ dissolution and plant growth were examined. Arsenic-hyperaccumulator *Pteris vittata* was grown for 7 d in 0.2-strength Fe-free Hoagland solution containing $FeAsO_4$ mineral and PG12-siderophore or fungal-siderophore desferrioxamine B (DFOB). Standard siderophore assays indicated that PG12-siderophore was catecholate-type. PG12-siderophore was more effective in promoting $FeAsO_4$ dissolution, and Fe and As plant uptake than DFOB. Media soluble Fe and As in PG12 treatment were 34.6 and 3.07 μM, 1.6- and 1.4-fold of that in DFOB. Plant Fe content increased from 2.93 to 6.24 g kg^{-1} in the roots and As content increased from 14.3 to 78.5 mg kg^{-1} in the fronds. Besides, *P. vittata* in PG12 treatment showed 2.6-times greater biomass than DFOB. While *P. vittata* fronds in PG12 treatment were dominated by AsIII, those in DFOB treatment were dominated by AsV (61–77%). This study showed that siderophore-producing arsenic-resistant rhizobacteria may have potential in enhancing phytoremediation of arsenic-contaminated soils.

Keywords: Siderophore; Arsenic; *Pseudomonas*; *Pteris vittata*; Phytoremediation

Ariadna S. Sánchez-López[a], Rogelio Carrillo-González[a], Ma. del Carmen Angeles González-Chávez[a], Greta Hanako Rosas-Saito[b], Jaco Vangronsveld[c]. ([a] Colegio de Postgraduados, km 36.5 Carretera México-Texcoco, Campus Montecillo, Texcoco, CP 56230, Mexico, [b] Instituto de Ecología, A.C. Unidad de Microscopía BioMimic, Carretera antigua a Coatepec, No. 351, El Haya, Xalapa, Ver. C.P. 91070, Veracruz, Mexico, [c] Hasselt University, Centre for Environmental Sciences, B-3590, Diepenbeek, Belgium). **Phytobarriers: Plants capture particles containing potentially toxic elements originating from mine tailings in semiarid regions. Environmental Pollution, Volume 205(2015): 33–42**

Retention of particles containing potentially toxic elements (PTEs) on plants that spontaneously colonize mine tailings was studied through comparison of washed and unwashed shoot samples. Zn, Pb, Cd, Cu, Ni, Co and Mn concentrations were determined in plant samples. Particles retained on leaves were examined by Scanning Electronic Microscopy and energy dispersive X-Ray analysis. Particles containing PTEs were detected on both washed and unwashed leaves.

This indicates that the thorough washing procedure did not remove all the particles containing PTEs from the leaf surface, leading to an overestimation of the concentrations of PTEs in plant tissues. Particularly trichomes and fungal mycelium were retaining particles. The quantity and composition of particles varied among plant species and place of collection. It is obvious that plants growing on toxic mine tailings form a physical barrier against particle dispersion and hence limit the spread of PTEs by wind.

Keywords: Particles deposition; Mine tailings; Air dispersion; Phytoremediation

Huaming Guo[a, b,], Zeyun Liu[a, b, c], Susu Ding[b], Chunbo Hao[b], Wei Xiu[a, b], Weiguo Hou[a]. ([a] State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Beijing 100083, PR China, [b] School of Water Resources and Environment, China University of Geosciences (Beijing), Beijing 100083, PR China, [c] Shanxi Conservancy Technical Institute, Yuncheng 044004, PR China). **Arsenate reduction and mobilization in the presence of indigenous aerobic bacteria obtained from high arsenic aquifers of the Hetao basin, Inner Mongolia. Environmental Pollution, Volume 203(2015): 50–59**

Intact aquifer sediments were collected to obtain As-resistant bacteria from the Hetao basin. Two strains of aerobic As-resistant bacteria (*Pseudomonas* sp. M17-1 and *Bacillus* sp. M17-15) were isolated from the aquifer sediments. Those strains exhibited high resistances to both As(III) and As(V). Results showed that both strains had *arr* and *ars* genes, and led to reduction of dissolved As(V), goethite-adsorbed As(V), scorodite As(V) and sediment As(V), in the presence of organic carbon as the carbon source. After reduction of solid As(V), As release was observed from the solids to solutions. Strain M17-15 had a higher ability than strain M17-1 in reducing As(V) and promoting the release of As. These results suggested that the strains would mediate As(V) reduction to As(III), and thereafter release As(III), due to the higher mobility of As(III) in most aquifer systems. The processes would play an important role in genesis of high As groundwater.

Keywords: Arsenic species; Biogeochemistry; Indigenous microorganism; Microbial; Redox; Hetao basin

S.Y. Wang[a], Y.C. Kuo[a], Y.Z. Huang[b], C.W. Huang[c], C.M. Kao[a]. ([a] Institute of Environmental Engineering, National Sun Yat-Sen University, Kaohsiung, Taiwan, [b] Bioenvironmental Engineering Department, Chung Yuan University, Chung Li, Taiwan, [c] Deaprtment of Biological Science, National Sun Yat-Sen University, Kaohsiung, Taiwan). **Bioremediation of 1,2-dichloroethane contaminated groundwater: Microcosm and microbial diversity studies. Environmental Pollution, Volume 203(2015): 97–106**

In this study, the effectiveness of bioremediating 1,2-dichloroethane (DCA)-contaminated groundwater under different oxidation–reduction processes was evaluated. Microcosms were constructed using indigenous bacteria and activated sludge as the inocula and cane molasses and a slow polycolloid-releasing substrate (SPRS) as the primary substrates. Complete DCA removal was obtained within 30 days under aerobic and reductive dechlorinating conditions. In anaerobic microcosms with sludge and substrate addition, chloroethane, vinyl chloride, and ethene were produced. The microbial communities and DCA-degrading bacteria in microcosms were characterized by 16S rRNA-based denatured-gradient-gel electrophoresis profiling and nucleotide sequence analyses. Real-time polymerase chain reaction was applied to evaluate the

variations in *Dehalococcoides* spp. and *Desulfitobacterium* spp. Increase in *Desulfitobacterium* spp. indicates that the growth of *Desulfitobacterium* might be induced by DCA. Results indicate that DCA could be used as the primary substrate under aerobic conditions. The increased ethene concentrations imply that dihaloelimination was the dominate mechanism for DCA biodegradation.

Keywords: Bioremediation; 1,2-Dichloroethane (DCA); Groundwater contamination; Real-time polymerase chain reaction (PCR)

Bashar Qasim, Mikael Motelica-Heino, Sylvain Bourgerie, Arnaud Gauthier, Domenico Morabito. (Institut des Sciences de la Terre d'Orléans (ISTO), Université d'Orléans, LBLGC EA 1207, INRA USC1328, Université d'Orléans, Laboratoire de Génie-Civil et géoEnvironnement (LGCgE), Université de Lille1). Effect of nitrate and ammonium fertilization on Zn, Pb, and Cd phytostabilization by *Populus euramericana* Dorskamp in contaminated technosol. Environmental Science and Pollution Research, Volume 22(23) (2015): 18759-18771

This study aimed at assessing the effect of nitrogen addition under two forms, nitrate and ammonium, on the stabilization of Zn, Pb, and Cd by *Populus euramericana* Dorskamp grown in contaminated soils for 35 days under controlled conditions. Temporal changes in the soil pore water (SPW) were monitored for pH, dissolved organic carbon (DOC), and total dissolved concentrations of metals in the soils rhizosphere. Rhizospheric SPW pH decreased gradually with NH_4^+ addition and increased with NO_3^- addition up to one unit, while it slightly decreased initially then increased for the untreated control soil DOC increased with time up to six times, the highest increase occurring with NH_4^+ fertilization. An increase in the metal concentrations in the rhizospheric SPW was observed for NH_4^+ addition associated with the lowest rhizospheric SPW pH, whereas the opposite was observed for the control soil and NO_3^- fertilization. Fertilization did not affect plant shoots or roots biomass development compared to the untreated control (without N addition). Metals were mostly accumulated in the rhizosphere and N fertilization increased the accumulation for Zn and Pb while Cd accumulation was enhanced for NH_4^+ addition. Collectively, our results suggest metal stabilization by *P. euramericana* Dorskamp rhizosphere with nitrogen fertilization and are potential for phytostabilization of contaminated technosol.

Keywords: Potentially toxic elements; Technosol; Phytostabilization; *Populus euramericana* Dorskamp; Nitrogen fertilizers

Anahí Magdaleno, Marina Peralta Gavensky, Anabella V. Fassiano, María C. Ríos de Molina, Marina Santos, Hugo March, Juan Moretton, Ángela B. Juárez. (Cátedra de Salud Pública e Higiene Ambiental, Facultad de Farmacia y Bioquímica, Universidad de Buenos Aires, Departamento de Química Biológica, IQUIBICEN UBA-CONICET, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Instituto Nacional de Tecnología Industrial (INTI), Agrofina S.A). Phytotoxicity and genotoxicity assessment of imazethapyr herbicide using a battery of bioassays. Environmental Science and Pollution Research, Volume 22(23) (2015): 19194-19202

The imazethapyr herbicide (formulation Verosil®) was evaluated for phytotoxicity and genotoxicity using a battery of bioassays: (1) the growth inhibition of the green alga *Pseudokirchneriella subcapitata*, (2) the root growth and germination of the higher plant *Lactuca sativa*, (3) the genetic damage using the *Salmonella*/microsome test, and (4) the aneugenic and clastogenic effects on *Allium cepa*. The Verosil® formulation was highly toxic to the non-target green alga (median effective concentration (EC50) = 1.05 ± 0.05 mg active

ingredient (a.i.) L^{-1}), and concentrations above 10 mg a.i. L^{-1} inhibited root elongation in lettuce: relative growth index (RGI) between 0.28 ± 0.01 and 0.66 ± 0.10. No genotoxic effect was observed in *Salmonella typhimurium* at 100 mg a.i. L^{-1}, either with or without the microsomal fraction. However, significant differences in the frequency of chromosomal aberrations in anaphases and telophases (bridges, chromosome fragments, and vagrants) were observed in *A. cepa* at concentrations between 0.01 and 1 mg a.i. L^{-1} with respect to the control. The frequencies of micronuclei showed significant differences with respect to the control at concentrations between 0.001 and 0.1 mg a.i. L^{-1}. A very high mitotic index ($MI = 93.8 \pm 5.8$) was observed associated with a high number of cells in the prophase stage at 100 mg a.i. L^{-1}, indicating cytotoxicity. These results showed that imazethapyr is toxic to the non-target populations in both aquatic and terrestrial ecosystems. This herbicide might also exert clastogenic and aneugenic mitotic damage in higher plants. Therefore, the imazethapyr formulation may constitute an environmental risk to plants.

Keywords: Imazethapyr; *Pseudokirchneriella subcapitata; Lactuca sativa;* Ames test; *Allium cepa;* Toxicity; Genotoxicity

A. Guermouche M'rassi, F. Bensalah, J. Gury, R. Duran. (Laboratoire de Génétique Microbienne, Faculté des Sciences de la Nature et de la Vie, Université Oran 1 Ahmed Ben Bella, Equipe Environnement et Microbiologie, UMR IPREM5254, IBEAS, Université de Pau et des Pays de l'Adour, Equipe Environnement et Microbiologie, UMR IPREM5254, IBEAS, Université de Pau et des Pays de l'Adour). **Isolation and characterization of different bacterial strains for bioremediation of *n*-alkanes and polycyclic aromatic hydrocarbons. Environmental Science and Pollution Research, Volume 22(20) (2015): 15332-15346**

Crude oil is a common environmental pollutant composed of a large number of both aromatic and aliphatic hydrocarbons. Biodegradation is carried out by microbial communities that are important in determining the fate of pollutants in the environment. The intrinsic biodegradability of the hydrocarbons and the distribution in the environment of competent degrading microorganisms are crucial information for the implementation of bioremediation processes. In the present study, the biodegradation capacities of various bacteria toward aliphatic and aromatic hydrocarbons were determined. The purpose of the study was to isolate and characterize hydrocarbon-degrading bacteria from contaminated soil of a refinery in Arzew, Algeria. A collection of 150 bacterial strains was obtained; the bacterial isolates were identified by 16S rRNA gene sequencing and their ability to degrade hydrocarbon compounds characterized. The isolated strains were mainly affiliated to the Gamma-Proteobacteria class. Among them, *Pseudomonas* spp. had the ability to metabolize high molecular weight hydrocarbon compounds such as pristane (C19) at 35.11 % by strain LGM22 and benzo[a] pyrene (C20) at 33.93 % by strain LGM11. Some strains were able to grow on all the hydrocarbons tested including octadecane, squalene, phenanthrene, and pyrene. Some strains were specialized degrading only few substrates. In contrast, the strain LGM2 designated as *Pseudomonas* sp. was found able to degrade both linear and branched alkanes as well as low and high poly-aromatic hydrocarbons (PAHs). The *alkB* gene involved in alkane degradation was detected in LGM2 and other *Pseudomonas*-related isolates. The capabilities of the isolated bacterial strains to degrade alkanes and PAHs should be of great practical significance in bioremediation of oil-contaminated environments.

Keywords: Oil; Degradation; Hydrocarbon-degrading bacteria16S rRNA genes; Bacterial diversity; Alkanes; PAHs; *Pseudomonas;* AlkB

Abdur Rahim Khan, Ihsan Ullah, Abdul Latif Khan, Gun-Seok Park, Muhammad Waqas, Sung-Jun Hong, Byung Kwon Jung, Yunyoung Kwak, In-Jung Lee. (School of Applied Biosciences, College of Agriculture and Life Sciences, Kyungpook National University, School of Applied Biosciences, College of Agriculture and Life Sciences, Kyungpook National UniversityInstitute of Biotechnology and Genetic Engineering, The Agriculture University Peshawar, UoN Chair of Oman's Medicinal Plants and Marine Natural Products, University of Nizwa, School of Applied Biosciences, College of Agriculture and Life Sciences, Kyungpook National University). **Improvement in phytoremediation potential of *Solanum nigrum* under cadmium contamination through endophytic-assisted *Serratia* sp. RSC-14 inoculation. Environmental Science and Pollution Research, Volume 22(18) (2015): 14032-14042**

The growth of hyperaccumulator plants is often compromised by increased toxicity of metals like cadmium (Cd). However, extraction of such metals from the soil can be enhanced by endophytic microbial association. Present study was aimed to elucidate the potential of microbe-assisted Cd phytoextraction in hyperaccumulator *Solanum nigrum* plants and their interactions under varied Cd concentrations. An endophytic bacteria *Serratia* sp. RSC-14 was isolated from the roots of *S. nigrum*. In addition to Cd tolerance up to 4 mM, the RSC-14 exhibited phosphate solubilization and secreted plant growth-promoting phytohormones such as indole-3-acetic acid (54 µg/mL). *S. nigrum* plants were inoculated with RSC-14 and were grown in different concentrations of Cd (0, 10, and 30 mg Cd kg^{-1} sand). Results revealed that Cd treatment caused significant cessation in plant growth, biomass, and chlorophyll content, whereas significantly higher malondialdehyde (MDA) and electrolyte production in leaves were observed in a dose-dependent manner. Conversely, RSC-14 inoculation relived the toxic effects of Cd-induced stress by significantly increasing root/shoot growth, biomass production, and chlorophyll content and decreasing MDA and electrolytes contents. Ameliorative effects on host growth were also observed by the regulation of metal-induced oxidative stress enzymes such as catalase, peroxidase, and polyphenol peroxidase. Activities of these enzymes were significantly reduced in RSC-14 inoculated plants as compared to control plants under Cd treatments. The lower activities of stress responsive enzymes suggest modulation of Cd stress by RSC-14. The current findings support the beneficial uses of *Serratia* sp. RSC-14 in improving the phytoextraction abilities of *S. nigrum* plants in Cd contamination.

Keywords: Cadmium; Endophytic bacterium; *Serratia* sp.; Phytoremediation; *Solanum nigrum*

Jennifer Mesa[a], Ignacio David Rodríguez-Llorente[a], Eloisa Pajuelo[a], José María Barcia Piedras[b], Miguel Angel Caviedes[a], Susana Redondo-Gómez[b], Enrique Mateos-Naranjo[b]. ([a]Departamento de Microbiologia, Facultad de Farmacia, Universidad de Sevilla, C/ Profesor García González 2, 41012 Sevilla, Spain, [b] Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, 1095, 41080 Sevilla, Spain). **Moving closer towards restoration of contaminated estuaries: Bioaugmentation with autochthonous rhizobacteria improves metal rhizoaccumulation in native *Spartina maritime.* Journal of Hazardous Materials, Volume 300(2015): 263–271**

Spartina maritima is an ecosystem engineer that has shown to be useful for phytoremediation purposes. A glasshouse experiment using soil from a metal-contaminated estuary was designed to investigate the effect of a native bacterial *consortium*, isolated from *S. maritima* rizhosphere and selected owing to their plant growth promoting properties and multiresistance to heavy

metals, on plant growth and metal accumulation. Plants of *S. maritima* were randomly assigned to three soil bioaugmentation treatments (without inoculation, one inoculation and repeated inoculations) for 30 days. Growth parameters and photosynthetic traits, together with total concentrations of several metals were determined in roots and/or leaves. Bacterial inoculation improved root growth, through a beneficial effect on photosynthetic rate (A_N) due to its positive impact on functionality of PSII and chlorophyll concentration. Also, favoured intrinsic water use efficiency of *S. maritima*, through the increment in A_N, stomatal conductance and in root-to-shoot ratio. Moreover, this consortium was able to stimulate plant metal uptake specifically in roots, with increases of up to 19% for As, 65% for Cu, 40% for Pb and 29% for Zn. Thus, bioaugmentation of *S. maritima* with the selected bacterial consortium can be claimed to enhance plant adaptation and metal rhizoaccumulation during marsh restoration programs.

Keywords: Metal pollution; Photosynthesis; Phytorremediation; Plant growth promoting rhizobacteria; *Spartina maritima*; Stomatal conductance

Carlos García-Delgado, Felipe Yunta, Enrique Eymar. (Department of Agricultural Chemistry and Food Sciences, University Autónoma of Madrid, 28049 Madrid, Spain). Bioremediation of multi-polluted soil by spent mushroom (*Agaricus bisporus)* substrate: Polycyclic aromatic hydrocarbons degradation and Pb availability. Journal of Hazardous Materials, Volume 300(2015): 281–288

This study investigates the effect of three spent *Agaricus bisporus* substrate (SAS) application methods on bioremediation of soil multi-polluted with Pb and PAH from close to a shooting range with respect natural attenuation (SM). The remediation treatments involve (i) use of sterilized SAS to biostimulate the inherent soil microbiota (SSAS) and two bioaugmentation possibilities (ii) its use without previous treatment to inoculate *A. bisporus* and inherent microbiota (SAS) or (iii) SAS sterilization and further *A. bisporus* re-inoculation (Abisp). The efficiency of each bioremediation microcosm was evaluated by: fungal activity, heterotrophic and PAH-degrading bacterial population, PAH removal, Pb mobility and soil eco-toxicity. Biostimulation of the native soil microbiology (SSAS) achieved similar levels of PAH biodegradation as SM and poor soil detoxification. Bioaugmented microcosms produced higher PAH removal and eco-toxicity reduction via different routes. SAS increased the PAH-degrading bacterial population, but lowered fungal activity. Abisp was a good inoculum carrier for *A. bisporus* exhibiting high levels of ligninolytic activity, the total and PAH-degrading bacteria population increased with incubation time. The three SAS applications produced slight Pb mobilization (<0.3%). SAS sterilization and further *A. bisporus* re-inoculation (Abisp) proved the best application method to remove PAH, mainly BaP, and detoxify the multi-polluted soil.

Keywords: Polycyclic aromatic hydrocarbons; Heavy metals; Ligninolytic enzymes; Biodegradation; Agricultural waste

Hongying Liu, Shanshan Guo, Kai Jiao, Junjun Hou, Han Xie, Heng Xu. (Key Laboratory of Bio-Resources and Eco-Environment (Ministry of Education), College of Life Sciences, Sichuan University, Chengdu, Sichuan 610064, China). Bioremediation of soils co-contaminated with heavy metals and 2,4,5-trichlorophenol by fruiting body of *Clitocybe maxima.* Journal of Hazardous Materials, Volume 294(2015): 121–127

Pot experiments were performed to investigate the single effect of 2,4,5-trichlorophenol (TCP) or heavy metals (Cu, Cd, Cu + Cd) and the combined effects of metals-TCP on the growth of

Clitocybe maxima together with the accumulation of heavy metals as well as dissipation of TCP. Results showed a negative effect of contaminations on fruiting time and biomass of the mushroom. TCP decreased significantly in soils accounting for 70.66–96.24% of the initial extractable concentration in planted soil and 66.47–91.42% in unplanted soil, which showed that the dissipation of TCP was enhanced with mushroom planting. Higher biological activities (bacterial counts, soil respiration and laccase activity) were detected in planted soils relative to unplanted controls, and the enhanced dissipation of TCP in planted soils might be derived from the increased biological activities. The metals accumulation in mushroom increased with the augment of metal load, and the proportion of acetic acid (HOAc) extractable metal in soils with *C. maxima* was larger than that in unplanted soils, which may be an explanation of metal uptake by *C. maxima*. These results suggested that the presence of *C. maxima* was effective in promoting the bioremediation of soil contaminated with heavy metals and TCP.

Keywords: Co-contamination; Soil; Bioremediation; Fruiting body; *Clitocybe maxima*

Shalini Srivastava[a], S.B. Agrawal[a], M.K. Mondal[b]. ([a] Department of Botany, Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India, [b] Department of Chemical Engineering and Technology, Indian Institute of Technology (Banaras Hindu University), Varanasi 221005, Uttar Pradesh, India). Biosorption isotherms and kinetics on removal of Cr(VI) using native and chemically modified *Lagerstroemia speciosa* bark. Ecological Engineering, Volume 85(2015): 56–66

The contamination of drinking and irrigation water with Cr(VI) ion is a recurring challenge, especially in developing countries. In the present study, feasibility of the native and chemically modified bark of *Lagerstroemia speciosa* (Pride of India) as biosorbent to remove Cr(VI) from synthetic wastewater was examined. Characterization of the native *L. speciosa* bark (NLSB) and chemically modified *L. speciosa* bark (CLSB) was performed by elemental analysis, SEM and FTIR spectroscopy. The adsorption of Cr(VI) ions was examined with respect to initial pH of the adsorbate, initial Cr(VI) ion concentration, biosorbent dose, biosorbent size and temperature. The applicability of pseudo second order kinetics was indicated by both the biosorbents in the process of Cr(VI) removal. Langmuir, Freundlich, D–R and Temkin isotherm models were studied. The Freundlich and Temkin isotherms showed high correlation coefficient for adsorption of Cr(VI) on NLSB and CLSB, respectively and revealed the presence of multi adsorption mechanism in biosorption process. The negative value of $\Delta G°$ indicated spontaneous nature of the biosorption process and positive value of $\Delta H°$ concluded favorable Cr(VI) ion removal at high temperature.

Keywords: *Lagerstroemia speciosa* bark; Biosorption isotherm; Wastewater treatment; Kinetics; Thermodynamics

M.M. Montiel-Rozas, E. Madejón, P. Madejón. (Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC), Av. Reina Mercedes 10, PO Box 1052, 41080 Sevilla, Spain). Evaluation of phytostabilizer ability of three ruderal plants in mining soils restored by application of organic amendments. Ecological Engineering, Volume 83(2015): 431–436

Abandoned mines involve a serious environmental problem because these soils contain high levels of trace elements. The aim of the study was selecting the most adequate autochthonous plant species to stabilize contamination and improve soil quality of a contaminated soil from an abandoned mine. For this purpose three plant species were studied: *Poa annua*, *Medicago polymorpha* and *Malva sylvestris*, in combination with two organic amendments (biosolid compost (BC) and “alperujo” compost (AC)) and a soil without amendments (CO). Soil pH

increased due to the effect of amendments under all studied plants, which promotes the immobilization of trace elements in soil. Water soluble C (WSC) increased with the addition of both amendments and the highest concentration was found in soils under *M. polymorpha*. The evolution of trace element availability in soil depended on the amendment, plant species and characteristics of the element. The best treatment to stimulate biomass production was AC. The highest concentration of As and Pb was found in *P. annua* whereas the highest concentration of Mn and Zn was found in *M. sylvestris*. Considering chemical and biochemical properties, and concentrations in shoots *M. polymorpha* would be the most suitable plant to stabilize trace elements and improve soil quality. Nevertheless, the best results were obtained with the plant-amendment combination.

Keywords: Ecological restoration; Degraded soil; Phytostabilization; Trace elements

Biotransformation

Martín A. Palazzolo, María L. Mascotti, Elizabeth S. Lewkowicz, Marcela Kurina-Sanz. (Area de Química Orgánica, Facultad de Química, Bioquímica y Farmacia, Universidad Nacional de San Luis, INTEQUI-CONICET. Laboratorio de Biotransformaciones, Departamento de Ciencia y Tecnología, Universidad Nacional de Quilmes). **Self-sufficient redox biotransformation of lignin-related benzoic acids with*Aspergillus flavus.* Journal of Industrial Microbiology & Biotechnology, Volume 42(12) (2015): 1581-1589**

Aromatic carboxylic acids are readily obtained from lignin in biomass processing facilities. However, efficient technologies for lignin valorization are missing. In this work, a microbial screening was conducted to find versatile biocatalysts capable of transforming several benzoic acids structurally related to lignin, employing vanillic acid as model substrate. The wild-type *Aspergillus flavus* growing cells exhibited exquisite selectivity towards the oxidative decarboxylation product, 2-methoxybenzene-1,4-diol. Interestingly, when assaying a set of structurally related substrates, the biocatalyst displayed the oxidative removal of the carboxyl moiety or its reduction to the primary alcohol whether electron withdrawing or donating groups were present in the aromatic ring, respectively. Additionally, *A. flavus* proved to be highly tolerant to vanillic acid increasing concentrations (up to 8 g/L), demonstrating its potential application in chemical synthesis. *A. flavus* growing cells were found to be efficient biotechnological tools to perform self-sufficient, structure-dependent redox reactions. To the best of our knowledge, this is the first report of a biocatalyst exhibiting opposite redox transformations of the carboxylic acid moiety in benzoic acid derivatives, namely oxidative decarboxylation and carboxyl reduction, in a structure-dependent fashion.

Keywords: Benzoic acids; Redox biotransformation; *Aspergillus flavus;* Carboxyl reduction; Oxidative decarboxylation

Jonathan Collins, Marcel Grund, Christoph Brandenbusch, Andreas Schmid, Bruno Bühler. (Laboratory of Chemical Biotechnology, TU Dortmund UniversityAmherst College, Laboratory of Chemical Biotechnology, TU Dortmund University Department Solar Materials, Helmholtz Center for Environmental Research, UFZ GmbH). **The**

dynamic influence of cells on the formation of stable emulsions in organic–aqueous biotransformations. Journal of Industrial Microbiology & Biotechnology, Volume 42(7) (2015): 1011-1026

Emulsion stability plays a crucial role for mass transfer and downstream processing in organic–aqueous bioprocesses based on whole microbial cells. In this study, emulsion stability dynamics and the factors determining them during two-liquid phase biotransformation were investigated for stereoselective styrene epoxidation catalyzed by recombinant *Escherichia coli*. Upon organic phase addition, emulsion stability rapidly increased correlating with a loss of solubilized protein from the aqueous cultivation broth and the emergence of a hydrophobic cell fraction associated with the organic–aqueous interface. A novel phase inversion-based method was developed to isolate and analyze cellular material from the interface. In cell-free experiments, a similar loss of aqueous protein did not correlate with high emulsion stability, indicating that the observed particle-based emulsions arise from a convergence of factors related to cell density, protein adsorption, and bioreactor conditions. During styrene epoxidation, emulsion destabilization occurred correlating with product-induced cell toxification. For biphasic whole-cell biotransformations, this study indicates that control of aqueous protein concentrations and selective toxification of cells enables emulsion destabilization and emphasizes that biological factors and related dynamics must be considered in the design and modeling of respective upstream and especially downstream processes.

Keywords: Two-liquid phase biotransformation; Whole-cell biocatalysis; Pickering emulsion; Emulsion stability; *E. coli*

R. Garcia-Morales, M. Rodríguez-Delgado, K. Gomez-Mariscal, C. Hernandez-Luna, C. Orona-Navar, E. Torres, R. Parra, D. Cárdenas-Chávez, J. Mahlknecht, N. Ornelas-Soto. (Centro del Agua para América Latina y el Caribe, Tecnológico de MonterreyUniversidad Juárez Autónoma de Tabasco, Centro del Agua para América Latina y el Caribe, Tecnológico de Monterrey, Laboratorio de Enzimología, Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León. Av. Universidad s/n, Ciudad Universitaria San Nicolás de los Garza). Biotransformation of Endocrine-Disrupting Compounds in Groundwater: Bisphenol A, Nonylphenol, Ethynylestradiol and Triclosan by a Laccase Cocktail from *Pycnoporus sanguineus* CS43. Water, Air, & Soil Pollution,_Volume 226(2015): 251

The biodegradation of organic compounds present in water at trace concentration has become a critical environmental problem. In particular, enzymatic oxidation by fungal laccases offers a promising alternative for efficient and sustainable removal of organic pollutants in water. In this work, the biocatalytic ability of laccases from the *Pycnoporus sanguineus* CS43 fungus was evaluated. A filtered culture supernatant (laccase cocktail) evidenced an enhanced biotransformation capability to remove common endocrine-disruptor compounds (EDCs), such as bisphenol A, 4-nonylphenol, 17-α-ethynylestradiol and triclosan. A biodegradation of around 89–100 % was achieved for all EDCs using synthetic samples (10 mg L^{-1}) and after the enzymatic treatment with 100 U L^{-1} (50.3 U mg $^{-1}$). The biodegradation rates obtained were fitted to a first order reaction. Furthermore, enzymatic biocatalytic activity was also evaluated in groundwater samples coming from northwestern Mexico, reaching biotransformation percentages between 55 and 93 % for all tested compounds. As far as we know this is the first study on real groundwater samples in which the enzymatic degradation of target EDCs by a laccase cocktail from any strain of *Pycnoporus sanguineus* was evaluated. In comparison with

purified laccases, the use of cocktail offers operational advantages since additional purification steps can be avoided.

Keywords: Laccases; *Pycnoporus sanguineus;* Endocrine disrupting compound (EDC); Groundwater

O. Chusova, H. Nõlvak, M. Odlare, J. Truu, M. Truu, K. Oopkaup, E. Nehrenheim. (School of Business, Society and Engineering, Mälardalen University, Institute of Ecology and Earth Sciences, University of Tartu, School of Business, Society and Engineering, Mälardalen University). Biotransformation of pink water TNT on the surface of a low-cost adsorbent pine bark. Biodegradation, Volume 26(5) (2015): 375-386

This two-week anaerobic batch study evaluated 2,4,6-trinitrotoluene (TNT) removal efficiency from industrial pink water by (1) adsorption on low-cost adsorbent pine bark, and (2) adsorption coupled with TNT biotransformation by specialised microbial communities. Samples of the supernatant and acetonitrile extracts of pine bark were analysed by HPLC, while the composition of the bacterial community of the experimental batches, inocula and pine bark were profiled by high-throughput sequencing the V6 region of the bacterial 16S rRNA gene. Integrated adsorption and biotransformation proved to be the most efficient method for TNT removal from pink water. The type of applied inoculum had a profound effect on TNT removal efficiencies and microbial community structures, which were dominated by phylotypes belonging to the *Enterobacteriaceae* family. The analysis of acetonitrile extracts of pine bark supported the hypothesis that the microbial community indigenous to pine bark has the ability to degrade TNT.

Keywords: TNT biotransformation; TNT adsorption; Pink water treatment; Pine bark; Next-generation sequencing; Microbial community structure

Igor A. Parshikov, Kellie A. Woodling, John B. Sutherland. (Institute of Applied Mechanics, Russian Academy of Sciences, Division of Biochemical Toxicology, National Center for Toxicological Research, U S Food and Drug Administration, Division of Microbiology, National Center for Toxicological Research, U S Food and Drug Administration). Biotransformations of organic compounds mediated by cultures of *Aspergillus niger.* Applied Microbiology and Biotechnology, Volume 99(17) (2015): 6971-6986

Many different organic compounds may be converted by microbial biotransformation to high-value products for the chemical and pharmaceutical industries. This review summarizes the use of strains of *Aspergillus niger*, a well-known filamentous fungus used in numerous biotechnological processes, for biochemical transformations of organic compounds. The substrates transformed include monocyclic, bicyclic, and polycyclic aromatic hydrocarbons; azaarenes, epoxides, chlorinated hydrocarbons, and other aliphatic and aromatic compounds. The types of reactions performed by *A. niger*, although not unique to this species, are extremely diverse. They include hydroxylation, oxidation of various functional groups, reduction of double bonds, demethylation, sulfation, epoxide hydrolysis, dechlorination, ring cleavage, and conjugation. Some of the products may be useful as new investigational drugs or chemical intermediates.

Keywords: Arenes; *Aspergillus niger;* Biotransformation; Hydrocarbons; Organic compounds

Gopi Gopal Ramakrishnan, Ganesh Nehru, Pandiaraj Suppuram, Sowmiya Balasubramaniyam, Brajesh Raman Gulab, Ramalingam Subramanian. (Centre for

Biotechnology, Anna University). Bio-transformation of Glycerol to 3-Hydroxypropionic Acid Using Resting Cells of *Lactobacillus reuteri.* Current Microbiology, Volume 71(4) (2015): 517-523

Lactobacillus reuteri grown in MRS broth containing 20 mM glycerol exhibits 3.7-fold up-regulation of 3-hydroxypropionic acid (3-HP) pathway genes during the stationary phase. Concomitantly, the resting cells prepared from stationary phase show enhancement in bio-conversion of glycerol, and the maximum specific productivity (q_p) is found to be 0.17 g 3-HP per g CDW per hour. The regulatory elements such as catabolite repression site in the up-stream of 3-HP pathway genes are presumed for the augmentation of glycerol bio-conversion selectively in stationary phase. However, in the repression mutant, the maximum q_p of 3-HP persisted in the stationary phase-derived resting cells indicating the role of further regulatory features. In the production stage, the external 3-HP concentration of 35 mM inhibits 3-HP synthesis. In addition, it has also moderated 1,3-propanediol formation, as it is a redox bio-catalysis involving NAD^+/NADH ratio of 6.5. Repeated batch bio-transformation has been used to overcome product inhibition, and the total yield (Ypx) of 3-HP from the stationary phase-derived biomass is 3.3 times higher than that from the non-repeated mode. With the use of appropriate gene expression condition and repeated transfer of biomass, 3-HP produced in this study can be used for low-volume, high-value applications.

Guangtong Chen, Hongjuan Ge, Yan Song, Jianlin Li, Xuguang Zhai, Juanjuan Wu, Xiang Ling. ([1]School of Pharmacy, Nantong University, Nantong, 226001, People's Republic of China. g.chen@infu.tu-dortmund.de, [2]Faculty of Chemistry and Chemical Biology, Institute of Environmental Research (INFU), TU Dortmund, 44221, Dortmund, Germany. g.chen@infu.tu-dortmund.de, [3]School of Pharmacy, Nantong University, Nantong, 226001, People's Republic of China, [4]School of Pharmacy, Nantong University, Nantong, 226001, People's Republic of China. xiang.nantong@gmail.com). Biotransformation of 20(*S*)-protopanaxatriol by *Mucor racemosus* and the anti-cancer activities of some products. Biotechnology Letters, Volume 37(10) (2015): 2005-2009

To produce new derivatives of 20(*S*)-protopanaxatriol by fungal biotransformation. Biotransformation of 20(*S*)-protopanaxatriol (**1**) by *Mucor racemosus* AS 3.205 afforded six products. Their structures were elucidated on the basis of extensive spectroscopic analyses. *M. racemosus* could selectively catalyze dehydrogenation at C-12 and further hydroxylation at C-7, C-11, and C-15, as well as rearrangement of double bond at C-26. Two of these new compounds exhibited potent inhibitory activity against SH-SY5Y and HepG2 cell lines.

Biotransformation by *M. racemosus* AS 3.205 was an effective approach to produce new derivatives of 20(*S*)-protopanaxatriol.

Keywords: Anti-cancer compounds Biocatalysis Biotransformation Cytotoxic activity Dehydrogenation *Mucor racemosus* 20(*S*)-Protopanaxatriol

Shivkesh Dahiya, Swati Ojha , Saroj Mishra. ([1]Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi, Hauz-Khas, New Delhi, 110016, India). Biotransformation of sucrose into hexyl-α-D-glucopyranoside and -polyglucosides by whole cells of Microbacterium paraoxydans. Biotechnology Letters, Volume 37(7) (2015): 1431-7

To determine the transglycosylation activity of cell-bound enzymes from *Microbacterium paraoxydans* to catalyze the synthesis of hexyl-α-D-glucoside (HG) and -polyglucosides using

sucrose as a glycosyl donor. Maximum HG yield (14.8 %) was achieved at 0.96 water activity in 12 h with sucrose at 0.5 M with lyophilized cells (equivalent to 8 IU α-glucosidase activity). The synthesized alkyl-glucosides and-polyglucosides were characterized by ESI-MS. Structural elucidation of the main product (purified by solid phase chromatography) was done by HSQC (2D NMR) which was confirmed as 1-hexyl-α-D-glucopyranoside. The synthesis was scaled up in a fed-batch reactor, with continuous feeding of whole cells every 6 h and a total yield of ~44 % was obtained for hexyl-glucoside and -polyglucosides under the optimized conditions.

Synthesis of HG, hexyl di- and tri-glucosides has been achieved using a novel method.

Keywords: Alkyl glucosides; A-glucosidase; Hexyl-α-D-glucopyranoside; Hexyl-polyglucosides; *Microbacterium paraoxydans* ; Transglycosylation ; Whole-cell catalysis

Dnyanada S. Khanolkar, Santosh Kumar Dubey, Milind Mohan Naik. (Laboratory of Bacterial Genetics and Environmental Biotechnology, Department of Microbiology, Goa University, Taleigao Plateau, Goa 403 206, India). Biotransformation of tributyltin chloride to less toxic dibutyltin dichloride and monobutyltin trichloride by *Klebsiella pneumoniae* strain SD9. International Biodeterioration & Biodegradation, Volume 104(2015): 212–218

A tributyltin chloride (TBTCl) resistant bacterial strain was isolated from the Zuari estuary, in Goa, India, and identified as *Klebsiella pneumoniae* based on biochemical characteristics and 16S rRNA sequence analysis, and designated as strain SD9. It could utilize TBTCl as a sole carbon source in mineral salt medium and tolerated up to 2.5 mM TBTCl with maximum growth at 2 mM. Nuclear magnetic resonance spectroscopic analysis of column purified TBTCl degradation products clearly demonstrated the presence of dibutyltin dichloride ($DBTCl_2$) and monobutyltin trichloride ($MBTCl_3$). Mass spectrometry further confirmed degradation of toxic TBTCl into its less toxic derivatives, viz., $DBTCl_2$ and $MBTCl_3$. This strain also showed enhanced siderophore production in the presence of TBTCl, which was demonstrated by chrome azurol S agar assay as an increase in diameter of the orange halo around the bacterial colony in the presence of 2 mM TBTCl; this seems to be a mechanism to counteract TBTCl toxicity. Furthermore, scanning electron microscopy revealed significant morphological alterations as shrinkage in cell size along with roughness of cell surface when bacterial cells were exposed to 2 mM TBTCl. These interesting characteristics of this estuarine bacterium make it a potential tool for bioremediation of TBTCl-contaminated sites since it possesses biotransformation capability to convert TBTCl into $DBTCl_2$ and $MBTCl_3$.

Keywords: TBTCl; Degradation; Biotransformation; Induced protein; Siderophore; Morphology

Sylwia Różalska, Przemysław Bernat, Piotr Michnicki, Jerzy Długoński. (Department of Industrial Microbiology and Biotechnology, Faculty of Biology and Environmental Protection, University of Łódź, Poland). Fungal transformation of 17α-ethinylestradiol in the presence of various concentrations of sodium chloride. International Biodeterioration & Biodegradation, Volume 103(2015): 77–84

17α-Ethinylestradiol (EE2) is a commonly used synthetic estrogen, which is resistant to degradation and accumulates in all parts of the environment. In this work the capability of thirty eight fungal strains to remove this xenobiotic from culture medium was checked. Nine out of the tested strains were able to completely remove EE2 (at initial concentration 10 mg l^{-1}) from the

culture medium during 3 d of incubation. The most efficient were two *Aspergillus* strains (*Aspergillus fumigatus* IM 6510 and *Aspergillus versicolor* IM 2161) which also possess the ability to eliminate the xenoestrogen in the presence of NaCl. *A. versicolor* seems to be less vulnerable to salinity and the transformation process was completed after 3 d of incubation in all tested NaCl concentrations. This strain transformed EE2 and formed its metabolites detected during liquid chromatography–(electrospray) triple quadrupole–mass spectrometry (LC–(ESI)MS–MS) analysis. The quantitative analyses revealed that the EE2 subsequent decrease in samples with or without salinity was accompanied by an increase in the concentrations of estrone (E1) and estradiol (E2). The presence of NaCl slightly inhibited E2 to E1 transformation during the first 24 h of incubation but at the end of the experiment the amount of nontoxic E1 prevailed in all tested samples. The results of this study suggest that *Aspergillus* sp. possesses an ability to utilize EE2 in the presence of NaCl.

Keywords: 17α-Ethinylestradiol (EE2); Fungal transformation; Biotransformation; Metabolites formation; NaCl

Jin-Soo Chang. (Molecular Biogeochemistry Laboratory, Biological & Genetic Resources Institute (BGRI), 505 Inno-Biz Park, 1646 Yuseong-daero, Yeseong-gu, Daejeon 305-811, Republic of Korea). Biotransformation of arsenite and bacterial *aox* activity in drinking water produced from surface water of floating houses: Arsenic contamination in Cambodia. Environmental Pollution, Volume 206(2015): 315–323

The potential arsenite bioteansformation activity of arsenic was investigated by examining bacterial arsenic arsenite-oxidizing gene such as *aox*S, *aox*R, *aox*A, *aox*B, *aox*C, and *aox*D in high arsenic-contaminated drinking water produced from the surface water of floating houses. There is a biogeochemical cycle of activity involving arsenite oxidase *aox* system and the *ars* (arsenic resistance system) gene operon and *aox*R leader gene activity in *Alcaligenes faecalis* SRR-11 and *aox*S leader gene activity in *Achromobacter xylosoxidans* TSL-66. Batch experiments showed that SRR-11 and TSL-66 completely oxidized 1 mM of As (III) to As (V) within 35–40 h. The leaders of *aox*S and *aox*R are important for gene activity, and their effects in arsenic bioremediation and mobility in natural water has a significant ecological role because it allows arsenite oxidase in bacteria to control the biogeochemical cycle of arsenic-contaminated drinking water produced from surface water of floating houses.

Maione W. Franco, Fernanda A. G. Ferreira, Igor F. Vasconcelos, Bruno L. Batista, Diego G. F. Pujoni, Sérgia M. S. Magalhães, Fernando BarbosaJr, Francisco A. R. Barbosa. (Laboratório de Limnologia, Ecotoxicologia e Ecologia Aquática, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais–UFMG, Departamento de Engenharia Metalúrgica e de Materiais, Universidade Federal do Ceará, Centro de Ciências Naturais e Humanas, Universidade Federal do ABC, Departamento de Farmácia Social, Universidade Federal de Minas Gerais, Laboratório de Toxicologia e Essencialidade de Metais, Faculdade de Ciências Farmacêuticas de Ribeirão Preto–USP). Arsenic biotransformation by cyanobacteria from mining areas: evidences from culture experiments. Environmental Science and Pollution Research, Volume 22(23)_ (2015): 18607-18615

Elucidating the role of cyanobacteria in the biotransformation of arsenic (As) oxyanions is crucial to understand the biogeochemical cycle of this element and indicate species with potential for its bioremediation. In this study, we determined the EC_{50} for As(III) and As(V) and evaluated the biotransformation of As by *Synechococcus* sp. through high-performance liquid chromatography hyphenated to inductively coupled plasma mass spectrometry (HPLC-ICP-MS) and X-ray absorption fine structure spectroscopy (XAFS). *Synechococcus* sp. exhibited higher

sensitivity to As(III) with an $EC_{50,\ 96\ h}$ of 6.64 mg L^{-1} that was approximately 400-fold lower than that for As(V). Even though the cells were exposed to concentrations of As(III) (6 mg L^{-1}) approximately 67-fold lower than those of As(V) (400 mg L^{-1}), similar intracellular concentrations of As (60.0 µg g^{-1}) were observed after 30 days. As(V) was the predominant intracellular As species followed by As(III). Furthermore, organic As species such as monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA) were observed in higher proportions after exposure to As(III). The differential toxicity among As oxyanions indicates that determining the redox state of As in the environment is fundamental to estimate toxicity risks to aquatic organisms. *Synechococcus* sp. demonstrated potential for its application in bioremediation due to the high accumulation of As and production of As organic compounds notably after exposure to As(III).

Keywords: Cyanobacteria; Arsenic speciation; *Synechococcus;* Growth inhibition; Bioremediation

Dhiraj Paul[a], Sufia K. Kazy[b], Tirtha Das Banerjee[b], Ashok K. Gupta[c], Taraknath Pal[d], Pinaki Sar[a]. ([a] Department of Biotechnology, Indian Institute of Technology, Kharagpur, 721302, India, [b] Department of Biotechnology, National Institute of Technology, Durgapur, 713209, India, [c] Department of Civil Engineering, Indian Institute of Technology, Kharagpur, 721302, India, [d] Central Headquarters, Geological Survey of India, Kolkata 700016, India). **Arsenic biotransformation and release by bacteria indigenous to arsenic contaminated groundwater. Bioresource Technology, Volume 188(2015): 14–23**

Arsenic (As) biotransformation and release by indigenous bacteria from As rich groundwater was investigated. Metabolic landscape of 173 bacterial isolates indicated broad catabolic repertoire including abundance of As^{5+} reductase activity and abilities in utilizing wide ranges of organic and inorganic respiratory substrates. Abundance of As homeostasis genes and utilization of hydrocarbon as carbon/electron donor and As^{5+} as electron acceptor were noted within the isolates. Sediment microcosm study (for 300 days) showed a pivotal role of metal reducing facultative anaerobic bacteria in toxic As^{3+} release in aqueous phase. Inhabitant bacteria catalyze As transformation and facilitate its release through a cascade of reactions including mineral bioweathering and As^{5+} and/or Fe^{3+} reduction activities. Compared to anaerobic incubation with As^{5+} reducing strains, oxic state and/or incubation with As^{3+} oxidizing bacteria resulted in reduced As release, thus indicating a strong role of such condition or biocatalytic mechanism in controlling *in situ* As contamination.

Keywords: Arsenic; Bacteria; As^{3+} oxidation; As^{5+} reduction; Microcosm

Biomarker

Hugo F. Olivares Rubio[1], M. Lysset Martínez-Torres[1], Minerva Nájera-Martínez[1], Ricardo Dzul-Caamal[1], María Lilia Domínguez-López[2], Ethel García-Latorre[2] and Armando Vega-López[1,*]. ([1]Laboratorio de Toxicología Ambiental, Escuela Nacional de Ciencias Biológicas, IPN, México, DF, México, [2]Laboratorio de Inmunoquímica I, Escuela Nacional de Ciencias Biológicas, IPN, México, DF, México). **Biomarkers involved in energy metabolism and oxidative stress response in the liver of *Goodea gracilis* Hubbs and Turner, 1939 exposed to**

the microcystin-producing *Microcystis aeruginosa* LB85 strain. Environmental Toxicology, Volume 30(10) (2015):1113–1124

Goodea gracilis is an endemic fish that only habitats in some water bodies of Central Mexico that are contaminated with cyanobacteria-producing microcystins (MC); however, a lack of information on this topic prevails. With the aim to generate the first approximation about the physiological changes elicited by cyanobacterium that produce MC congeners in this fish species, specimens born in the laboratory was exposed for 96 h to cell densities of 572.5, 1145, 2290, 4580, and 9160 × 10^6 cells of *Microcystis aeruginosa* strain LB85/L, and a set of novel endpoint related to hepatic gluconeogenesis (ADH/LDH) and pro-oxidant forces O_2^-, H_2O_2) in addition to biomarkers of oxidative damage and antioxidant response was evaluated in the liver. Results suggest that high inhibition of protein serine/threonine phosphatase (PP) may trigger many metabolic processes, such as those related to hepatic gluconeogenesis (ADH/LDH) and pro-oxidant O_2^-, H_2O_2, TBARS, ROOH, RC=O) as well as antioxidant (SOD, CAT, GPx) response to oxidative stress. Particularly, we observed that inhibition of LDH and PP, and H_2O_2 increase and TBARS production were the key damages induced by high densities of *M. aeruginosa*. However, changes between aerobic and anaerobic metabolism related with ROS metabolism and ADH/LDH balance are apparently an acclimation of this fish species to exposure to cyanobacteria or their MCs. Fish species living in environments potentially contaminated with cyanobacteria or their MCs possess mechanisms of acclimation that allow them to offset the damage induced, even in the case of fish that have never been exposed to MCs.

Keywords: ADH; LDH; protein phosphatase; lipid peroxidation; hydroperoxide radical; carbonyl proteins; superoxide anion; hydrogen peroxide; SOD; CAT; GPx

Annerose Seidel[1,*], Peter Seidel[2], Olaf Manuwald[3] and Olf Herbarth[1]. (Environmental Medicine and Hygiene, Faculty of Medicine, University of Leipzig, Leipzig, Germany, [2]Institute of Medical Biophysics and Physics, Faculty of Medicine, University of Leipzig, Leipzig, Germany. [3]Institute of Environmental Medicine, Erfurt, Germany). **Modified nucleosides as biomarkers for early cancer diagnose in exposed populations. Environmental Toxicology, Volume 30(8) (2015): 956–967**

There is increasing worldwide interest in developing of markers for tumor diagnosis and identification of individuals who are at high cancer risk. Cancer, like other diseases accompanied by metabolic disorders, causes characteristic effects on cell turnover rate, activity of modifying enzymes, and RNA/DNA modifications. This results in an increased excretion of modified nucleosides in cancer patients. Therefore, for many years modified nucleosides have been suggested as tumor markers. The aim of the study was to elucidate further the usefulness of urinary nucleosides as possible markers at early detection of cancer in persons which are exposed against tumor promoting influences during their working life. Uranium miners are exposed to many kinds of pollutants that can cause health damage even lead to carcinogenesis. We analyzed modified nucleosides in urine samples from 92 miners who are at high risk for lung cancer to assess the levels of nucleosides by a multilayer perceptron (MLP) classifier – a neural network model. Eighteen nucleosides/metabolites were detected with reversed-phase high-pressure liquid chromatography (RP-HPLC). A valid set of urinary metabolites were selected and multivariate statistical technique of multilayer perceptron neural network were applied. In a previous study, MLP shows a sensitivity and specificity of 97 and 85%, respectively. MLP classification including the most relevant markers/nucleosides clearly demonstrates the elevation of RNA metabolism in miners, which is associated with possible malignant disease. We found

that there were 30 subjects with early health disorders among 92 uranium workers based on MLP technique using modified nucleosides. The combination of RP-HPLC analysis of modified nucleosides and subsequent MLP analyses represents a promising tool for the development of a non-invasive prediction system and may assist in developing management and surveillance procedures.

Keywords: occupational cancer; modified nucleosides; HPLC; uranium miners; environmental health surveillance

Long Li[a], Lina Zhang[b], Jinghua Yu[a], Shenguang Ge[a,], Xianrang Song[c]. ([a] Key Laboratory of Chemical Sensing and Analysis in Universities of Shandong, School of Chemistry and Chemical Engineering, University of Jinan, Jinan 250022, PR China, [b] Shandong Provincial Key Laboratory of Preparation and Measurement of Building Materials, University of Jinan, Jinan 250022, PR China, [c] Cancer Research Center Shandong Tumor Hospital, Jinan 250117, PR China). **All-graphene composite materials for signal amplification toward ultrasensitive electrochemical immunosensing of tumor marker. Biosensors and Bioelectronics, Volume 71(2015): 108–114**

Graphene has shown great potential for use in biosensors because of its versatile surface modification, good water dispersibility, and extraordinary electrical conductivity. Here, a novel enzyme-free and all-graphene electrochemical immunosensor, based on two novel graphene nanocomposites, for the ultrasensitive immunosensing of α-fetoprotein (AFP) was reported. Noncovalent ultrathin gold nanowire functionalized graphene sheets (GNWs/GO) with the extraordinary biological and electrical properties, which exhibited high water solubility and further biological molecule functionalization, was prepared in situ solution phase to be used as an enhanced electrochemical sensing platform. In addition, a new electrocatalyst, CuS nanoparticle-decorated graphene (CuS/GO) composites was successfully prepared by a simple method for in situ growth of CuS on the surface of graphene sheets. Covalent binding of the detection antibody of AFP on the CuS/GO composites produced a sensitive electrochemical bioprobe for detection of AFP by sandwich immunosensing. The corresponding immunosensor, employing an inexpensive and portable 3D paper-based analytical device, possessed a wide calibration range of 0.001–10 ng mL^{-1} and a low detection limit of 0.5 pg mL^{-1}(S/N=3), which was successfully applied to the detection of AFP in serum samples from both healthy people and cancer patients. The present work thus demonstrated the promising application of graphene-based nanocomposites in developing highly sensitive, environmentally friendly, and cost-effective electrochemical biosensors.

Keywords: Graphene; Gold nanowires; Copper sulfide; Paper-based electrochemical immunodevice

Cheng Wang[a, b, 1], Jinho Kim[a, 1], Yibo Zhu[a], Jaeyoung Yang[a], Gwan-Hyoung Lee[c], Sunwoo Lee[d], Jaeeun Yu[e], Renjun Pei[f], Guohua Liu[b], Colin Nuckolls[e], James Hone[a], Qiao Lin[a]. ([a] Department of Mechanical Engineering, Columbia University, New York, NY 10027, USA, [b] Department of Microelectronic Engineering, Nankai University, Tianjin 300071, China, [c] Department of Materials Science and Engineering, Yonsei University, Seoul 120749, Republic of Korea, [d] Department of Electrical Engineering, Columbia University, New York, NY 10027, USA, [e] Department of Chemistry, Columbia University, New York, NY 10027, USA, [f] Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, Suzhou, Jiangsu 215123, China). **An aptameric graphene nanosensor**

for label-free detection of small-molecule biomarkers. Biosensors and Bioelectronics, Volume 71(2015): 222–229

This paper presents an aptameric graphene nanosensor for detection of small-molecule biomarkers. To address difficulties in direct detection of small molecules associated with their low molecular weight and electrical charge, we incorporate an aptamer-based competitive affinity assay in a graphene field effect transistor (FET), and demonstrate the utility of the nanosensor with dehydroepiandrosterone sulfate (DHEA-S), a small-molecule steroid hormone, as the target analyte. In the competitive affinity assay, DHEA-S specifically binds to aptamer molecules pre-hybridized to their complementary DNA anchor molecules immobilized on the graphene surface. This results in the competitive release of the strongly charged aptamer from the DNA anchor and hence a change in electrical properties of the graphene, which can be measured to achieve the detection of DHEA-S. We present experimental data on the label-free, specific and quantitative detection of DHEA-S at clinically appropriate concentrations with an estimated detection limit of 44.7 nM, and analyze the trend observed in the experiments using molecular binding kinetics theory. These results demonstrate the potential of our nanosensor in the detection of DHEA-S and other small molecules in biomedical applications.

Keywords: Aptamer; Competitive assay; Dehydroepiandrosterone sulfate (DHEA-S); Graphene; Nanobiosensor; Small molecule

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Acute myocardial infarction or myocardial infarction (MI) is a major health problem, due to diminished flow of blood to the heart, leads to higher rates of mortality and morbidity. Data from World Health Organization (WHO) accounted 30% of global death annually and expected more than 23 million die annually by 2030. This fatal effects trigger the need of appropriate biomarkers for early diagnosis, thus countermeasure can be taken. At the moment, the most specific markers for cardiac injury are cardiac troponin I (cTnI) and cardiac troponin T (cTnT) which have been considered as ‘gold standard’. Due to higher specificity, determination of the level of cardiac troponins became a predominant indicator for MI. Several ways of diagnostics have been formulated, which include enzyme-linked immunosorbent assay, chemiluminescent, fluoro-immunoassays, electrical detections, surface plasmon resonance, and colorimetric protein assay. This review represents and elucidates the strategies, methods and detection levels involved in these diagnostics on cardiac superior biomarkers. The advancement, sensitivity, and limitations of each method are also discussed. In addition, it concludes with a discussion on the point-of care (POC) assay for a fast, accurate and ability of handling small sample measurement of cardiac biomarker.

Keywords: Cardiac troponin; Biomarker; Myocardial infarction; Biosensor

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Environment, Akvaplan-niva, FRAM, High North Research Centre for Climate and the EnvironmentDepartment of Engineering and Safety, UiT the Arctic University of Norway, Littoral Environnement et Sociétés (LIENSs), UMR 7266, CNRS-Université de La Rochelle, Littoral Environnement et Sociétés (LIENSs), UMR 7266, CNRS-Université de La Rochelle). Biomarker modulation associated with marine diesel contamination in the Iceland scallop (*Chlamys islandica*). Environmental Science and Pollution Research, Volume 22(23) (2015): 19292-19296

The decrease of ice cover in the Arctic will lead to an increase of ship traffic in the upcoming decades. Consequently, oil pollution is expected. In this context, the goals of this study were to evaluate the biological impact of marine diesel contamination and, on this basis, to determine analytical tools of interest (biomarkers) for future biomonitoring of diesel spills. Using a 7-day contamination protocol, this study investigated biochemical modulations in the digestive gland of the Iceland scallop (*Chlamys islandica*). Incorporation of contaminants was verified assessing haemolymph metabolites. Results showed a response of glutathione-S-transferase to contamination suggesting detoxification processes and the suitability of such a tool for diesel spill biomonitoring. The lack of modulation of superoxide dismutase activity and lipid peroxidation suggests no oxidative stress and the unsuitability of these molecular tools for biomonitoring.

Keywords: Marine diesel Iceland scallops; Glutathione-S-transferase; Oxidative stress; Haemolymph metabolites; Digestive gland

Utkarsh A. Reddy, P. V. Prabhakar, G. Sankara Rao, Pasham Rajasekhar Rao, K. Sandeep, M. F. Rahman, S. Indu Kumari, Paramjit Grover, Haseeb A. Khan. (Toxicology Unit, Biology Division, Indian Institute of Chemical Technology, Analytical and Molecular Bioscience research group, Department of Biochemistry, College of Science, King Saud University). Biomarkers of oxidative stress in rat for assessing toxicological effects of heavy metal pollution in river water. Environmental Science and Pollution Research, Volume 22(17) (20150: 13453-13463

Increasing use of heavy metals in various fields, their environmental persistency, and poor regulatory efforts have significantly increased their fraction in river water. We studied the effect of Musi river water pollution on oxidative stress biomarkers and histopathology in rat after 28 days repeated oral treatment. River water analysis showed the presence of Zn and Pb at mg/l concentration and Ag, As, Ba, Cd, Co, Cr, Cu, Mn, Mo, Ni, Sn, and Sb at µg/l concentration. River water treatment resulted in a dose-dependent accumulation of metals in rat organs, being more in liver followed by kidney and brain. Metal content in both control and low-dose group rat organs was below limit of detection. However, metal bioaccumulation in high- and medium-dose group organs as follows: liver—Zn (21.4 & 14.5 µg/g), Cu (8.3 & 3.6 µg/g), and Pb (8.2 & 0.4 µg/g); kidney—Zn (16.2 & 7.9 µg/g), Cu (3.5 & 1.4 µg/g), Mn (2.9 & 0.5 µg/g), and Pb (2.6 & 0.5 µg/g); and brain—Zn (2.4 & 1.1 µg/g), and Ni (1 & 0.3 µg/g). These metals were present at high concentrations in respective organs than other metals. The increased heavy metal concentration in treated rat resulted significant increase in superoxide dismutase, glutathione peroxidase, glutathione reductase, glutathione S transferase enzymes activity, and lipid peroxidation in a dose-dependent manner. However, glutathione content and catalase activity were significantly decreased in treated rat organs. Histopathological examination also confirmed morphological changes in rat organs due to polluted river water treatment. In conclusion, the

findings of this study clearly indicate the oxidative stress condition in rat organs due to repeated oral treatment of polluted Musi river water.

Keywords: Polluted water; Heavy metals; Liver; Kidney; Brain; Biodistribution; Oxidative stress; Histopathology

Biocomposting

Guilherme Malafaia[a, b], Dieferson da Costa Estrela[a], Abraão Tiago Batista Guimarães[c], Fernando Godinho de Araújo[d], Wilson Mozena Leandro[e], Aline Sueli de Lima Rodrigues[a]. ([a] Laboratório de Pesquisas Biológicas, Departamento de Ciências Biológicas, Instituto Federal de Educação, Ciência e Tecnologia Goiano – Câmpus Urutaí, Urutaí, Goiás, Brazil, [b] Programa de Pós-Graduação em Biodiversidade Animal, Universidade Federal de Goiás, Câmpus Samambaia, Goiânia, Brazil, [c] Laboratório de Pesquisas Biológicas, Instituto Federal de Educação, Ciência e Tecnologia Goiano – Câmpus Urutaí, Urutaí, Goiás, Brazil, [d] Laboratório de Pesquisas Biológicas, Departamento de Agronomia, Instituto Federal de Educação, Ciência e Tecnologia Goiano – Câmpus Urutaí, Urutaí, Brazil, [e] Departamento de Agricultura, Universidade Federal de Goiás – Câmpus Samambaia, Goiânia, Brazil). **Vermicomposting of different types of tanning sludge (liming and primary) mixed with cattle dung. Ecological Engineering, Volume 85(2015): 301–306**

The complexity of the generation of solid residues is a present issue, because of the polluting potential of many materials produced. Therefore, the objective of this study is to assess vermicomposting of different types of tanning sludge (liming and primary), aiming at reuse in agriculture. Thus, the types of tanning sludge known as liming and primary (tannery industry from, Pires do Rio, Goiás, Brazil) were mixed to cattle dung in different proportions (10, 20, 30, 40 and 50%, dry basis) and then earthworms of the species*Eisenia foetida* were introduced. After 120 days, the composts were chemically analyzed. Our results demonstrate that the vermicomposting of different types mixtures of the of tannery sludge with cattle dung (10–50% concentrations) is capable of increasing concentrations of N, K, Ca, Mg and Na. Primary sludge mixtures with cattle dung, at higher concentrations (20–50%) reduce the concentration of the Cu, while liming sludge mixtures with cattle dung (20–50% concentrations) increase the concentration of the element. On the other hand, mixtures containing primary sludge reduces the concentration of Fe and increase the concentration of Zn. Finally, independent of the sludge mixed and the concentrations of the cattle dung used in this study, these substrates reduce the TOC concentration and C/N, which are one of the most traditional indicators of the maturation of a compost.

Keywords: Vermiculture; Solid residues; Earthworms; Agroecology

T. Reuter, B.H. Gilroyed, W. Xu, T.A. McAllister, K. Stanford. (Government of Alberta, Lethbridge, AB, Canada. Correspondence : Tim Reuter, Government of Alberta, Lethbridge, AB T1J 4V6, Canada. E-mail: tim.reuter@gov.ab.ca. University of Guelph, Ridgetown, ON, Canada. Dalian University of Technology, Panjin, China. Agriculture and Agri-Food Canada, Lethbridge, AB, Canada. Government of Alberta, Lethbridge, AB, Canada). **Compost biodegradation of recalcitrant hoof keratin by bacteria and fungi. Journal of Applied Microbiology, Volume 119(2) (2015): 425–434**

Compost activities efficiently break down a wide range of organic substances over time. In this study, bovine hoof was used as recalcitrant protein model to gain so far cryptic information on biodegradation during livestock mortalities composting.

Bovine hooves (black and white), containing different amounts of melanin, placed into nylon bags were monitored during composting of cattle mortalities for up to 230 days. Besides physiochemical analysis, bacterial 16S and fungal 18S DNA fragments were amplified by PCR and profiles were separated by DGGE. Sequence analysis of separated fragments revealed various bacterial and fungal identities during composting. The microbial diversity was affected by a time-temperature interaction and by the hoof colour. Our molecular data, supported by electron microscopy, suggest hoof colonization by shifting bacteria and fungi communities.

During composting, microbial communities work collaboratively in the degradation of recalcitrant organic matter such as keratin over time. A number of biomolecules including recalcitrant proteins may persist in environmental reservoirs, but breakdown can occur during composting. A combination of bioactivity and physiochemical conditions appear to be decisive for the fate of persistent biomolecules.

N. Hussain, Tasneem Abbasi[1], S.A. Abbasi. (Centre for Pollution Control & Environmental Engineering, Pondicherry University, Chinakalapet, Puducherry 605 014, India). Vermicomposting eliminates the toxicity of *Lantana* (*Lantana camara*) and turns it into a plant friendly organic fertilizer. Journal of Hazardous Materials, Volume 298(2015): 46–57

In evidently the first study of its kind, vermicompost derived solely from a weed known to possess plant and animal toxicity was used to assess its impact on the germination and early growth of several plant species. No pre-composting or supplementation of animal manure was done to generate the vermicompost in order to ensure that the impact is clearly attributable to the weed. Whereas the weed used in this study, *Lantana* (*Lantana camara*), is known to possess strong negative allelopathy, besides plant/animal toxicity in other forms, its vermicompost was seen to be a good organic fertilizer as it increased germination success and encouraged growth of all the three botanical species explored by the authors – green gram (*Vigna radiata*), ladies finger (*Abelmoschus esculentus*) and cucumber (*Cucumis sativus*). In terms of several physical, chemical and biochemical attributes that were studied, the vermicompost appeared plant-friendly, giving best results in general when employed at concentrations of 1.5% in soil (w/w). Fourier transform infrared spectrometry revealed that the phenols and the sesquiterpene lactones that are responsible for the allelopathic impact of *Lantana* were largely destroyed in the course of vermicomposting. There is also an indication that lignin content of *Lantana* was reduced during its vermicomposting. The findings open up the possibility that the billions of tons of phytomass that is generated annually by *Lantana* and other invasives can be gainfully utilized in generating organic fertilizer via vermicomposting.

Keywords: *Lantana camara*; *Abelmoschus esculentus*; Allelopathy; *Cucumis sativus*; Vermicompost; Seed germination; *Vigna radiata*

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de Agricultura, Universidade Federal de Goiás – Câmpus Samambaia, Goiânia, Brazil). Vermicomposting of different types of tanning sludge (liming and primary) mixed with cattle dung. Ecological Engineering, Volume 85(2015): 301–306

The complexity of the generation of solid residues is a present issue, because of the polluting potential of many materials produced. Therefore, the objective of this study is to assess vermicomposting of different types of tanning sludge (liming and primary), aiming at reuse in agriculture. Thus, the types of tanning sludge known as liming and primary (tannery industry from, Pires do Rio, Goiás, Brazil) were mixed to cattle dung in different proportions (10, 20, 30, 40 and 50%, dry basis) and then earthworms of the species *Eisenia foetida* were introduced. After 120 days, the composts were chemically analyzed. Our results demonstrate that the vermicomposting of different types mixtures of the of tannery sludge with cattle dung (10–50% concentrations) is capable of increasing concentrations of N, K, Ca, Mg and Na. Primary sludge mixtures with cattle dung, at higher concentrations (20–50%) reduce the concentration of the Cu, while liming sludge mixtures with cattle dung (20–50% concentrations) increase the concentration of the element. On the other hand, mixtures containing primary sludge reduces the concentration of Fe and increase the concentration of Zn. Finally, independent of the sludge mixed and the concentrations of the cattle dung used in this study, these substrates reduce the TOC concentration and C/N, which are one of the most traditional indicators of the maturation of a compost.

Keywords: Vermiculture; Solid residues; Earthworms; Agroecology

Su Lin Lim, Ta Yeong Wu. (Chemical Engineering Discipline, School of Engineering, Monash University, Jalan Lagoon Selatan, 47500 Bandar Sunway, Selangor Darul Ehsan, Malaysia). Determination of maturity in the vermicompost produced from palm oil mill effluent using spectroscopy, structural characterization and thermogravimetric analysis. Ecological Engineering, Volume 84(2015): 515–519

Vermicompost produced from palm oil mill effluent was evaluated for its maturity using: (i) spectroscopic analysis (Fourier transform infrared spectroscopy (FT-IR) and ultraviolet visible (UV–vis) spectroscopy); (ii) structural characterization (scanning electron microscope (SEM) and Brunauer, Emmett and Teller (BET) surface area) and (iii) thermogravimetric (TG) analysis. The FT-IR showed increased mineralization of polysaccharides, carbohydrates and aliphatic methylene compounds in the vermicompost as compared to the control (without earthworms). A slight increase of aromatic compounds was observed and proven by UV–vis spectroscopy analysis for vermicompost. Structural characterization (SEM micrographs) of the vermicompost was revealed to be more fragmented than initial wastes and control. The vermicompost also showed larger surface area by using BET method. Finally, the TG analysis showed lower mass loss in the vermicompost in comparison with the initial wastes and control, suggesting higher stability in feedstock which had undergone vermicomposting process. The first derivative curve from TG analysis also showed degradation of various compounds, which was consistent with the spectroscopic characterization.

Keywords: BET surface area; *Eudrilus eugeniae*; FT-IR; Organic fertilizer; UV–vis; Vermicomposting

S. Das[a], J. Bora[a], L. Goswami[a], P. Bhattacharyya[b], P. Raul[c], M. Kumar[a], S.S. Bhattacharya[a.] ([a]Department of Environmental Science, Tezpur University, Assam 784028, India, [b] Indian Statistical Institute, North East Centre, Tezpur, Assam 784028, India, [c] Defence Research Laboratory, DRDO, Tezpur, Assam, India). Vermiremediation of Water

Treatment Plant Sludge employing *Metaphire posthuma*: A soil quality and metal solubility prediction approach. Ecological Engineering, Volume 81(2015): 200–206

Water Treatment Plant Sludge (WTPS) is formed during sewage treatment and is extremely rich in nutrients (N, P and K) and toxic heavy metals. In this work, efficiency of vermicomposting technology was evaluated using an endogeic earthworm *Metaphire posthuma*, against aerobic composting in regard to stabilization of WTPS. Different combinations of WTPS and cow dung were utilized as feed stock. Low pH of WTPS changed towards neutrality under both the biocomposting systems. The contents of N (45–61%), P (50–80%) and K (83–88%) increased significantly under *Metaphire* vermicomposting system accompanied by substantial reduction in total organic C. Interestingly, improvement in soil quality and low accumulation of heavy metal (Cr and Cu) in soil under vermistabilized WTPS treatments was noteworthy. Moreover, the solubility pattern of non metal and metal ions in vermistabilized and crude WTPS was studied to understand their impacts on moist soil environment with the help of MINTEQ geochemical model. The model predicted decrement of metal solubility (Cr, Zn, Cu, and Mn) in WTPS+CD (1:1) and WTPS+CD (2:1) vermicompost as compared to untreated WTPS. The overall results suggest that *Metaphire posthuma* could be utilized as a successful candidate for bioprocessing toxic WTPS materials.

Keywords: Water Treatment Plant Sludge (WTPS); Vermicomposting; Soil quality; Metal solubility; Visual MINTEQ

Biopesticides

E.O. Juárez-Hernández. (Life Science Division, Graduate Program in Biosciences Irapuato, University of Guanajuato Campus Irapuato-Salamanca, Irapuato, Guanajuato, México). *Bacillus thuringiensis* subsp. *israelensis* producing endochitinase ChiA74Δsp inclusions and its improved activity against *Aedes aegypti*. *Journal of Applied Microbiology*, Volume 119(6) (2015): 1692–1699

The objective of this study was to produce stable inclusions of chitinase ChiA74Δsp in *Bacillus thuringiensis* subsp. *israelensis* (Bti) and to assay its insecticidal activity against *Aedes aegypti* larvae.

Bti was transformed with *chiA74*Δsp regulated by its own promoter or by the strong chimeric *cytAp/*STAB-SD promoter system to generate two recombinant Bti strains. These recombinants produced their native parasporal bodies composed of Cry4Aa, Cry4Ba, Cry11Aa and Cyt1Aa and ChiA74Δsp inclusions, and showed a approx. threefold increase in both endochitinase activity and viable spore count when compared with the parental strain. Both recombinants were approximately twofold more toxic (LC_{50s} 8·02, 9·6 ng ml^{-1}) than parental Bti (19·8 ng ml^{-1}) against 4th instars of *A. aegypti* larvae.

ChiA74Δsp inclusions, together with the insecticidal crystals and spores of Bti increased the toxicity against *A. aegypti* larvae by at least twofold.

We report for the first time the engineering of Bti to produce spore-parasporal body-ChiA74Δsp inclusions in the same sporangium, which are released together following autolysis. Our work

lays a foundation for engineering Bti to produce more efficacious combinations of Cry4Aa, Cry4Ba, Cry11Aa, Cyt1Aa and chitinase inclusions.

D. Yu, J. Wang, X. Shao, F. Xu, H. Wang. (Department of Food Science and Engineering, Ningbo University, Ningbo, China. Correspondence : Xingfeng Shao, Department of Food Science and Engineering, Ningbo University, Ningbo 315211, China. E-mail: shaoxingfeng@nbu.edu.cn). Antifungal modes of action of tea tree oil and its two characteristic components against *Botrytis cinerea. Journal of Applied Microbiology,* Volume 119(5) (2015): 1253–1262

The essential oil of *Melaleuca alternifolia* (tea tree) has been evaluated as a potential eco-friendly antifungal agent against *Botrytis cinerea*. In this study, we investigated the antifungal activity and mode of action of tea tree oil (TTO) and its components against *B. cinerea*.

Of the components we tested in contact phase, terpinen-4-ol had the highest antifungal activity, followed by TTO, α-terpineol, terpinolene, then 1,8-cineole. As one of characteristic components of TTO, terpinen-4-ol treatment led to pronounced alterations in mycelial morphology, cellular ultrastructure, membrane permeability under scanning electron microscope, transmission electron microscope and fluorescent microscope, and also reduced the ergosterol content of fungi. As another characteristic component, 1,8-cineole caused serious intracellular damage but only slightly affected *B. cinerea* otherwise. When terpinen-4-ol and 1,8-cineole were used together, the synergistic antifungal activity was significantly higher than either component by itself.

The results of our study confirmed that terpinen-4-ol and 1,8-cineole act mainly on the cell membranes and organelles of *B. cinerea*, respectively, and when combined are similar to TTO in antifungal activity due to their differences. Understanding the mechanism of terpinen-4-ol and 1,8-cineole antifungal action to *B. cinerea* is helpful for investigation on their synergistic effect and explaining antifungal action modes of TTO.

R.U. Abhishek, S. Thippeswamy, K. Manjunath, D.C. Mohana. (Department of Microbiology and Biotechnology, Bangalore University, Bengaluru, India. Correspondence: Devihalli C. Mohana, Department of Microbiology and Biotechnology, Bengaluru University, Jnana Bharathi, Bengaluru-560 056, India. E-mail: mohanadc@gmail.com). Antifungal and antimycotoxigenic potency of *Solanum torvum* Swartz. leaf extract: isolation and identification of compound active against mycotoxigenic strains of *Aspergillus flavus* and *Fusarium verticillioides. Journal of Applied Microbiology,* Volume 119(6) (2015): 1624–1636

The main objective of this study was to investigate the antifungal effect of *Solanum torvum* leaves against different field and storage fungi, and to identify its active compound. In addition, to evaluate *in vitro* and *in vivo* inhibitory efficacy on toxigenic strains of *Aspergillus flavus* and *Fusarium verticillioides.*

Leaves of *S. torvum* were sequentially extracted with petroleum ether, toluene, chloroform, methanol and ethanol. The antifungal compound isolated from chloroform extract was identified as torvoside K based on spectral analysis. The antifungal activity of chloroform extract and torvoside K was determined by broth microdilution and poisoned food techniques. The minimum inhibitory concentration (MIC), minimum fungicidal concentration (MFC) and zone of inhibition (ZOI) were recorded. Further, inhibitory effects of chloroform extract and torvoside K on growth of *A. flavus* and *F. verticillioides*, and their toxin productions were evaluated using *in vitro* and *in vivo* assays. Torvoside K showed the significant activity against tested fungi with ZOIs and

MICs ranging from 33·4 to 87·4% and 31·25–250 μg ml^{-1}, respectively. Further, torvoside K showed concentration-dependent antimycotoxigenic activity against aflatoxin B1 and fumonisin B1 production by *A. flavus* and *F. verticillioides*, respectively.

It was observed that the compound torvoside K significantly inhibited the growth of all fungi tested. Growth of *A. flavus* and *F. verticillioides*, and aflatoxin B1 and fumonisin B1 productions were completely inhibited *in vitro* and *in vivo* by torvoside K with increasing concentration. Control of mycotoxigenic fungi requires compounds that able to inhibit both fungal growth and mycotoxin production. The antimycotoxigenic potential of torvoside K of *S. torvum* is described in this study for the first time. The results indicate the possible use of *S. torvum* as source of antifungal agents against postharvest fungal infestation of food commodities and mycotoxin contaminations.

Adriana M. do Nascimento, Mateus Gonçalves Soares, Fernanda K. V. da Silva Torchelsen, Jorge A. Viana de Araujo, Paula S. Lage, Mariana C. Duarte, Pedro H. R. Andrade, Tatiana G. Ribeiro, Eduardo A. F. Coelho, Andréa M. do Nascimento. (Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Departamento de Química, Instituto de Ciências Exatas e Biológicas, Universidade Federal de Ouro Preto, Programa de Pós-Graduação em Ciências da Saúde: Infectologia e Medicina Tropical, Faculdade de Medicina e Departamento de Patologia Clínica, COLTEC, Universidade Federal de Minas Gerais). Antileishmanial activity of compounds produced by endophytic fungi derived from medicinal plant *Vernonia polyanthes* and their potential as source of bioactive substances. World Journal of Microbiology and Biotechnology, Volume 31(11) (2015): 1793-1800

The purpose of this work was to evaluate the antileishmanial activity of endophytic fungi isolated from leaves of *Vernonia polyanthes* plant and their prospective use in the discovery of bioactive compounds. Sixteen endophytes were isolated by using potato dextrose agar medium and submitted to cultivation in rice medium. The fungal cultures were extracted with ethanol and used as crude extracts for testing their antileishmanial activity. The most active ethanol extract was obtained from P2-F3 strain, which was identified as *Cochliobolus sativus* by ITS rRNA gene sequence data. Followed by a bioassay-guided fractionation, the cochlioquinone A, isocochlioquinone A and anhydrocochlioquinone A compounds were isolated from the crude extracts and demonstrated to inhibit the parasites. From the present work, it is possible to conclude that endophytic fungi derived from medicinal plant *V. polyanthes* may be considered promising source for the discovery of bioactive compounds.

Keywords: *Vernonia polyanthes;* Endophytes; Bioprospection; Antileishmanial activity; *Leishmania amazonensis*

Thulasya Ramanathan, Yen-Peng Ting. (Department of Chemical and Biomolecular Engineering, National University of Singapore). Selective Copper Bioleaching by Pure and Mixed Cultures of Alkaliphilic Bacteria Isolated from a Fly Ash Landfill Site. Water, Air, & Soil Pollution, Volume, 226(2015): 374

With the gradual depletion of high-grade copper ore deposits, secondary wastes are gaining importance as a source for metal recovery. However, the alkalinity and low copper concentration in some of these resources underscore the need for selective leaching agents. In this work, indigenous alkaliphiles from a fly ash landfill site with inherent pH tolerance, metal tolerance

and copper leaching capability were isolated and investigated. Four isolates, namely *Agromyces aurantiacus* TRTYP3, *Alkalibacterium pelagium* TRTYP5, *Alkalibacterium* sp. TRTYP6 and *Bacillus foraminis* TRTYP17, each selectively leached about 50 % copper from 1 % (*w*/*v*) of fly ash. Mixed culture of these bacteria resulted in higher leaching of copper. The optimal combination was TRTYP3, TRTYP5, TRTYP6 and TRTYP17 in the ratio 1:1:3:1, which leached 88, 81, 78, 76, 70 and 55 % Cu from 1, 2.5, 5, 10, 15 and 20 % (*w*/*v*) of fly ash. While Cu and Pb were bioleached into solution, Fe and Zn were precipitated.

Keywords: Copper recovery; Fly ash; Bioleaching; Alkaliphilic isolates; Pure and mixed culture

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This study presents bioleaching of metals from a vanadium-rich oil-fired ash (OFA) sample using adapted *Acidithiobacillus ferrooxidans.* OFA is a major by-product of thermal power plants that contains metals such as V, Ni and Cu. The adaptation of bacteria to the ash sample was carried up to 4% (w/v), then three factors affecting metals recovery including initial pH, initial Fe^{2+} concentration and inoculum percentage were selected to be optimized. Initial pH of 1, inoculum of 1% and initial Fe^{2+} concentration of 1 g/l were determined as optimal condition. Under optimum condition after 10 days the maximum recovery for V, Ni and Cu was obtained 82%, 86%, and 87%, respectively. Results showed that in comparison with chemical leaching, bioleaching recovery of V, Ni and Cu were improved 20%, 16% and 8%, respectively. To determine the rate limiting step of the process, modified shrinking core model was used and result showed that diffusion step controlled the overall dissolution. The morphology and crystallinity of the samples before and after bioleaching were investigated by X-ray diffraction (XRD) and field emission scanning electron microscopy (FE-SEM), respectively. Risk assessments of OFA before and after bioleaching by the toxicity characteristic leaching procedure (TCLP) were done and results indicated the bioleaching process detoxified OFA and the bioleached residue was well within the regulatory limits.

Keywords: Bioleaching; Oil-fired ash; *Acidithiobacillus ferrooxidans*; Kinetics; Toxicity assessment

Alex Echeverría-Vega, Cecilia Demergasso. (Centro de Biotecnología "Profesor Alberto Ruiz", Universidad Católica del Norte, Antofagasta, Chile). Copper resistance, motility and the mineral dissolution behavior were assessed as novel factors involved in bacterial adhesion in bioleaching. Hydrometallurgy, Volume 157(2015): 107–115

A study was carried out on the adhesion to sulfide minerals of chemolithoautotrophic acidophilic bacteria obtained from industrial copper bioleaching operation. For this purpose, a mixed culture obtained from an industrial process and two metabolically different pure strains of *Acidithiobacillus*: *A. ferrooxidans* and *A. ferridurans* were used. These microorganisms showed significant differences in adhesion with respect to pyrite and chalcocite in terms of the temporal dynamics patterns and preference. A complex dynamics that involve cycles of attachment and detachment can only be explained by considering both, the intrinsic characteristics of the microorganisms, such as hydrophobicity, resistance and motility, and the properties of each mineral like their hydrophobicity, dissolution behavior and ionic contribution.

Keywords: Adhesion; Bioleaching; Chalcocite; Mineral surface; Detachment

Nadia Landero Valenzuela[a], Daniel Nieto Angel[a], Daniel Téliz Ortiz[a], Raquel Alatorre Rosas[a], Carlos Fredy Ortíz García[b], Mario Orozco Santos[c]. ([a] Colegio de Postgraduados Campus Montecillo, Carretera México Texcoco Km. 6.5, Montecillo, Texcoco 56230, Estado de México, Mexico, [b] Colegio de Postgraduados, Campus Tabasco. Periférico Carlos A. Molina, s/n, Carretera Cárdenas-Huimanguillo, km 3, Cárdenas, Tabasco, Mexico, [c] Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), Carretera Colima-Manzanillo, km. 35, Colonia Predio La Escondida, Tecomán, C.P. 28930, Colima, Colima, Mexico).

Biological control of anthracnose by postharvest application of *Trichoderma* spp. on maradol papaya fruit. Biological Control, Volume 91(2015): 88–93

Papaya is one of the most cultivated fruit in tropical and subtropical countries. It is affected by several postharvest pathogens, including *Colletotrichum gloeosporioides*. The main goal of this research was to evaluate the antagonistic capacity of five strains of *Trichoderma* against *C. gloeosporioides* using *in vitro* and *in vivo* tests. All strains of *Trichoderma* inhibited radial growth on a plate of *Colletotrichum* by 50–60%. Moreover, *Trichoderma longibrachiatum* showed the highest colonization (87.45%) on *Colletotrichum*. In tests to determine the mechanism of action, mycoparasitism was observed. *Trichoderma harzianum* was mainly found invading mycelium of *C. gloeosporioides*. The severity measure showed that it was the interaction of the strain with the different time of inoculation that influenced the size of the lesion, with the largest decrease in lesion size occurring when *Trichoderma viride* was inoculated 24 h before the pathogen. On the other hand, the *Trichoderma* strains did not cause color changes on papaya fruits.

Keywords: *Trichoderma* spp.; *Colletotrichum gloeosporioides*; Colonization; Inhibition; Phytotoxicity; *Carica papaya*

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Efficacy of *Bacillus subtilis* and *Trichoderma asperellum* against *Pythium aphanidermatum* in tomatoes. Biological Control, Volume 90(2015): 92–95

Seedling damping-off disease caused by *Pythium aphanidermatum* is the most important seedling disease in tomato production in Kenya. The disease causes seedling losses of up to 30%. Greenhouse trials were conducted to evaluate the application of *Bacillus subtilis* and *Trichoderma asperellum*, as seed coating for management of damping-off in tomato from April 2011 to August 2014. Tomato seeds (var. Rio Grande) were coated with either *B. subtilis* or *T. asperellum* at a concentration of 10^6 CFU/ml. The interaction between the two biocontrol agents and NPK fertilizer was assessed. To simulate the effect of high disease pressure, the coated seeds were planted in *P. aphanidermatum* inoculated media. The post-emergence seedling damping-off on seeds coated with *B. subtilis* and *T. asperellum* was 20.19% and 24.07% respectively while the control (non-coated) had 65.89% seedling mortality. A combination of NPK fertilizer and biocontrols in seedling management resulted to a significantly higher dry mass compared to the use of either biocontrol agent or fertilizer alone ($P \leqslant 0.001$). This study indicates that coating of tomato seeds with *B. subtilis* and *T. asperellum* may be useful in the management of damping-off disease.

Keywords: Damping-off disease; Biological control; Fungal isolates; Coated seed

Roshan Manandhar[a, b, 1], Mark G. Wright[b]. ([a] Lincoln University, Cooperative Research and Extension, 900 Chestnut Street, Allen Hall 302, Jefferson City, MO 65101, USA, [b] Department of Plant and Environmental Protection Sciences, University of Hawaii at Manoa, 3050 Maile Way, Gilmore Hall 310, Honolulu, HI 96822, USA). **Enhancing biological control of corn earworm, *Helicoverpa zea* and thrips through habitat management and inundative release of *Trichogramma pretiosum* in corn cropping systems. Biological Control, Volume 89(2015): 84–90**

Conservation-(habitat management) and augmentative biological control (field releases of natural enemies) are important pest biological control methods in agricultural systems. When these methods are employed at a critical stage of the crop and pest phenology, they can be effective and economically viable to suppress the target pest below its economic threshold. Field experiments consisting three treatments: (1) corn intercropped with sunn hemp (habitat management: conservation biological control), (2) corn monoculture with release of *Trichogramma pretiosum* (inundative biological control), and (3) corn monoculture as a control were conducted. This study aimed to compare the effectiveness of (I) conservation- and inundative biological control (biocontrol-enhanced treatments) with corn monoculture in terms of improving parasitism of *Helicoverpa zea* eggs by *T. pretiosum*, (II) conservation biological control with corn monoculture on predation of *H. zea* eggs and thrips by *Orius* spp. Results showed parasitism of *H. zea* eggs on corn silks was greater in the biocontrol-enhanced treatments compared to the monoculture control, and was greater in the *T. pretiosum* released treatment compared to the habitat management. Abundance of *Orius* spp. in relation to prey availability was greater in the habitat management treatment compared to the monoculture control. Proportion of corn ears damaged in *Trichogramma* release plots was lower than other treatments. These results suggest that inundative release of *T. pretiosum* is a potentially more viable management tool for *H. zea* control in corn compared to the habitat management with sunn hemp as an intercrop.

Keywords: Habitat management; Inundative biological control; *Helicoverpa zea*; *Trichogramma pretiosum*; *Orius* spp.

Sébastien Massart[a], Margarita Martinez-Medina[b], M. Haissam Jijakli[a]. ([a] Laboratory of Integrated and Urban Phytopathology, University of Liège, Gembloux Agro-Bio Tech, Passage des déportés 2, 5030 Gembloux, Belgium, [b] Laboratory of Molecular Microbiology, Department of Biology, University of Girona, Girona, Spain). **Biological control in the microbiome era: Challenges and opportunities. Biological Control, Volume 89(2015): 98–108**

Biocontrol research has long been focused on the study of single strains of biocontrol agents (BCAs) and on their interaction with pathogens and host plants. Further focus on plant-associated microbial communities was suggested several years ago, but significant advances only occurred recently. The advent of high-throughput sequencing (or next-generation sequencing – NGS) technologies is now driving a paradigm change that allows researchers to integrate microbial community studies into the traditional biocontrol approach. This integration could answer old scientific questions, and will raise new biocontrol hypotheses. Microbial communities could impact disease control through their interaction with host plants, pathogens, and BCAs. A better understanding of these interactions will provide unexpected opportunities to develop innovative biocontrol methods against plant pathogens. For example, formulation or timing of BCA application can be improved, “helper” microbial strains can be selected, or

molecules driving the microbiota to a pathogen-resistant composition ("prebiotic" approach) can be developed. The five main challenges of microbiome implementation in biocontrol research are also described, i.e. (i) the management of technical errors and biases, (ii) the growing importance of bioinformatics, (iii) the adaptation of experimental schemes, (iv) the appropriate interplay between NGS and other technologies, and (v) the need to complete current genome databases.

Keywords: Helper strain; Plant prebiotics; Pathobiome; Plant protection

Sebastien Massart, Michele Perazzolli, Monica Höfte, Ilaria Pertot, M. Haïssam Jijakli. (Laboratory of Integrated and Urban Phytopathology, Gembloux Agro-Bio Tech, University of Liège, Research and Innovation Centre, Fondazione Edmund Mach (FEM). **Impact of the omic technologies for understanding the modes of action of biological control agents against plant pathogens. BioControl, Volume 60(6) (2015): 725-746**

The characterization of microbial biological control agents (MBCAs) is crucial to improve their efficacy and consistency as biopesticides. Powerful approaches to characterize MBCA's modes of action are provided by modern molecular technologies. This paper reviews improvements achieved in this subject by three "omics" approaches: namely the genomic, the transcriptomic and the proteomic approaches. The paper discusses the advantages and drawbacks of new molecular techniques and 'discovery driven' approaches to the study of the biocontrol properties against plant pathogens. Omics technologies are capable of: (i) identifying the genome, transcriptome or proteome features of an MBCA strain, (ii) comparing properties of strains/mutants with different biocontrol efficacy, (iii) identifying and characterizing genes, mRNAs and proteins involved in MBCA modes of action, and (iv) simultaneously studying the transcriptome or proteome of the plant host, the plant pathogen and the MBCAs in relation to their bi- or tri-trophic interactions.

Keywords: Biological control; Omics; Genomics; Transcriptomics; Proteomics; Biocontrol agent

Shahar Samra, Murad Ghanim, Alex Protasov, Zvi Mendel. (Department of Entomology, The Volcani CenterFaculty of Agriculture, The Hebrew University of Jerusalem, Department of Entomology, The Volcani Center). **Spatial distribution and niche partitioning in the *Ooencyrtus* spp. complex parasitizing the eggs of *Stenozygum coloratum*. BioControl, Volume 60(6) (2015): 747-760**

The way in which species coexist is an important ecological question. Often, several parasitoid species may share a common host species. Five species of *Ooencyrtus* Ashmead (Hymenoptera: Encyrtidae) co-inhabit the egg clusters of *Stenozygum coloratum* Klug (Hemiptera: Pentatomidae), in the East Mediterranean region. Their relative abundance and spatial and seasonal occurrence were investigated. Parasitism and parasitoid male ratios gradually increased to about 50 and 26.8 %, respectively, from May to October. *O. telenomicida* Vassiliev was dominant in Mediterranean climatic regions and absent from arid areas, *O. fecundus* Ferrière and Voegelè dominated semi-arid areas, and *O.* near *nigerrimus* was the commonest in hot-arid areas. *O.* near *fecundus* occurred everywhere but was most abundant in the more extreme weather conditions. *O. pityocampae* Mercet was uncommon in most areas and absent from arid ones. *O. telenomicida* abundance was positively, and that of *O. fecundus* negatively, correlated with annual rainfall. *O.* near *fecundus* and *O.* near *nigerrimus* abundance was positively

correlated with temperature extremes. The results display a clear picture for climatic based spatial niche partitioning, although there is evidence that interspecific competition also plays a significant role in the frequency of occurrence of the studied *Ooencyrtus* spp.

Keywords: Egg parasitism; Encyrtidae; Hymenoptera; Niche partitioning; Sex ratio; Variegated caper bug

Pasquale Cascone, Simona Carpenito, Stine Slotsbo, Luigi Iodice, Jesper Givskov Sørensen, Martin Holmstrup. (Institute for Sustainable Plant Protection, National Research Council, Department of Bioscience, Aarhus UniversityDepartment of Bioscience, Aarhus University). Improving the efficiency of *Trichogramma achaeae* to control *Tuta absoluta.* BioControl, Volume 60(6) (2015): 761-771

Tuta absoluta Meyrick (Lepidoptera: Gelechiidae), commonly known as the tomato borer, is native to South America and has rapidly spread in various European countries becoming one of the major threats of tomato crop. The parasitic wasp *Trichogramma achaeae* Nagaraja and Nagarkatti (Hymenoptera: Trichogrammatidae) has been suggested as a possible biological control agent of the invasive pest and several aspects of its taxonomy have been elucidated. As for other egg parasitoids, the parasitism rate of this species is influenced by the rearing host and by the biotic environment, especially temperature. Starting from commercially available material, we assessed the influence of different rearing host eggs on *T. achaeae* longevity and fertility. We found that a single generation of the parasitoid on *Tuta absoluta* eggs laid on tomato leaf significantly improved *T. achaeae* attack rate against the tomato borer. Moreover, we found a positive effect between temperatures during development (acclimation) and the fertility of the parasitoid at different temperatures. This was particularly evident at 15 °C which was optimal for parasitoid fertility at low temperatures. We conclude that the combination of rearing system (plant + host egg) and temperatures (during development and use) are crucial factors for optimizing efficiency in terms of longevity and fertility of this species as a biocontrol agent of the tomato borer.

Keywords: Tomato borer; Rearing history; *Ephestia kuehniella; Sitotroga cerealella;* Temperature conditioning

Sergio Pérez-Guerrero, Asnake Gelan-Begna, Enrique Vargas-Osuna. (Laboratorio de Entomología, IFAPA, Centro "Las Torres-Tomejil", Departamento de Ciencias y Recursos Agrícolas y Forestales, Área de Entomología Agroforestal, ETSIAM, Universidad de Córdoba). Compatibility of *Orius laevigatus* and *Cheiracanthium pelasgicum* for predation on *Helicoverpa armigera* eggs: effects of density and day/night activity on intraguild predation, BioControl, Volume 60(6)(2015): 783-793

Intraguild predation (IGP) among predatory arthropods can impair pest control efforts and endanger the joint-action compatibility of groups of natural enemies. The present study used plant microcosms to examine IGP of *Cheiracanthium pelasgicum* (C. L. Koch) (Araneae: Miturgidae) on minute pirate bugs *Orius laevigatus* (Fieber) (Hemiptera: Anthocoridae), two of the major lepidopteran-egg predators in southern Spanish cotton fields, and its effects on the control of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) eggs. Intensive unidirectional IGP of *C. pelasgicum* on *O. laevigatus* was observed under plant arena conditions: over 90 % of minute bugs were killed by spiders in the first 24 h. However, no negative interaction between *C. pelasgicum* and minute pirate bugs was found under different egg-density conditions with *Orius* alone, and the combination of two predator treatments displayed significantly higher predation rates than the spider-alone treatment after 24 h. Increased egg density did not affect control by predators, nor did it prompt a significant reduction in IGP.

During a day–night bioassay, negative interaction between the two predators was found under night conditions, impacting on egg predation rates due to the combination of two predators. Predation of spiders on *H. armigera* eggs took place mainly at night, while predation by minute bugs was recorded both by day and by night. Finally, IGP by *C. pelasgicum* on minute pirate bugs was significantly higher by night. These outcomes demonstrate that diurnal and more intensive nocturnal IGP by spiders on minute pirate bugs had a moderate impact on the early control of *H. armigera*, with no negative effects after 24 h.

Keywords: *Cheiracanthium pelasgicum; Orius laevigatus; Helicoverpa armigera;* Intraguild predation; Egg density; Diel activity

Catherine Gacheri, Thomas Kigen, Lene Sigsgaard. (Dudutech –A Division of Finlays Horticulture Kenya Limited, Kingfisher Farm, Department of Plant and Environmental Sciences, Faculty of Sciences, University of Copenhagen). Hot-spot application of biocontrol agents to replace pesticides in large scale commercial rose farms in Kenya, BioControl, Volume 60(6)(2015): 795-803

Rose (*Rosa hybrida* L.) is the most important ornamental crop in Kenya, with huge investments in pest management. We provide the first full-scale, replicated experiment comparing cost and yield of conventional two-spotted spider mite (*Tetranychus urticae* Koch) control with hot-spot applications of the predatory mite *Phytoseiulus persimilis* (Acari: Phytoseidae) in large commercial rose greenhouses. Hot-spot treatments replaced acaricides except at high infestations and the two treatments were applied in seven greenhouses each. With the conventional treatment, acaricides were applied when *T. urticae* populations exceeded 250 motile individuals per plant based on scouting. Treatments with acaricides and *P. persimilis* were guided by weekly scouting and hot-spot treated greenhouses with infestations exceeding 1000 individuals m^{-2} (calculated as average mites/leaflet × average leaflets per plant) were first blanket-treated with an acaricide to decrease infestations. Roses subjected to the hot-spot treatment had significantly lower *T. urticae* infestations compared with conventionally treated roses. In addition, significantly fewer high spider mite infestations were recorded in roses with the hot-spot treatment. The cost of pest management was significantly lower in the hot-spot-treated greenhouses than in the conventional treatment. However, there was no significant difference in the number of harvested stems from the two treatments. It can therefore be concluded that acaricides can be replaced by *P. persimilis* hot-spot treatments in commercial cut rose production, effectively reducing pest management costs with no loss in crop yield.

Keywords: Acari; Phytoseidae; Cost-benefit; Rose; *Phytoseiulus persimilis; Tetranychus urticae*

Abid Hussain, Muhammad Rizwan-ul-Haq, Hassan Al-Ayedh, Sohail Ahmed, Ahmed Mohammed Al-Jabr., Life Science and Environment Research Institute, King Abdulaziz City for Science and Technology, Department of Agri-Entomology, University of Agriculture Faisalabad). Effect of *Beauveria bassiana* infection on the feeding performance and antioxidant defence of red palm weevil, *Rhynchophorus ferrugineus.* BioControl, Volume 60(6) (2015): 849-859

The entomopathogenic fungal infection of target hosts depends on pathogen fitness and host defence mechanisms. Pathogen-host interactions in red palm weevil, *Rhynchophorus ferrugineus* larvae are poorly understood. In order to explore this interaction, 4th, 8th, and 12th instar red

palm weevil larvae were immersed in conidial suspensions of four isolates of *Beauveria bassiana*. Significant differences in the virulence of the tested isolates were revealed by LT_{50} values. Conidia of B8463, a highly virulent isolate, showed 33.53 % higher relative hydrophobicity and twice as much Pr1 activity than conidia of B8465. Growth indices, calculated after 72 h of incubation, revealed significant differences in the food utilization efficiencies of all studied larval instars infected with different isolates. Conidial infection with B8463 caused 39–45 % reduction in efficacy of consumption of ingested food (ECI) and 55–61 % reduction in digested food (ECD). The least virulent isolate, B8465, caused the smallest reduction in ECI (2–4 %) and ECD (3–9 %). Furthermore, enhanced expression of target antioxidant genes (*catalases* and *peroxidase*) was observed in larvae infected with virulent isolates. Similarly, approximate digestibility showed an opposite trend, with the highest values being recorded from samples infected with the most virulent conidia (B8463) at each studied larval instar. In conclusion, isolate B8463 significantly affected the growth and development of red palm weevil larvae and has good potential for use in eco-friendly *R. ferrugineus* management.

Keywords: Defense; Entomopathogenic fungi; Pathogen fitness; Nutritional indices; Red palm weevil; Virulence

Johanna Mayerhofer, Jürg Enkerli, Roland Zelger, Hermann Strasser. (Institute of Microbiology, Leopold-Franzens University InnsbruckMolecular Ecology, Institute for Sustainability Sciences, Molecular Ecology, Institute for Sustainability Sciences, Research Centre for Agriculture and Forestry Laimburg, Institute of Microbiology, Leopold-Franzens University Innsbruck). **Biological control of the European cockchafer: persistence of *Beauveria brongniartii* after long-term applications in the Euroregion Tyrol. BioControl, Volume 60(5) (2015): 617-629**

Melocont® Pilzgerste, a commercial product based on the entomopathogenic fungus *Beauveria brongniartii* (Sacc.) Petch (Ascomycota: Hypocreales) strain BIPESCO 2, was applied at different rates and time points over a period of 24 years in East-, North- and South Tyrol (Austria and Italy) to control the European cockchafer (*Melolonthamelolontha* L. and *M. hippocastani* F.). *Beauveria* spp. density was assessed and *Beauveria* spp. isolates were characterized at species and genotype level using Bloc intergenic region sequence and simple sequence repeat marker analyses. BIPESCO 2 was detected at 41 % of the treated sites, predominantly at sites where the fungus was applied at least once during the four years prior to sampling. At one site BIPESCO 2 was detected 15 years after the last treatment. Results showed that applications should be repeated to achieve good persistence of the biological control agent, and it indicated that despite intensive applications diverse populations of *B. brongniartii* or *Beauveria* spp. consortia can coexist in these habitats.

Keywords: Mycoinsecticide; Inoculation biological control; Hypocreales; Cordycipitaceae; Coleoptera; Scarabaeidae

Chetana Aggarwal, Sangeeta Paul, Vishwas Tripathi, Bishwajeet Paul, Md. Aslam Khan. (Division of Microbiology, Indian Agricultural Research Institute, School of Biotechnology, Gautam Buddha University, Division of Entomology, Indian Agricultural Research Institute, Department of Biology, Faculty of Science, Jazan University). **Chitinolytic activity in *Serratia marcescens* (strain SEN) and potency against different larval instars of *Spodoptera litura* with effect of sublethal doses on insect development. BioControl, Volume 60(5) (2015): 631-640**

Chitinase-producing bacteria were isolated from diseased insect [*Pieris brassicae* Linnaeus (Lepidoptera: Pieridae) and *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae)] cadavers. *Serratia marcescens* strain SEN showed highest enzyme production at temperature 27 °C and pH 9.0 and was selected for further studies. It possessed exochitinase, endochitinase and chitobiosidase activities, of which endochitinase was found to be the predominant chitinase. *Serratia marcescens* strain SEN showed insecticidal activity against all the developmental stages of *S. litura* larvae. Ingestion of sublethal doses of *S. marcescens* strain SEN led to a decrease in the larval and pupal weight, percent normal pupation, adult emergence and a significant increase of the larval period. Effect on fecundity and egg hatchability were studied at LC_{20} and LC_{50} doses. Fecundity was significantly reduced at both doses tested, while egg hatchability was significantly affected only at the highest dose. To our knowledge, this is the first report of the potential of an entomopathogenic *S. marcescens* strain against different developmental stages of *S. litura*. The tested *S. marcescens* strain SEN showed promise as a biocontrol agent of *S. litura*.

Keywords: *Spodoptera litura; Serratia marcescens;* Chitinase activity; Sublethal dose; Insect development

Da Fu, Lizhen Zeng, Xiaodong Zheng, Ting Yu. (College of Biosystems Engineering and Food Science, Fuli Institute of Food Science, Key Laboratory for Agro-Food Processing, R & D Center for Food Technology and Equipment, Zhejiang University). Effect of β-glucan on stress tolerances and biocontrol efficacy of *Cryptococcus laurentii* against *Penicillium expansum* in pear fruit. BioControl, Volume 60(5) (2015): 669-679

The objective of this study was to determine the effect of β-glucan on stress tolerances and biocontrol efficacy of *Cryptococcus laurentii* against *Penicillium expansum* in pear fruit. The results showed that biocontrol efficacy and the population growth of *C. laurentii* harvested from nutrient yeast dextrose broth amended with β-glucan at 0.5 % (NYGB) were significantly higher compared to that harvested from nutrient yeast dextrose broth. Moreover, the viability of *C. laurentii* under heat, oxidative and water stress was markedly improved by cultivating in NYGB. In addition, the activity of superoxide dismutase in yeast cells was induced after exposure to heat, oxidative and water stresses. These results indicate that the application of β-glucan might be an effective method to improve the stress tolerances and biocontrol efficacy of *C. laurentii*. To our knowledge, this is the first report regarding the function of β-glucan in enhancing various stress tolerances of post-harvest biocontrol yeasts.

Keywords: Antagonistic yeast; Blue mold; Postharvest disease; Stress tolerance

Gloria Innocenti, Roberta Roberti, Federica Piattoni. (Department of Agricultural Sciences, Alma Mater Studiorum - University of Bologna). Biocontrol ability of *Trichoderma harzianum* strain T22 against *Fusarium* wilt disease on water-stressed lettuce plants. BioControl, Volume 60(4) (2015): 573-581

The control ability of *Trichoderma harzianum* strain T22 against *Fusarium* wilt of lettuce caused by *Fusarium oxysporum* f. sp. *lactucae* strain 365.07 was studied through mesocosm assays under extreme soil water content available for plants (−0.5 and −0.03 MPa). T22 was applied to nursery substrate at seeding, and to mesocosm soil at transplant of seedlings artificially infected by the pathogen. T22 treatment decreased disease severity in comparison to infected controls by 57 and 78 % in dry and wet conditions, respectively. Plant biomass was increased by T22 under both moisture levels. T22 colony growth, spore germination and antagonism to the pathogen

were investigated under different water potentials (−0.03, −0.1, −0.5, −1.0, −2.0, −7.0 and −14.0 MPa) on minimal agar medium. All these parameters were influenced by water potential. However, they were similar at the same MPa values tested in the mesocosm assays. Our results provide evidence that *T. harzianum* strain T22 could be effective to control wilt disease caused by *F. oxysporum* f. sp. *lactucae* strain 365.07 under extreme soil moisture regimes already present in Italy, and susceptible to become more frequent in the near future.

Keywords: *Fusarium oxysporum* f. sp. *lactucae* strain 365.07; *Trichoderma harzianum* strain T22; *Lactucasativa* L.; Water stress

Tuan Manh Nguyen, Jaisoo Kim. (Department of Life Science, College of Natural Sciences, Kyonggi University). *Streptomyces bambusae* sp. nov., Showing Antifungal and Antibacterial Activities, Isolated from Bamboo (*Bambuseae)* Rhizosphere Soil Using a Modified Culture Method. Current Microbiology, Volume 71(6) (2015): 658-668

Strain T110^T was isolated from a bamboo rhizosphere soil sample in the Republic of Korea and was found to produce antibiotics and secondary metabolites against a broad range of bacterial and fungal pathogens. It is a gram-positive actinobacterium with a straight and smooth, spore chain morphology. Morphological, physiological, and biochemical characterization suggest that T110^T belongs to the genus *Streptomyces*. The predominant menaquinones of strain T110^T were MK-9 (H_6), MK-9 (H_8), and MK-10 (H_4). The cell wall peptidoglycan contained LL-diaminopimelic acid, glutamic acid, alanine, and glycine. Ribose and glucose were detected as whole-cell hydrolysates. The polar lipids consisted of diphosphatidylglycerol, phosphatidylethanolamine, phosphatidylglycerol, and phosphatidylinositol. The main fatty acids were anteiso-$C_{15:0}$, anteiso-$C_{17:0}$, $C_{16:0}$, and iso-$C_{16:0}$. Sequence analysis of the 16S rRNA gene (GenBank accession no. KM229361) combined with multiple alignment tools revealed that T110^T shared the highest degree of similarity with *Streptomyces albosporeus* subsp. *labilomyceticus* NBRC 15387^T (97.9 %). However, DNA–DNA hybridization and phylogenetic analysis indicate that strain T110^T is distinct from its most closely related species. Therefore, we conclude that strain T110^T is a novel species of the genus *Streptomyces* and propose naming it *Streptomyces bambusae*. The type strain is T110^T (=KEMB 9005-214^T = KACC 18225^T = NBRC 110903^T).

Rajan Maheswaran, Savarimuthu Ignacimuthu. (Entomology Research Institute, Loyola CollegeDepartment of Zoology, Periyar University, Entomology Research Institute, Loyola College). A novel biopesticide PONNEEM to control human vector mosquitoes *Anopheles stephensi* L. and *Culex quinquefasciatus* Say. Environmental Science and Pollution Research, Volume 22(17) (2015): 13153-13166

Organophosphate pesticides are widely used in vector mosquito management and agricultural pest management. These chemicals enter into natural water bodies and soil and cause hazards to the environment. The objective of this study was to prepare a natural pesticide which will not harm the environment and yet control vector mosquitoes. PONNEEM, a novel biopesticide, patented and prepared from the oils of *Azadirachta indica* and *Pongamia glabra*, was tested against *Anopheles stephensi* and *Culex quinquefasciatus*. One hundred percent larvicidal and ovicidal activities were observed at 0.1-ppm concentration of PONNEEM against the two mosquito species under laboratory and sunlight conditions up to 12 months from the date of manufacture. Very high oviposition reduction of 26.46 and 32.16 % is also recorded. Reductions in α-esterase level (0.0818 ± 0.340 and 0.2188 ± 0.003), β-esterase level (0.0866 ± 0.026 and 0.0398 ± 0.010 µg naphthol produced/min/mg larval protein), glutathione S-transferase enzyme (14.2571 ± 0.51 and 15.3326 ± 0.51 µmol/min/mg larval protein) and total protein levels

(0.0390 ± 0.008 and 0.1975 ± 0.029 mg/individual larva in treated groups of *A. stephensi* and *C. quinquefasciatus* at 0.1-ppm concentration, respectively. The non-target organisms such as *Gambusia affinis* and *Diplonychus indicus* were not affected. Biopesticides are good alternatives to synthetic pesticides. PONNEEM can be effectively used for the management of human vector mosquitoes. Since it has a biodegradable nature and does not alter the environmental condition of water and soil.

Keywords: PONNEEM; Mosquito larvicidal; Ovicidal; Oviposition deterrent; Enzymatic activity; Non-target organisms

Biodegradation

Watsana Penkhrue, Chartchai Khanongnuch, Kazuo Masaki, Wasu Pathom-aree, Winita Punyodom, Saisamorn Lumyong. (Department of Biology, Faculty of Science, Chiang Mai University. Division of Biotechnology, Faculty of Agro-Industry, Chiang Mai University, National Research Institute of Brewing (NRIB), Department of Biology, Faculty of Science, Chiang Mai University). Isolation and screening of biopolymer-degrading microorganisms from northern Thailand. World Journal of Microbiology and Biotechnology, September 2015, Volume 31(9) (2015): 1431-1442

Forty agricultural soils were collected from Chiang Mai and Lampang provinces in northern Thailand. Bacteria, actinomycetes and fungi were isolated and screened for their ability to degrade polylactic acid (PLA), polycaprolactone (PCL) and poly(butylene succinate) (PBS) by the agar diffusion method. Sixty-seven actinomycetes, seven bacteria and five fungal isolates were obtained. The majority of actinomycetes were *Streptomyces* based on morphological characteristic, chemotaxonomy and 16S rRNA gene data. Seventy-nine microorganisms were isolated from 40 soil samples. Twenty-six isolates showed PLA-degradation (32.9 %), 44 isolates showed PBS-degradation (55.7 %) and 58 isolates showed PCL-degradation (73.4 %). Interestingly, 16 isolates (20.2 %) could degrade all three types of bioplastics used in this study. The *Amycolatopsis* sp. strain SCM_MK2-4 showed the highest enzyme activity for both PLA and PCL, 0.046 and 0.023 U/mL, respectively. Moreover, this strain produced protease, esterase and lipase on agar plates. Approximately, 36.7 % of the PLA film was degraded by *Amycolatopsis* sp. SCM_MK2-4 after 7 days of cultivation at 30 °C in culture broth.

Keywords: Polylactic acid; Polycaprolactone; Poly(butylene succinate); Biodegradation; Bioplastic; Thailand; *Amycolatopsis* sp.; Remediation

S. Mafla, R. Moraga, C. G. León, V. G. Guzmán-Fierro, J. Yañez, C. T. Smith, M. A. Mondaca, V. L. Campos. (Environmental Microbiology Laboratory, Department of Microbiology, Faculty of Biological Sciences, University of Concepción, Microbiology Laboratory, Faculty of Renewable Natural Resources, Arturo Prat University, Environmental Microbiology Laboratory, Department of Microbiology, Faculty of Biological Sciences, University of Concepción, Environmental Microbiology Laboratory, Department of Microbiology, Faculty of Biological Sciences, University of Concepción, Department of Analytical Chemistry, Faculty of Chemical Science, University of Concepción, Department of Microbiology, Faculty of Biological Sciences, University of

Concepción, Environmental Microbiology Laboratory, Department of Microbiology, Faculty of Biological Sciences, University of Concepción, Environmental Microbiology Laboratory, Department of Microbiology, Faculty of Biological Sciences, University of Concepción). Biodegradation of roxarsone by a bacterial community of underground water and its toxic impact. World Journal of Microbiology and Biotechnology, Volume 31(8) (2015): 1267-1277

Roxarsone is included in chicken food as anticoccidial and mainly excreted unchanged in faeces. Microorganisms biotransform roxarsone into toxic compounds that leach and contaminate underground waters used for human consumption. This study evaluated roxarsone biotransformation by underground water microorganisms and the toxicity of the resulting compounds. Underground water from an agricultural field was used to prepare microcosms, containing 0.05 mM roxarsone, and cultured under aerobic or anaerobic conditions. Bacterial communities of microcosms were characterized by PCR–DGGE. Roxarsone degradation was measured by HPLC/HG/AAS. Toxicity was evaluated using HUVEC cells and the Toxi-ChromoTest kit. Roxarsone degradation analysis, after 15 days, showed that microcosms of underground water with nutrients degraded 90 and 83.3 % of roxarsone under anaerobic and aerobic conditions, respectively. Microcosms without nutrients degraded 50 and 33.1 % under anaerobic and aerobic conditions, respectively. Microcosms including nutrients showed more roxarsone conversion into toxic inorganic arsenic species. DGGE analyses showed the presence of Proteobacteria, Firmicutes, Actinobacteria, Planctomycetes and Spirochaetes. Toxicity assays showed that roxarsone biotransformation by underground water microorganisms in all microcosms generated degradation products toxic for eukaryotic and prokaryotic cells. Furthermore, toxicity increased when roxarsone leached though a soil column and was further transformed by the bacterial community present in underground water. Therefore, using underground water from areas where roxarsone containing manure is used as fertilizer might be a health risk.

Keywords: Roxarsone; Arsenic; Underground-water; Microcosms; Toxicity; Biodegradation

Rui Li, Yanan Liu, Yu Sun, Wenjuan Zhang, Ruiwen Mu, Xiang Li, Hong Chen, Pin Gao, Gang Xue, Stephanie Ognier. (School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, School of Environmental Science and Engineering, Dong Hua University, and Laboratoire de Génie des Procédés et Traitements de Surface, UPMC Univ Paris 06, EA 3492). Degradation of p-Nitrophenol in Soil by Dielectric Barrier Discharge Plasma. Water, Air, & Soil Pollution, Volume 226(2015) :419

Dielectric barrier discharges (DBDs) were utilized for the remediation of soil contaminated with p-nitrophenol (PNP). The effect of treatment time, applied discharge voltage, initial PNP concentration, pH of contaminated soil, and airflow rate were investigated in this study. The results showed that 63.2 % of the PNP in the contaminated soil was degraded in 50 min with a voltage of 38.2 kV with no airflow. This degradation reaction followed the first order reaction kinetics. The degradation by ozone alone was compared with the plasma treatment to identify the role of ozone. Chromatographic analysis was applied to monitor the intermediates produced

during the oxidation process, and the main byproducts were maleic acid, p-benzoquinone, 4-nitrocatechol, methanoic acid, acetic acid, oxalic acid, NO_2^-, and NO_3^-. Possible pathways for the degradation of PNP in this system were deduced, which would provide evidence for the researches about the remediation of soils polluted by organic pollutants.

Keywords: DBD plasmaSoil remediationp-Nitrophenol, Degradation mechanism

Risky Ayu Kristanti Tony Hadibarata. (Faculty of Engineering Technology, Universiti Malaysia Pahang, Centre for Environmental Sustainability and Water Security (IPASA), Research Institute for Sustainable Environment, Universiti Teknologi MalaysiaDepartment of Environmental Engineering, Faculty of Civil Engineering, Universiti Teknologi Malaysia). Biodegradation and Identification of Transformation Products of Fluorene by Ascomycete Fungi. Water, Air, & Soil Pollution, Volume 226 (2015):406

Fluorene belongs to the polycyclic aromatic hydrocarbons (PAHs) which are potentially carcinogenic or mutagenic. However, very few studies on biodegradation of three-ring fluorene were investigated as compared to other three-ring PAHs such as phenanthrene and anthracene. The aim of this work is to evaluate fluorene degradation by fungal strain isolated from the decayed wood in tropical rain forest, Malaysia, and examine the effectiveness of the strain for degrading fluorene in liquid culture supplemented with the nonionic surfactants. Detailed taxonomic studies identified the organisms as *Pestalotiopsis* species and designated as strain *Pestalotiopsis* sp. W15. In this study, fluorene was totally degraded by *Pestalotiopsis* sp. W15 after incubation for 23 days. Various analytical studies confirmed the biotransformation of fluorene by detection of two metabolites in the treated medium: indanone (R_f 0.45; λ_{max} 240 and 290 nm; t_R 7.1 min and *m/z* 132) and salicylic acid (λ_{max} 205, 235, 290 nm; t_R 9.4 min and *m/z* 382). Based on these products, a probable pathway has been proposed for the degradation of fluorene by *Pestalotiopsis* sp. W15. None of the intermediates were identified as dead-end metabolites.

Keywords: Biotransformation; Indanone; *Pestalotiopsis* sp.; W15; Nonionic surfactants; Salicylic acid

J. R. Moraes Jr, E. D. Bidoia (Department of Biochemistry and Microbiology, IB, UNESP – Sao Paulo State University, Department of Biochemistry and Microbiology, IB, UNESP – Sao Paulo State University). Colour Degradation of Simulated Textile Effluent by Electrolytic Treatment and Ecotoxicological Evaluation. Water, Air, & Soil Pollution, Volume 226(2015): 402

Since the last century, humanity has sought ways to minimize the impact of the industrial growth in the environment. The textile industry, as one of the major contributors to water pollution, has been dumping coloured effluents which cause great impact in water bodies. The electrolytic process not only degrades the colour of the effluent but also transforms recalcitrant substances by direct or indirect oxidation. The ecotoxicological tests are used nowadays as a way to verify the toxicity degree of water bodies polluted by industrial and farming activities. The ecotoxicological tests consist in exposing determined organisms to the samples with the intention to evaluate their toxicity by observing the organisms' responses. This study had the objective to degrade, by electrolytic process, a simulated textile effluent containing a mixture of Acid Blue 40 and Acid Red 151 dyes and the toxicity evaluation of the treated effluent by

ecotoxicological tests. The bioassays used were tests with seeds of *Lactuca sativa* (lettuce), *Eruca sativa* (rocket), and *Cucumis sativus* (cucumber). Tests with the micro crustaceous *Artemia salina* and the yeast *Saccharomyces cerevisiae* were also conducted. The electrolytic treatment degraded the initial colour of the textile effluent, and the ecotoxicological tests indicated low toxicity to the treatment.

Keywords: Textile dye; Ecotoxicity; Wastewater; Advanced oxidative processes

Marcia E. Ojeda-Morales, Marivel Domínguez-Domínguez, Miguel A. Hernández-Rivera, Joel Zavala-Cruz. (Colegio de PostgraduadosLaboratorio de biotecnología, Universidad Juárez Autónoma de Tabasco, Colegio de Postgraduados, Laboratorio de biotecnología, Universidad Juárez Autónoma de Tabasco, Colegio de Postgraduados). Biosurfactant Production by Strains of *Azospirillum* Isolated from Petroleum-Contaminated Sites. Water, Air, & Soil Pollution, Volume 226 (2015): 401

Some microorganisms can produce biotensoactive when in contact with hydrocarbons, which favours micelle formation, allowing microbial cells to metabolise them effectively. In this study, we evaluated the capacity of nitrogen-fixing (NFB) and hydrocarbonoclastic bacterial strains to generate biotensoactive. The sampling site was in a flood plain of the Chico Zapote River, on the low basin of the Tonalá River in Tabasco, Mexico. Rhizospheres and soil contaminated by oil were collected, and the concentration of oil and botanic samples were determined for their taxonomic classification. The collected rhizosphere oil was seeded into Congo red cultures to obtain *Azospirillum* (NFB) bacteria. The NFB strain was placed in liquid mineral medium with oil as the only carbon source to identify the hydrocarbonoclastic strains. Biochemical and physiological evaluations determined that the species were *Azospirillum brasilense* and *Azospirillum lipoferum*. The strains were placed into Kim medium for generating a biosurfactant. The biosurfactant produced by *A. brasilense* showed an emulsion stability of 229 min, yield of 0.1375 g L^{-1}, emulsion capacity of 80 % and superficial tension of 38 mN m^{-1}, and while the biotensoactive produced by *A. lipoferum* had an emulsion stability of 260 min, yield of 0.22 g L^{-1}, emulsion capacity of 90 % and superficial tension of 35.5 mN m^{-1}.

Keywords: *Azospirillum;* Biosurfactants; Hydrocarbonoclastic bacteria

Hui-Chun Lee, Mengshan Lee, Walter De. (Department of Environmental Science and Engineering, Tunghai University, Department of Environmental Science and Engineering, Tunghai UniversityTunghai Green Energy Development and Management Institute (TGEI), Tunghai University, Department of Environmental Science and Engineering, Tunghai UniversityTunghai Green Energy Development and Management Institute (TGEI), Tunghai University). *Spirulina maxima* for Phenol Removal: Study on its Tolerance, Biodegradability and Phenol-Carbon Assimilability. Water, Air, & Soil Pollution, Volume 226(2015): 395

Microalgae-based bioremediation processes pose dual abilities of simultaneous CO_2 fixation through photosynthesis and degradative effect on environmental pollutants. This study intends to investigate the tolerance and biodegradation capability of *Spirulina maxima* for removal of phenol. An assimilation study of the phenol-carbon was also conducted to elucidate if the phenol removal was dominated by physical adsorption on cell walls or through metabolic activities. *S. maxima* cells were found to be capable of growing on phenol up to a concentration of 400 mg l^{-1}, and they had a highest specific growth rate at a phenol concentration of 50 mg l^{-1}. The results suggested that the removal of phenol (as high as 97.5 %) was mainly due to biodegradation processes rather than a bioadsorption process. Moreover, it was evident that nearly 30 % of the ^{13}C-labeled phenol content was discovered in the cellular fraction, indicating

that the ^{13}C-phenol-carbon was indeed assimilated to biomass followed by mineralize the carbon to CO_2.

Keywords: Microalgae; Carbon assimilation; Phenol tolerance; Wastewater; ^{13}C-phenol

Lin Jiang, Qi Wang, Hui Liu, Juejun Yao. (Beijing Key Laboratory for Risk Modeling and Remediation of Contaminated Sites, National Engineering Research Center of Urban Environmental Pollution Control, Beijing Municipal Research Institute of Environmental Protection, Beijing Key Laboratory for Risk Modeling and Remediation of Contaminated Sites, National Engineering Research Center of Urban Environmental Pollution Control, Beijing Municipal Research Institute of Environmental Protection, Beijing Key Laboratory for Risk Modeling and Remediation of Contaminated Sites, National Engineering Research Center of Urban Environmental Pollution Control, Beijing Municipal Research Institute of Environmental Protection, Beijing Key Laboratory for Risk Modeling and Remediation of Contaminated Sites, National Engineering Research Center of Urban Environmental Pollution Control, Beijing Municipal Research Institute of Environmental Protection). Influence of Degradation Behavior of Coexisting Chlorobenzene Congeners Pentachlorobenzene, 1,2,4,5-Tetrachlorobenzene, and 1,2,4-Trichlorobenzene on the Anaerobic Reductive Dechlorination of Hexachlorobenzene in Dye Plant Contaminated Soil. Water, Air, & Soil Pollution, Volume 226(2015): 299

The degradation of hexachlorobenzene (HCB) is of great concern and attracts considerable scientific and regulatory interests, due to the high toxicity, great bioaccumulation, and persistence of HCB in the environment. However, in the real HCB-contaminated soil, the effect of coexisting chlorobenzene congeners on the degradation capacity of HCB is poorly known. In this work, the anaerobic degradation behaviors of three coexisting chlorobenzene congeners pentachlorobenzene (PeCB), 1,2,4,5-tetrachlorobenzene (1,2,4,5-TeCB), and 1,2,4-trichlorobenzene (1,2,4-TCB) and the influence of initial pH and reaction temperature on the dechlorination of HCB in HCB-contaminated soil from the dye plant were studied. The amount and extent of accumulated coexisting chlorobenzenes was analyzed under different environmental conditions. The results indicate that the concentrations of three coexisting chlorobenzene congeners change in the form of wave. The anaerobic degradation activity of HCB is reduced due to the feedback inhibition caused by accumulation of coexisting chlorobenzene congeners, and the feedback inhibition varies from environmental conditions.

Keywords: Hexachlorobenzene; Coexisting chlorobenzene congener; Feedback inhibition; Accumulation; Anaerobic; Degradation behavior

Dorota Domaradzka, Urszula Guzik, Katarzyna Hupert-Kocurek, Danuta Wojcieszyńska. (Department of Biochemistry, Faculty of Biology and Environmental Protection, University of Silesia in Katowice, Department of Biochemistry, Faculty of Biology and Environmental Protection, University of Silesia in Katowice, Department of Biochemistry, Faculty of Biology and Environmental Protection, University of Silesia in Katowice, Department of Biochemistry, Faculty of Biology and Environmental Protection, University of Silesia in Katowice). Cometabolic Degradation of Naproxen by *Planococcus* sp. Strain S5. Water, Air, & Soil Pollution, Volume 226(2015): 297

Naproxen is a non-steroidal anti-inflammatory drug frequently detected in the influent and effluent of sewage treatment plants. The Gram-positive strain *Planococcus* sp. S5 was able to

remove approximately 30 % of naproxen after 35 days of incubation in monosubstrate culture. Under cometabolic conditions, with glucose or phenol as a growth substrate, the degradation efficiency of S5 increased. During 35 days of incubation, 75.14 ± 1.71 % and 86.27 ± 2.09 % of naproxen was degraded in the presence of glucose and phenol, respectively. The highest rate of naproxen degradation observed in the presence of phenol may be connected with the fact that phenol is known to induce enzymes responsible for aromatic ring cleavage. The activity of phenol monooxygenase, naphthalene monooxygenase, and hydroxyquinol 1,2-dioxygenase was indicated in *Planococcus* sp. S5 culture with glucose or phenol as a growth substrate. It is suggested that these enzymes may be engaged in naproxen degradation.

Keywords: *Planococcus;* Cometabolism; Biodegradation; Naproxen; Dioxygenase; Monooxygenase

Jirui Yang, Hongwen Sun. (MOE Key Laboratory of Pollution Processes and Environmental Criteria, College of Environmental Science and Engineering, Nankai University, MOE Key Laboratory of Pollution Processes and Environmental Criteria, College of Environmental Science and Engineering, Nankai University). **Degradation of γ-Hexachlorocyclohexane Using Carboxymethylcellulose-Stabilized Fe/Ni Nanoparticles. Water, Air, & Soil Pollution, Volume 226(2015): 280**

Carboxymethylcellulose (CMC)-stabilized and Ni-doped nanoscale zero valent iron (nZVI) particles (CMC-Fe/Ni) were synthesized to remove γ-hexachlorocyclohexane (γ-HCH) in aqueous solution. Fourier transform infrared spectroscopy results suggested that the CMC molecules were adsorbed onto iron primarily through carboxylate groups by monodentate complexation, and hydroxyl groups were also involved in the interactions between CMC and iron. The adsorbed CMC made the zeta potential of Fe/Ni nanoparticles more negative. At reaction pH of 8.3, the absolute value of zeta potential of the CMC-Fe/Ni was almost twice that of the bare one. The stability of colloidal nanoparticles was greatly enhanced as initial CMC concentration increased from 0 to 0.1 % (*w*/*w*) and did not increase further with higher CMC doses. Batch studies showed that 99.9 % of 10 mg/L γ-HCH was removed after 4 h at a mono nZVI loading level of 0.1 g/L, while the γ-HCH could be completely removed in 5 min using CMC-Fe/Ni, which exhibited a 13 times greater k_{obs} as compared to that using bare Fe/Ni. Within 20 h, 60 mg/L γ-HCH was totally removed through 6 cycles of consecutive treatment using CMC-Fe/Ni. GC-MS analysis showed that 3,4,5,6-tetrachlorocyclohexene was the main intermediate and chlorobenzene was the final product when using mono nZVI. When treating by Fe/Ni nanoparticles, 1,2,3,4,5-pentachlorocyclohexene, 3,4,5,6-tetrachlorocyclohexene, and 1,4-dichlorobenzene were formed as intermediates and benzene and chlorobenzene as the final products. Possible degradation pathways were proposed based on the identified intermediates, and dehydrochlorination, dichloroelimination, and hydrogenolysis were involved in dechlorination.

Keywords: γ-Hexachlorocyclohexane; Carboxymethylcellulose; Nanoscale zero valent iron; Dechlorination

Jie Ma, Guangxu Yan, Wenfeng Ma, Chunmao Cheng, Qinghong Wang, Shaohui Guo. (State Key Laboratory of Heavy Oil Processing, Beijing Key Lab of Oil and Gas Pollution Control, China University of Petroleum-BeijingCollege of Chemical Engineering, China University of Petroleum-Beijing, State Key Laboratory of Heavy Oil Processing, Beijing Key Lab of Oil and Gas Pollution Control, China University of Petroleum-BeijingCollege of Chemical Engineering, China University of Petroleum-Beijing, State Key Laboratory of Heavy Oil Processing, Beijing Key Lab of Oil and Gas Pollution Control, China University

of Petroleum-BeijingCollege of Chemical Engineering, China University of Petroleum-Beijing, State Key Laboratory of Heavy Oil Processing, Beijing Key Lab of Oil and Gas Pollution Control, China University of Petroleum-BeijingCollege of Chemical Engineering, China University of Petroleum-Beijing, State Key Laboratory of Heavy Oil Processing, Beijing Key Lab of Oil and Gas Pollution Control, China University of Petroleum-BeijingCollege of Chemical Engineering, China University of Petroleum-Beijing, State Key Laboratory of Heavy Oil Processing, Beijing Key Lab of Oil and Gas Pollution Control, China University of Petroleum-BeijingCollege of Chemical Engineering, China University of Petroleum-Beijing). Isolation and Characterization of Oil-Degrading Microorganisms for Bench-Scale Evaluations of Autochthonous Bioaugmentation for Soil Remediation. Water, Air, & Soil Pollution, Volume 226(2015): 272

Autochthonous bioaugmentation (uses microorganisms indigenous to the target sites) is proposed as a promising remediation technique that can overcome ecological barriers which usually impede successful applications of conventional bioaugmentation remedy. This study aimed to select and characterize strains for bench-scale evaluations of autochthonous bioaugmentation for remediation for oil-contaminated soil. Twenty-one oil-degrading stains were isolated from contaminated soil in an oil refinery plant in China. Six strains with high oil-degradation efficiencies were chosen for further morphological and biochemical characterizations, and their biosurfactant production potentials were measured. All six strains were able to produce biosurfactant, and the strain with the highest oil-degradation efficiency had the highest biosurfactant production potential, indicating the important role that biosurfactant played in accelerating biodegradation. Then we prepared the bioaugmentation consortium by mixing equal proportions of these six strains. Microcosm experiments showed that, after 84 days of incubation, the residual oil concentration in bioaugmented microcosms decreased by 63.2 ± 20.1 % while the residual oil concentration in the control only decreased by 21.3 ± 5.2 %. Gas chromatography-mass spectrum analysis further corroborated that 84 days of bioaugmentation significantly reduced the total number of contaminants and changed contaminant composition (resulting in higher relative abundance of short-chain alkanes and lower relative abundance of long-chain alkanes). All of these evidence showed that autochthonous bioaugmentation was an effective remediation technology, and the microbial consortium we isolated was an excellent bioaugmentation agent for crude oil-contaminated site.

Keywords: Petroleum; Hydrocarbon; Soil; Groundwater; Reinoculation; Isolation

Ihuoma N. Anyanwu, Kirk T. Semple. (Lancaster Environment Centre, Lancaster UniversityDepartment of Biological Sciences, Federal University Ndufu-Alike Ikwo, Lancaster Environment Centre, Lancaster University). Biodegradation of Phenanthrene-Nitrogen-Containing Analogues in Soil. Water, Air, & Soil Pollution, Volume 226 (2015): 252

Nitrogen- heterocyclic polycyclic aromatic hydrocarbons (N-PAHs) are ubiquitous constituents of contaminated sites in which their high water solubility and lower k_{ow} values imply greater mobility and impacts. Biodegradation is a major route of loss for organic contaminants in soil. In this study, microbial degradation was investigated in soil artificially contaminated with N-PAHs and monitored for over 200 days. The results showed that all the aromatic chemicals exhibited loss with increasing incubation time; however, only 0.05 ± 0.04 mg kg day^{-1} loss was observed for N-PAHs at 10 mg kg^{-1} amendments over the first 30 days incubation, with the exception of

4,7-phenanthroline which recorded 0.19 ± 0.03 mg kg day^{-1}. The study showed that soil microflora have the potential to degrade N-PAHs since all of the aromatics recorded chemical losses under aerobic condition. However, degradation rates varied between chemicals and this was attributed to *N*-atom position and/or number of *N*-substituents. Further, relatively little or no biodegradation was observed in B[h]Q amended soils with increasing concentration; indicating that B[h]Q is more resistance to biodegradation in soil.

Keywords: Biodegradation; PAHs; N-PAHs; Biotransformation; Soil

Mirosław Szyłak-Szydłowski. (Faculty of Environmental Engineering, Warsaw University of Technology). Odour Samples Degradation During Detention in Tedlar® Bags. Water, Air, & Soil Pollution, Volume 226(2015): 227

In indirect olfactometry analysis, to avoid condensation or adsorption processes during or storage of the sample, containers made of suitable materials should be used. Also, reaction between the chemicals during transport from the source of the odour to the research laboratory is an important process which can influence on examinations' results. Study included determination of the odour and compound concentrations of six gas mixtures. Gas samples were collected by silicone hoses into Tedlar® bags and tested by Nasal Ranger, SM-100 olfactometers and Photovac Voyager gas chromatograph. Time of keeping gas in bags was 78 h, and concentration of compounds was measured every hour, eight times per day. For benzene, acetone, 1,1-dichloroethylene, c-1,2-dichloroethylene, t-1,2-dichloroethylene, methyl ethyl ketone and vinyl chloride, 100 % decrease of concentration has been noticed within 78 h of holding in the bag. Average rate of loss of most compounds concentration was from 0.01 to 2.50 % for the first 30 h and from 0.35 to 18.50 % during the last 48 h of examination. Decreasing of odour concentration measured by Nasal Ranger (NR) in all series was between 0.00 and 4.98 % till 30 h, between 1.91 and 100 % in the last 48 h of test and between 1.61 and 100 % in 78 h. In case of odour concentration measured by SM, those values were, respectively, 1.26–4.93 %, 1.39–4.93 % and 2.40–3.18 %. Values of average rate of intensity decreasing were, respectively, 0.77–1.75 %, 2.36–4.67 % and 1.18–2.07 %. Statistically significant correlation coefficients for compound concentrations and intensity, odour concentration obtained by SM-100 as well as NR were, respectively, 0.55–0.97, 0.47–0.99 and 0.37–0.98.

Keywords: Chromatography; Containers; Odours; Sampling; Tedlar

Lu Xiong, Zhong-Hua Tong, Jie-Jie Chen, Ling-Li Li, Han-Qing Yu. (CAS Key Laboratory of Urban Pollutant Conversion, Department of Chemistry, University of Science & Technology of China, CAS Key Laboratory of Urban Pollutant Conversion, Department of Chemistry, University of Science & Technology of China, CAS Key Laboratory of Urban Pollutant Conversion, Department of Chemistry, University of Science & Technology of China, CAS Key Laboratory of Urban Pollutant Conversion, Department of Chemistry, University of Science & Technology of China, CAS Key Laboratory of Urban Pollutant Conversion, Department of Chemistry, University of Science & Technology of China). Morphology-dependent antimicrobial activity of Cu/Cu_xO nanoparticles. Ecotoxicology, Volume 24(10) (2015): 2067-2072

Cu/Cu_xO nanoparticles (NPs) with different morphologies have been synthesized with glucose as a reducing agent. The X-ray diffraction and Scanning electron microscopy imaging show that the Cu/Cu_xO NPs have fine crystalline peaks with homogeneous polyhedral, flower-like, and thumbtack-like morphologies. Their antimicrobial activities were evaluated on inactivation of *Escherichia coli* using a fluorescence-based live/dead staining method. Dissolution of copper ions from these NPs was determined. Results demonstrated a significant growth inhibition for

these NPs with different morphologies, and the flower-like Cu/Cu_xO NPs were the most effective form, where more copper ions were dissolved into the culture media. Surface free energy calculations based on first-principle density functional theory show that different crystal facets of the copper NPs have diverse surface energy, indicating the highest reactivity of the flower-like NPs, which is consistent with the results from the dissolution study and antimicrobial activity test. Together, these results suggest that the difference between the surface free energy may be a cause for their morphology-dependent antimicrobial activity.

Keywords: Copper nanoparticles; Morphology; Antimicrobial activity; Surface free energy

Ewa Liwarska-Bizukojc, Cedric Maton. (Institute of Fermentation Technology and Microbiology, Lodz University of Technology, Faculty of Bioscience Engineering, Department of Sustainable Organic Chemistry and Technology, Ghent University). Biodegradation of imidazolium ionic liquids by activated sludge microorganisms. Biodegradation, Volume 26(6) (2015): 453-463

Biological properties of ionic liquids (ILs) have been usually tested with the help of standard biodegradation or ecotoxicity tests. So far, several articles on the identification of intermediate metabolites of microbiological decay of ILs have been published. Simultaneously, the number of novel ILs with unrecognized characteristics regarding biodegradability and effect on organisms and environment is still increasing. In this work, seven imidazolium ionic liquids of different chemical structure were studied. Three of them are 1-alkyl-3-methyl-imidazolium bromides, while the other four are tetra- or completely substituted imidazolium iodides. This study focused on the identification of intermediate metabolites of the aforementioned ionic liquids subjected to biodegradation in a laboratory activated sludge system. Both fully substituted ionic liquids and 1-ethyl-3-methyl-imidazolium bromide were barely biodegradable. In the case of two of them, no biotransformation products were detected. The elongation of the alkyl side chain made the IL more susceptible for microbiological decomposition. 1-Decyl-3-methyl-imidazolium bromide was biotransformed most easily. Its primary biodegradation up to 100 % could be achieved. Nevertheless, the cleavage of the imidazolium ring has not been observed.

Keywords: Activated sludge; Biodegradation; Imidazolium ionic liquids; Intermediate metabolites; Mass spectrometry

Xiaobiao Zhu, Rui Liu, Cong Liu, Lujun Chen. (College of Chemical Engineering, Beijing University of Chemical Technology, Key Laboratory of Water Science and Technology of Zhejiang Province, School of Environment, Tsinghua University, School of Environment, Tsinghua UniversityKey Laboratory of Water Science and Technology of Zhejiang Province). Bioaugmentation with isolated strains for the removal of toxic and refractory organics from coking wastewater in a membrane bioreactor. Biodegradation, Volume 26(6) (2015): 465-474

The bioaugmentation strains for phenol, pyridine, quinoline, carbazole, and naphthalene degradation were employed to treat coking wastewater in a membrane bioreactor (MBR). The results showed that the bioaugmented MBR was much better in pollutant removal than that of the control MBR with conventional activated sludge. Compared to the control MBR, the bioaugmented MBR displayed an additional 3.2 mg/L of phenol, pyridine, quinoline, naphthalene and carbazole in total by the addition of the degrading strains. Also, about 10 % of the chemical oxygen demand in the effluent was further removed by the bioaugmentation. The

pyrosequencing analysis of the sludge in the MBRs revealed that the microbial community shifted in response to the addition of the degrading strains. The diversity of the microbial community increased during the bioaugmentation, and some bacterial taxa favorable to the removal of toxic and refractory pollutants appeared in the bioaugmented MBR. The results indicated that the use of high-efficiency bacteria was a feasible method for industrial coking wastewater treatment.

Keywords: Bioaugmentation; High-efficiency bacteria; Microbial community; MBR

Emily R. Gilson, Shan Huang, Peter R. Jaffé. (Department of Civil and Environmental Engineering, Princeton University, Department of Civil and Environmental Engineering, Princeton University, Department of Civil and Environmental Engineering, Princeton University). Biological reduction of uranium coupled with oxidation of ammonium by *Acidimicrobiaceae* bacterium A6 under iron reducing conditions. Biodegradation, Volume 26(6) (2015): 475-482

This study investigated the possibility of links between the biological immobilization of uranium (U) and ammonium oxidation under iron (Fe) reducing conditions. The recently-identified *Acidimicrobiaceae* bacterium A6 (ATCC, PTA-122488) derives energy from ammonium oxidation coupled with Fe reduction. This bacterium has been found in various soil and wetland environments, including U-contaminated wetland sediments. Incubations of *Acidimicrobiaceae* bacteria A6 with nontronite, an Fe(III)-rich clay, and approximately 10 μM U indicate that these bacteria can use U(VI) in addition to Fe(III) as an electron acceptor in the presence of ammonium. Measurements of Fe(II) production and ammonium oxidation support this interpretation. Concentrations of approximately 100 μM U were found to entirely inhibit *Acidimicrobiaceae* bacteria A6 activity. These results suggest that natural sites of active ammonium oxidation under Fe reducing conditions by *Acidimicrobiaceae* bacteria A6 could be hotspots of U immobilization by bioreduction. This is the first report of biological U reduction that is not coupled to carbon oxidation.

Keywords: Bioreduction; Nontronite; Feammox; Uranium; *Acidimicrobiaceae* bacterium A6; Ammonium

Daniel Kekacs, Brian D. Drollette, Michael Brooker, Desiree L. Plata, Paula J. Mouser. (Department of Civil, Environmental, and Geodetic Engineering, The Ohio State University, Chemical and Environmental Engineering, Yale University, Department of Civil, Environmental, and Geodetic Engineering, The Ohio State University, Chemical and Environmental Engineering, Yale University, Department of Civil, Environmental, and Geodetic Engineering, The Ohio State University). Aerobic biodegradation of organic compounds in hydraulic fracturing fluids. Biodegradation, Volume 26(4) (2015): 271-287

Little is known of the attenuation of chemical mixtures created for hydraulic fracturing within the natural environment. A synthetic hydraulic fracturing fluid was developed from disclosed industry formulas and produced for laboratory experiments using commercial additives in use by Marcellus shale field crews. The experiments employed an internationally accepted standard method (OECD 301A) to evaluate aerobic biodegradation potential of the fluid mixture by monitoring the removal of dissolved organic carbon (DOC) from an aqueous solution by activated sludge and lake water microbial consortia for two substrate concentrations and four salinities. Microbial degradation removed from 57 % to more than 90 % of added DOC within 6.5 days, with higher removal efficiency at more dilute concentrations and little difference in overall removal extent between sludge and lake microbe treatments. The alcohols isopropanol and octanol were degraded to levels below detection limits while the solvent acetone

accumulated in biological treatments through time. Salinity concentrations of 40 g/L or more completely inhibited degradation during the first 6.5 days of incubation with the synthetic hydraulic fracturing fluid even though communities were pre-acclimated to salt. Initially diverse microbial communities became dominated by 16S rRNA sequences affiliated with *Pseudomonas* and other *Pseudomonadaceae* after incubation with the synthetic fracturing fluid, taxa which may be involved in acetone production. These data expand our understanding of constraints on the biodegradation potential of organic compounds in hydraulic fracturing fluids under aerobic conditions in the event that they are accidentally released to surface waters and shallow soils.

Keywords: Hydraulic fracturing fluid; Organic additives; Acetone; Shale energy development; Aerobic biodegradation; *Pseudomonas*

Siqing Yue, Bruce A. Ramsay, Juliana A. Ramsay. (Chemical Engineering, Queen's University). Biodegradation of naphthenic acid surrogates by axenic cultures. Biodegradation, Volume 26 (4) (2015): 313-325

This is the first study to report that bacteria from the genera *Ochrobactrum*, *Brevundimonas* and *Bacillus* can be isolated by growth on naphthenic acids (NAs) extracted from oil sands process water (OSPW). These pure cultures were screened for their ability to use a range of aliphatic, cyclic and aromatic NA surrogates in 96-well microtiter plates using water-soluble tetrazolium redox dyes (Biolog Redox Dye H) as the indicator of metabolic activity. Of the three cultures, *Ochrobactrum* showed most metabolic activity on the widest range of NA surrogates. *Brevundomonas* and especially *Ochrobactrum* had higher metabolic activity on polycyclic aromatic compounds than other classes of NA surrogates. *Bacillus* also oxidized a wide range of NA surrogates but not as well as *Ochrobactrum*. Using this method to characterize NA utilisation, one can identify which NAs or NA classes in OSPW are more readily degraded. Since aromatic NAs have been shown to have an estrogenic effect and polycyclic monoaromatic compounds have been suggested to pose the greatest environmental threat among the NAs, these bacterial genera may play an important role in detoxification of OSPW. Furthermore, this study demonstrates that bacteria belonging to the genera *Ochrobactrum* and *Bacillus* can also degrade surrogates of tricyclic NAs.

Keywords: Biodegradation; Naphthenic acids; Tetrazolium redox dyes

Łukasz Ławniczak, Katarzyna Materna, Grzegorz Framski, Alicja Szulc, Anna Syguda. (Faculty of Chemical Technology, Poznan University of Technology, Institute of Bioorganic Chemistry, Polish Academy of Sciences). Comparative study on the biodegradability of morpholinium herbicidal ionic liquids. Biodegradation, Volume 26(4) (2015): 327-340

This study focused on evaluating the toxicity as well as primary and ultimate biodegradability of morpholinium herbicidal ionic liquids (HILs), which incorporated MCPA, MCPP, 2,4-D or Dicamba anions. The studied HILs were also subjected to determination of surface active properties in order to assess their influence on toxicity and biodegradability. The study was carried out with microbiota isolated from different environmental niches: sediments from river channel, garden soil, drainage trench collecting agricultural runoff stream, agricultural soil and municipal waste repository. The obtained results revealed that resistance to toxicity and biodegradation efficiency of the microbiota increased in the following order: microbiota from the waste repository > microbiota from agricultural soil ≈ microbiota from an agricultural runoff stream > microbiota from garden soil > microbiota from the river sludge. It was observed that

the toxicity of HILs increased with the hydrophobicity of the cation, however the influence of the anion was more notable. The highest toxicity was observed when MCPA was used as the anion (EC_{50} values ranging from 60 to 190 mg L^{-1}). The results of ultimate biodegradation tests indicated that only HILs with 2,4-D as the anion were mineralized to some extent, with slightly higher values for HILs with the 4-decyl-4-ethylmorpholinium cation (10–31 %) compared to HILs with the 4,4-didecylmorpholinium cation (9–20 %). Overall, the cations were more susceptible (41–94 %) to primary biodegradation compared to anions (0–61 %). The obtained results suggested that the surface active properties of the studied HILs may influence their toxicity and biodegradability by bacteria in different environmental niches.

Keywords: Biodegradation; Ionic liquids; Herbicides; Surface active properties; Toxicity

Dzianis Smirnou, Martin Krčmář, Jaromír Kulhánek, Martina Hermannová, Lenka Bobková, Lukáš Franke, Stanislav Pepeliaev, Vladimír Velebný. (Contipro Biotech s.r.o.). Characterization of Hyaluronan-Degrading Enzymes from Yeasts. Applied Biochemistry and Biotechnology, Volume 177(3) (2015): 700-712

Hyaluronidases (HAases) from yeasts were characterized for the first time. The study elucidated that hyaluronate 4-glycanohydrolase and hyaluronan (HA) lyase can be produced by yeasts. Six yeasts producing HAases were found through express screening of activities. The extracellular HAases from two of the yeast isolates, *Pseudozyma aphidis* and *Cryptococcus laurentii*, were characterized among them. *P. aphidis* HAase hydrolyzed β-1,4 glycosidic bonds of HA, yielding even-numbered oligosaccharides with *N*-acetyl-d-glucosamine at the reducing end. *C. laurentii* produced hyaluronan lyase, which cleaved β-1,4 glycosidic bonds of HA in β-elimination reaction, and the products of HA degradation were different-sized even-numbered oligosaccharides. The shortest detected HA oligomer was dimer. The enzymes' pH and temperature optima were pH 3.0 and 37–45 °C (*P. aphidis*) and pH 6.0 and 37 °C (*C. laurentii*), respectively. Both HAases showed good thermostability.

Keywords: Hyaluronate 4-glycanohydrolase; Lyase; Characteristics; Thermostability; *Pseudozyma aphidis; Cryptococcus laurent*

Umme Kalsoom, Haq Nawaz Bhatti, Muhammad Asgher. (Department of Chemistry, Govt College Women University, Environmental & Material Chemistry Laboratory, Department of Chemistry, University of Agriculture, Department of Biochemistry, University of Agriculture). Characterization of Plant Peroxidases and Their Potential for Degradation of Dyes: a Review. Applied Biochemistry and Biotechnology, Volume 176(6) (2015): 1529-1550

Peroxidases are ubiquitously found in all vascular plants and are promising biocatalysts for oxidization of wide range of aromatic substrates including various industrial dyes. Peroxidases can catalyze degradation of chemical structure of aromatic dyes either by precipitation or by opening the aromatic ring structure. Both soluble and immobilized peroxidases have been successfully used in batches as well as in continuous processes for the treatment of aromatic dyes present in industrial effluents. Plant peroxidases are stable catalysts that retain their activities over a broad range of pH and temperatures. The performance of an enzyme for degradation process depends upon the structure of dyes and the operational parameters like concentration of enzyme, H_2O_2 and dye, incubation time, pH, and temperature. Recalcitrant dyes can also be mineralized by plant peroxidases in the presence of redox mediators. Thus, plant peroxidases are easily available, inexpensive, and ecofriendly biocatalysts for the treatment of wastewaters containing a wide spectrum of textile and non-textile synthetic dyes. This article

reviews the recent developments in isolation and characterization of plant peroxidases and their applications for bioremediation of synthetic dyes.

Keywords: Peroxidases; Isolation; Characterization; Synthetic dyes; Bioremediation

Bei Jiang, Zunchun Zhou, Ying Dong, Wei Tao, Bai Wang, Jingwei Jiang, Xiaoyan Guan. (Liaoning Key Lab of Marine Fishery Molecular Biology, Liaoning Ocean and Fisheries Science Research Institute, Liaoning Key Lab of Marine Fishery Molecular Biology, Liaoning Ocean and Fisheries Science Research Institute, Liaoning Key Lab of Marine Fishery Molecular Biology, Liaoning Ocean and Fisheries Science Research Institute, Dongbei University of Finance and Economics, Liaoning Key Lab of Marine Fishery Molecular Biology, Liaoning Ocean and Fisheries Science Research Institute). Biodegradation of Benzene, Toluene, Ethylbenzene, and *o*-, *m*-, and *p*-Xylenes by the Newly Isolated Bacterium *Comamonas* sp. JB. Applied Biochemistry and Biotechnology, Volume 176(6) (2015): 1700-1708

A bacterium designated strain JB, able to degrade six benzene, toluene, ethylbenzene, and *o*-, *m*-, and *p*-xylene (BTEX) compounds, was isolated from petroleum-contaminated soil. Taxonomic analyses showed that the isolate belonged to *Comamonas*, and until now, the genus *Comamonas* has not included any known BTEX degraders. The BTEX biodegradation rate was slightly low on the mineral salt medium (MSM), but adding a small amount of yeast extract greatly enhanced the biodegradation. The relationship between specific degradation rate and individual BTEX was described well by Michaelis-Menten kinetics. The treatment of petrochemical wastewater containing BTEX mixture and phenol was shown to be highly efficient by BTEX-grown JB. In addition, toxicity assessment indicated the treatment of the petrochemical wastewater by BTEX-grown JB led to less toxicity than untreated wastewater.

Keywords: BTEX compounds; *Comamonas* sp. JB; Petrochemical ; wastewater

Akashdeep Singh Oberoi, Ligy Philip, S. Murty Bhallamudi. (Environmental and Water Resources Engineering Division, Department of Civil Engineering, IIT Madras). Biodegradation of Various Aromatic Compounds by Enriched Bacterial Cultures: Part B—Nitrogen-, Sulfur-, and Oxygen-Containing Heterocyclic Aromatic Compounds. Applied Biochemistry and Biotechnology, Volume 176(6) (2015): 1746-1769

Present study focused on the biodegradation of various heterocyclic nitrogen, sulfur, and oxygen (NSO) compounds using naphthalene-enriched culture. Target compounds in the study were pyridine, quinoline, benzothiophene, and benzofuran. Screening studies were carried out using different microbial consortia enriched with specific polycyclic aromatic hydrocarbon (PAH) and NSO compounds. Among different microbial consortia, naphthalene-enriched culture was the most efficient consortium based on high substrate degradation rate. Substrate degradation rate with naphthalene-enriched culture followed the order pyridine > quinoline > benzofuran > benzothiophene. Benzothiophene and benzofuran were found to be highly recalcitrant pollutants. Benzothiophene could not be biodegraded when concentration was above 50 mg/l. It was observed that 2-(1H)-quinolinone, benzothiophene-2-one, and benzofuran-2,3-dione were formed as metabolic intermediates during biodegradation of quinoline, benzothiophene, and benzofuran, respectively. Quinoline-N and pyridine-N were transformed into free ammonium ions during the biodegradation process. Biodegradation pathways for various NSO compounds are proposed. Monod inhibition model was able to simulate single

substrate biodegradation kinetics satisfactorily. Benzothiophene and benzofuran biodegradation kinetics, in presence of acetone, was simulated using a generalized multi-substrate model.

Keywords: Biodegradation; Heterocyclic NSO compounds; Acclimatized mixed culture; Naphthalene-enriched culture; Metabolic intermediates

Xia He, Qian Zhang, Michael J. Cooney, Tao Yan. (Department of Civil and Environmental Engineering, University of Hawaii at Manoa). Biodegradation of fat, oil and grease (FOG) deposits under various redox conditions relevant to sewer environment. Applied Microbiology and Biotechnology, Volume 99(14) (2015): 6059-6068

Fat, oil and, grease (FOG) deposits are one primary cause of sanitary sewer overflows (SSOs). While numerous studies have examined the formation of FOG deposits in sewer pipes, little is known about their biodegradation under sewer environments. In this study, FOG deposit biodegradation potential was determined by studying the biodegradation of calcium palmitate in laboratory under aerobic, nitrate-reducing, sulfate-reducing, and methanogenic conditions. Over 110 days of observation, calcium palmitate was biodegraded to CO_2 under aerobic and nitrate-reducing conditions. An approximate 13 times higher CO_2 production rate was observed under aerobic condition than under nitrate-reducing condition. Under sulfate-reducing condition, calcium palmitate was recalcitrant to biodegradation as evidenced by small reduction in sulfate. No evidence was found to support calcium palmitate degradation under methanogenic condition in the simulated sewer environment. Dominant microbial populations in the aerobic and nitrate-reducing microcosms were identified by Illumina seqeuncing, which may contain the capability to degrade calcium palmitate under both aerobic and nitrate-reducing conditions. Further study on these populations and their functional genes could shed more light on this microbial process and eventually help develop engineering solutions for SSOs control in the future.

Keywords: Fat, oil and grease (FOG) deposits; Biodegradation; Redox conditions; Sewer systems

Jianliang Xue, Yang Yu, Yu Bai, Liping Wang, Yanan Wu. (College of Chemical and Environmental Engineering, Shandong University of Science and Technology, Laboratory Technician, Citic Pacific Mining Management Pty Ltd, Key Laboratory of Environmental Aquatic Chemistry, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Sansom Institute for Health Research, School of Pharmacy and Medical Sciences, University of South Australia). Marine Oil-Degrading Microorganisms and Biodegradation Process of Petroleum Hydrocarbon in Marine Environments: A Review. Current Microbiology, Volume 71(2) (2015): 220-228

Due to the toxicity of petroleum compounds, the increasing accidents of marine oil spills/leakages have had a significant impact on our environment. Recently, different remedial techniques for the treatment of marine petroleum pollution have been proposed, such as bioremediation, controlled burning, skimming, and solidifying. (Hedlund and Staley in Int J Syst Evol Microbiol 51:61–66, 2001). This review introduces an important remedial method for marine oil pollution treatment—bioremediation technique—which is considered as a reliable, efficient, cost-effective, and eco-friendly method. First, the necessity of bioremediation for marine oil pollution was discussed. Second, this paper discussed the species of oil-degrading microorganisms, degradation pathways and mechanisms, the degradation rate and reaction model, and the factors affecting the degradation. Last, several suggestions for the further research in the field of marine oil spill bioremediation were proposed.

Guoqiang Guan[a], Zhicai Zhang[a, b], Hongxue Ding[a], Ming Li[a], Defu Shi[a], Maxiaoqi Zhu[a], Lili Xia[a]. ([a] Institute of Agro-Production Processing Engineer, Jiangsu University, Zhenjiang 212013, PR China, [b] Beijing Green Technology and Natural Biotechnology Co. Ltd., Beijing 102300, PR China). Enhanced degradation of lignin in corn stalk by combined method of *Aspergillus oryzae* solid state fermentation and H_2O_2 treatment. Biomass and Bioenergy, Volume 81(2015): 224–233

To shorten the time of corn stalk pretreatment and increase the degradation of lignin, solid state fermentation (SSF) with *Aspegillus oryzae* CGMCC5992 in the presence of H_2O_2 was carried out to degrade lignin in stalk. In this study, the conditions for lignin hydrolysis catalyzed by enzymes produced in SSF for 10 days were optimized by mono-factor-at-a-time design and response surface method (RSM). The removal rate of lignin increased from 30% (before hydrolysis) to 80.3% (after hydrolysis) under the temperature of 55 °C, pH 6.0, water/stalk ratio of 40, and the concentration of H_2O_2 at 4% (w/w). In comparison, the removal rate of lignin after 50 days of SSF only reached 57.8%. Proteomic analysis provided support for the increased lignin hydrolysis. Fermentation with *A. oryzae* CGMCC5992 in the presence of H_2O_2 increased the amount of peroxidase and intracellular catalase and decreased the amount of extracellular catalase. Therefore, the method introduced in this study can significantly shorten the time of SSF and increase the removal rate of lignin.

Keywords: *Aspergillus oryzae*; Corn stalk; Lignin degradation; Enzyme; Proteomic analysis

X. Liu, R. Bayard', H. Benbelkacem, P. Buffière, R. Gourdon. (Université de Lyon, INSA-Lyon, Laboratoire DEEP, Bât. S. Carnot, 9 rue de la Physique, F-69621 Villeurbanne, France). Evaluation of the correlations between biodegradability of lignocellulosic feedstocks in anaerobic digestion process and their biochemical characteristics. Biomass and Bioenergy, Volume 81(2015): 534–543

Biochemical composition and reactivity are key factors controlling the biodegradability of lignocellulosic residues. In the present study, 14 lignocellulosic substrates including 6 agricultural and 8 forest residues were analyzed for 9 biochemical characteristics, including BioMethane Potential (BMP), Biological Oxygen Demand (BOD), Enzymatic Cellulose Degradation tests (ECD), Van Soest and NREL fractionation methods. The data obtained were exploited by principal component analysis (PCA) and other statistical methods to investigate the possible correlations between the parameters. The study showed that the contents in particular lignin or in non-extractible residues (RES) were the characteristics which influenced most the anaerobic biodegradability (BMP), while the influence of the soluble fraction was quite low. BMP was well correlated with the ratio of the contents in non-lignin over lignin fractions and the cellulose to lignin ratio. Regarding agricultural residues, BMP was better correlated with lignin content than with RES content. Agricultural and forest residues exhibited distinct characteristics of aerobic and anaerobic biodegradability. Good correlation was observed between ECD and lignin content. Finally, it was also observed that Van Soest's and NREL methods did not provide the same results in terms of biochemical composition.

Keywords: Anaerobic digestion; Biomethane potential; Lignocellulosic residues; Biochemical analyses; Biological oxygen demand; Enzymatic hydrolysis

Emile S. Massima Mouele, Jimoh O. Tijani, Ojo O. Fatoba, Leslie. F. Petrik. (Department of Chemistry, University of the Western Cape). Degradation of organic pollutants and

microorganisms from wastewater using different dielectric barrier discharge configurations—a critical review. Environmental Science and Pollution Research, Volume 22(23): 18345-18362

The growing global drinking water crisis requires the development of novel advanced, sustainable, and cost-effective water treatment technologies to supplement the existing conventional methods. One such technology is advanced oxidation based on dielectric barrier discharge (DBD). DBD such as single and double planar and single and double cylindrical dielectric barrier configurations have been utilized for efficient degradation of recalcitrant organic pollutants. The overall performance of the different DBD system varies and depends on several factors. Therefore, this review was compiled to give an overview of different DBD configurations vis-a-viz their applications and the in situ mechanism of generation of free reactive species for water and wastewater treatment. Our survey of the literature indicated that application of double cylindrical dielectric barrier configuration represents an ideal and viable route for achieving greater water and wastewater purification efficiency.

Keywords: Wastewater treatment; Organic contaminants; DBD; Plasma; Electrode geometry; Ecosystem

Sana Sheik[a], K.R. Chandrashekar[a, b], K. Swaroop[b], H.M. Somashekarappa[b]. ([a]Department of Applied Botany, Mangalore University, Mangalagangothri, 574199, Mangalore, Karnataka, India, [b] Centre for Application of Radioisotopes and RadiationTechnology (CARRT), Mangalore University, Mangalagangothri, 574199, Karnataka, India). **Biodegradation of gamma irradiated low density polyethylene and polypropylene by endophytic fungi. International Biodeterioration & Biodegradation, Volume 105(2015): 21–29**

Biodegradation of plastic waste through fungal strains offer a solution to serious issues of pollution as fungi are known to release plastic degrading enzymes. In the present study, the isolated endophytic fungi from two endemic plants, *Psychotria flavida* and *Humboldtia brunonis* which produced laccase enzymes and grew profusely over hydrophobic surface of plastic films were tested for biodegrading ability. The fungi were inoculated on the polythene and polypropylene films irradiated with different doses of radiation, (0–1000 kGy for Low Density Polyethylene and 0–100 kGy for Polypropylene) and incubated for 90 days. The extent of biodegradation pattern of endophytic fungi was measured for the highest dose mainly by analyzing changes using FTIR spectroscopy, DSC, SEM, alteration in viscosity and thereby average molecular weight. The decrease in intrinsic viscosity and average molecular weight of gamma irradiated LDPE strips inoculated with *Aspergillus* sp., *Paecilomyces lilacinus* from *H. brunonis* and *Lasiodiplodia theobromae* from *Psychotria flavida* indicate fungal efficiency in plastic degradation. Only *L. theobromae* from *P. flavida* could degrade irradiated polypropylene film with 0.3 mg on actual weight loss basis. Further work on employing these endophytic fungi in biodegradation of plastics is warranted.

Keywords: *Lasiodiplodia theobromae*; LDPE; FTIR; Biofilm

Ágnes Kis[a, b, c], Krisztián Laczi[a], Szilvia Zsíros[a], Gábor Rákhely[a, b, c], Katalin Perei[a]. ([a]Department of Biotechnology, University of Szeged, Közép fasor 52, H-6726 Szeged, Hungary, [b] Institute of Environmental Sciences, University of Szeged, Rerrich Béla tér 1, H-6720 Szeged, Hungary, [c] Institute of Biophysics, Biological Research Centre Hungarian Academy of Sciences, Temesvári krt. 62., H-6726 Szeged, Hungary). **Biodegradation of animal fats and vegetable oils by *Rhodococcus erythropolis* PR4. International Biodeterioration & Biodegradation, Volume 105((2015):114–119**

The alkane (pristane) degradation capacity of *Rhodococcus erythropolis* PR4 (NBRC 100887), isolated from marine environment, was previously observed. In this study, the ability of this strain for biodegradation of various animal fats, such as pig lards and poultry fats as well as butter, margarine and sunflower cooking oil was studied. Bioconversion of fats and oil was determined as methyl-ester (FAME) derivatives by GC–MS. *R. erythropolis* PR4 strain could utilize all substrates tested but the bioconversion rate and efficacies varied. The optimum pH for decomposition of pig lard and poultry fat was 8.5, respectively. Addition of carbonate to the media dramatically improved the efficiency of the process via stabilization of pH of the fermentation. Biotransformation of poultry fat was complete in four days and around 80% conversion was reached in the case of pig lard in media containing carbonate. The extracellular lipase activity of the *R. erythropolis* PR4 strain was also demonstrated by various techniques. The results suggest the *R. erythropolis* PR4 strain studied is a promising candidate in bioremediation/bioconversion of fat-containing wastes within a relatively short time.

Keywords: Animal fats; Biodegradation; Fatty acids; Lipase; *Rhodococcus erythropolis*; Vegetable oil

G. Tóth, N. Nemestóthy, K. Bélafi-Bakó, D. Vozik, P. Bakonyi. (Research Institute on Bioengineering, Membrane Technology and Energetics, University of Pannonia, Egyetem ut 10, 8200 Veszprém, Hungary). Degradation of hydrogen sulfide by immobilized *Thiobacillus thioparus* in continuous biotrickling reactor fed with synthetic gas mixture. International Biodeterioration & Biodegradation, Volume 105(2015): 185–191

In this work, a sulfur-oxidizing bacteria, *Thiobacillus thioparus* (immobilized on Mavicell B support) was employed to develop a microaerobic, biotrickling filter reactor for the efficient elimination of H_2S from synthetic (bio)gas. To test the capability of this particular strain in oxygen-limited atmosphere, fixed bed reactor was operated under 0.25–5 vol.% O_2 concentrations and its H_2S decomposing ability was statistically evaluated. It was found that the system achieved 100% H_2S elimination efficiency when at least 2.5 vol.% oxygen was provided. Further decrease of O_2 levels to 0.25–1 vol.% cut the reliability and caused the loss of H_2S biodegradation performance. The results of this study contributed to understand the behavior of *T. thioparus* under microaerobic conditions and thus may help to design efficient gas purification processes for biogas technology.

Keywords: *T. thioparus*; Microaerobic; Packed bed reactor; H_2S elimination; Biogas

Salgo Merin Jacob, A.M. Bhagwat, Varsha Kelkar-Mane. (University Department of Biotechnology, University of Mumbai, Vidyanagari, Kalina, Santacruz (E), Mumbai 98, India). *Bacillus* species as an intrinsic controller of fungal deterioration of archival documents. International Biodeterioration & Biodegradation, Volume 104(2015): 46–52

The present study samples 19th century maps (belonging to India's Great Trigonometrical Survey) and daptars (official papers of Maratha history) to isolate the microflora and explore their interactions within that niche. Amongst the array of microbial isolates, the work successfully isolates a novel strain of *Bacillus*, producing a potent, low molecular weight, broad spectrum antagonistic protein fraction. The predominance of this species rendered the documents sampled resistant to biodeterioration in comparison to others. The antifungal activity of the isolate was attributed to a low molecular weight, heat, pH stable, extracellular protein fraction that was isolated with 30% and 60% ammonium sulfate precipitation. The activity of this

fraction was established by bio-autography. Its stability upto 50 °C and resistance to proteolytic cleavage makes this protein fraction a novel broad spectrum potent antifungal candidate.

Keywords: Archival documents; Antifungal protein; Fungal deteriogens; *Bacillus licheniformis*; *Bacillus* species

Chao Meng[a, 1], Qin He[a, 1], Jun-Wei Huang[a], Qin Cao[b], Xin Yan[a], Shun-Peng Li[a], Jian-Dong Jiang[a]. ([a]Department of Microbiology, Key Lab of Microbiological Engineering of Agricultural Environment, Ministry of Agriculture, College of Life Sciences, Nanjing Agricultural University, 210095, Nanjing, PR China, [b] China National Center for Biotechnology Development, Building 4, No. 16, Xisihuanzhonglu, Haidian District, 100039, Beijing, 100039, PR China). **Degradation of chlorothalonil through a hydrolytic dehalogenase secreted from *Bacillus subtilis* WB800. International Biodeterioration & Biodegradation, Volume 104(2015): 97–104**

To achieve the secretory expression of chlorothalonil hydrolytic dehalogenase (Chd), the *chd* gene was cloned into the vector pP43NMK under the control of the P43 promoter and the NprB signal peptide-encoding sequence and extracellularly expressed in the protease-deficient strain *Bacillus subtilis* WB800. The optimization of Chd production in submerged culture through Plackett-Burman and Box-Behnken designs enhanced the activity of Chd from 6.80 to 14.50 U l^{-1} and the protein expression amount from 1.93 μg ml^{-1} to 5.65 μg ml^{-1}. The obtained Chd catalyzed a hydroxyl substitution at the 4-chlorine atom of chlorothalonil to form 4-hydroxy-trichloroisophthalonitrile, which is more soluble in water and easier to remove from the surface of vegetables. Six types of vegetables classified by the edible organ were selected for the chlorothalonil enzymatic degradation assay. After enzymatic reaction for 120 min, almost all of the 25 mg kg^{-1} chlorothalonil on cherry tomatoes was removed, approximately 82% of the 45 mg kg^{-1} chlorothalonil on lactuca sativa was removed, and approximately 40%–67% of the chlorothalonil on all other vegetables was removed. Moreover, the chlorothalonil eluted from the vegetables could be degraded to <1 mg l^{-1} after 3 h. The results of the present study demonstrated the potential of Chd to clean up chlorothalonil residue on the surfaces of vegetables.

Keywords: Chlorothalonil hydrolytic dehalogenase (Chd); Secretory expression; *Bacillus subtilis*; Enzymatic degradation; Vegetables

Ashok Kumar Chauhan[a], Abrar Ahmad[a], Surya Pratap Singh[b], Ashwani Kumar[a]. ([a]Environmental Biotechnology Division, Indian Institute of Toxicology Research (Council of Scientific & Industrial Research), M.G. Marg, Lucknow 226001, India, [b] Department of Biochemistry, Faculty of Science, Banaras Hindu University, Varanasi, India). **Biodesulfurization of benzonaphthothiophene by an isolated *Gordonia* sp. IITR100. International Biodeterioration & Biodegradation, Volume 104(2015): 105–111**

Studies on the desulfurization of three or more ringed-compounds, which are considered to inhibit biodesulfurization of crude oil, are rare. In this paper, desulfurization of a three-ringed compound benzo[*b*]naphtho[2,1-*d*]thiophene (BNT) by an isolated strain *Gordonia* sp. IITR100 is described. The bacterium mediates desulfurization of BNT and utilizes the released sulfur for its growth. The reaction is accompanied with the formation of metabolites BNT-sulfone and BNT-sulfinate, in addition to the reported BNT-hydroxide. Recombinant *E. coli* cells, harboring DszC or DszA, were also able to mediate the metabolism of BNT to BNT-sulfone, or of BNT-sulfone to BNT-sulfinate, respectively. Desulfurization of BNT, both by IITR100 and *E. coli*-DszC cells was strongly inhibited in the presence of dibenzothiophene. The results are discussed

in the context of the biodesulfurization of petroleum fractions where several organosulfur compounds are present together.

Keywords: Biodesulfurization; *Gordonia* sp. IITR100; Benzonapthothiophene; Dibenzothiophene; Crude oil

Marianela Maza[a], Hipólito Fernando Pajot[b], María Julia Amoroso[b, c], Marta Graciela Yasem[a]. ([a]Cátedra de Fitopatología, Facultad de Agronomía y Zootecnia, Universidad Nacional de Tucumán, Florentino Ameghino S/N, El Manantial, Tucumán, T4104AUD, Argentina, [b] PROIMI-CONICET, Av. Belgrano y Caseros, Tucumán, T4001MVB, Argentina, [c] Instituto de Microbiología, Facultad de Bioquímica, Química y Farmacia, Universidad Nacional de Tucumán, Ayacucho 471, Tucumán, Argentina). ***In-vitro* degradation of Czapek and molasses amended post-harvest sugarcane residue by lignocellulolytic fungal strains. International Biodeterioration & Biodegradation, Volume 104(2015): 118–122**

Post-harvest sugarcane residue (SCR), deposited on sugarcane fields after green harvesting, could serve as a substrate for fungal biomass and lignocellulolytic enzymes production. In the present study, the mycelial growth of six strains (*Trametes* sp. Y–H11, *Bjerkandera* sp. Y-HHM2, *Phanerochaete* sp. Y-RN1, *Pleurotus* sp. Y-RN3, *Myrothecium* sp. S-3.20 and *Hypocrea nigricans* SCT-4.4) was measured *in-vitro* by applying a modified Gompertz equation. *In-vitro* assays showed shorter lag phases for fungi in modified Czapek, 0.3% and 1.0% molasses amended post-harvest SCR. Further increments in molasses concentrations produced a reduction on the specific growth rates for all tested fungi. Fungal degradation of post-harvest SCR and the concomitant enzyme production were tested under solid-state fermentation (SSF) of Czapek or molasses amended post-harvest SCR. Under SSF, *Pleurotus* sp. Y-RN3 produced the highest laccase titers but no hydrolytic activity could be detected. *Trametes* sp. Y–H11 and *Myrothecium* sp. S-3.20 showed high endoglucanase activities. Endoxylanase production was detected exclusively in Czapek amended media. These findings have implications for the fungal treatment of post-harvest SCR and its potential impact on the use of these residues in the production of biofuels and ligninolytic enzymes.

Keywords: Post-harvest sugarcane residue; Molasses; Growth model; Solid-state fermentation; Decomposition; Laccase

Evelise Bach, Fernanda Cortez Lopes, Adriano Brandelli. (Laboratório de Bioquímica e Microbiologia Aplicada, Instituto de Ciência e Tecnologia de Alimentos, Universidade Federal do Rio Grande do Sul (UFRGS), 91501-970, Porto Alegre, Brazil). **Biodegradation of α and β-keratins by Gram-negative bacteria. International Biodeterioration & Biodegradation, Volume 104(2015): 136–141**

The increasing amount of recalcitrant keratinous wastes generated as byproducts of agroindustrial processing has attracted attention to keratinolytic enzymes able to convert these proteins into valuable products through non-polluting processes. This work aimed to evaluate the biodegradation of α and β-keratins by three Gram-negative bacteria. All bacteria degraded feathers and feather meal and the production of keratinolytic proteases was confirmed through the azokeratin assay. An increase of thiol concentration was observed in the keratinous media cultivated with these strains, probably due to the reduction of disulfide bonds of the keratin substrate. In addition, the strains *Chryseobacterium indologenes* A22 and *Aeromonas hydrophila*

K12 could also degrade hair and wool, showing a broad spectrum of keratinous wastes degradation. The influence of pH and feather meal concentration on *C. indologenes* A22 enzyme production was also investigated. This strain presented an optimal keratinase production on neutral pH and 15 g L^{-1} of substrate concentration.

Keywords: Keratinase; α-keratin; Biodegradation; Hard protein

Olga Marchut-Mikolajczyk, Ewa Kwapisz, Dorota Wieczorek, Tadeusz Antczak. (Department of Biotechnology and Food Science, Institute of Technical Biochemistry, Lodz University of Technology, Lodz, Poland). Biodegradation of diesel oil hydrocarbons enhanced with *Mucor circinelloides* enzyme preparation. International Biodeterioration & Biodegradation, Volume 104(2015): 142–148

The aim of the study was to use immobilized *in situ Mucor circinelloides* (*MC*) enzymes preparation as an agent for enhanced microbial hydrocarbons biodegradation. It is a new element of complex biological degradation of diesel oil hydrocarbons (8% v/v) performed by bacterial consortia (*Gordonia alkanivorans S7* (S7), *Achromobacter xylosoxidans G21* (*G21*), *Pseudomonas sp. A34* (*A34*)). After 14 days of biodegradation experiments, addition of *M. circinelloides* enzyme preparation not only increased the efficiency of hydrocarbons degradation in about 20 %–30 % compared to samples without the preparation, but also resulted in higher metabolic activity of microorganisms (higher respiratory activity, 30% decrease in critical oxygen concentration). The use of *M. circinelloides* enzyme preparation has significant influence on the emulsifying activity of the strains, which is very important in case of utilization of hydrophobic substances, such as hydrocarbons. Values of the parameter were relatively higher in the presence of the preparation (trail with *A. xylosoxidans G21* and *MC* $OD_{500} = 1.3 \pm 20.8 \times 10^{-3}$ at the same time trail with *A. xylosoxidans G21* $OD_{500} = 0.925 \pm 0.5 \times 10^{-3}$). Data obtained with GC chromatographic analysis confirmed the positive impact of fungal enzyme preparation on the process of diesel oil hydrocarbons degradation.

Keywords: Biodegradation; Hydrocarbons; Enzymes; Fungi

Zuzanna Szczepaniak[a], Paweł Cyplik[b], Wojciech Juzwa[b], Jakub Czarny[c], Justyna Staninska[b], Agnieszka Piotrowska-Cyplik[a]. ([a] Institute of Food Technology of Plant Origin, Poznań University of Life Sciences, Wojska Polskiego 31, 60-624 Poznań, Poland, [b] Department of Biotechnology and Food Microbiology, Poznań University of Life Sciences, Wojska Polskiego 48, 60-627 Poznań, Poland, [c] Institute of Forensic Genetics, Al. Mickiewicza 3/4, 85-071 Bydgoszcz, Poland). Antibacterial effect of the *Trichoderma viride* fungi on soil microbiome during PAH's biodegradation. International Biodeterioration & Biodegradation, Volume 104(2015): 170–177

The aim of this study was to evaluate the influence of *Trichoderma viride* on the metabolic activity and the community dynamics of soil bacteria during polyaromatic hydrocarbons (PAHs) biodegradation. Sixteen PAHs were introduced into soil microcosms mimicking natural conditions to achieve an initial concentration of 2000 mg kg^{-1} of soil. After 12 months of treatment, the efficiency of PAH removal was of 78% for the microcosms inoculated with a PAH-degrading bacterial consortium designated S3, 64% for those inoculated with the consortium S3 + *T. viride*, whereas an efficiency of only 47% was achieved in the microcosms inoculated with *T. viride* alone. Flow cytometry analysis of the bacterial metabolic activities, expressed as the oxidation-reduction potential, allowed differentiating single cells with regard to their metabolic activities. Prior to its introduction in soil microcosms, the consortium S3 consisted of 195 bacterial species which were identified by employing next generation sequencing (MiSeq, Illumina). It has been established that significant changes in the composition

of the bacterial community occurred during the biodegradation process when it was carried out in the presence of *T. viride*. After such treatment only 73 bacterial species were identified from the metabiome, with the dominance of *Stenotrophomonas retroflexus* (47.46%), *Ochrobactrum intermedium* (25.83%) and *Citrobacter freundii* (19.87%). *T. viride* was able to degrade PAHs; however its presence mainly contributed to modify the bacterial metabiome *via* antagonistic interactions with the bacteria, which notably reduced the biodegradation efficiency and biodiversity in the microcosms.

Keywords: Bioaugmentation; Bioremediation; PAH; NGS; *Trichoderma viride*

Dongmei Ma[a], Donglei Zou[a], Dandan Zhou[b], Tingting Li[a], Shanshan Dong[a], Zhengxue Xu[a], Shuangshi Dong[a, c]. ([a] Key Lab of Groundwater Resources and Environment, Ministry of Education, Jilin University, Changchun 130021, PR China, [b] School of Environment, Northeast Normal University, Changchun 130024, PR China, [c] State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, Harbin 150090, PR China). **Phenol removal and biofilm response in coupling of visible-light-driven photocatalysis and biodegradation: Effect of hydrothermal treatment temperature. International Biodeterioration & Biodegradation, Volume 104(2015): 178–185**

Intimate coupling of visible-light-responsive photocatalysis and biodegradation (VPCB) provides novel insights into removal of inhibitory pollutants. Under these reactions, microbes are prone to photocatalytic activity. In this study, microbial responses to photocatalytic activity in VPCB used for phenol degradation were investigated. VPCB was conducted with Er^{3+}:$YAlO_3$/TiO_2 photocatalysts prepared at heat-treatment temperatures [HT] of 110 °C, 130 °C, and 150 °C to evaluate photocatalytic activities. The highest phenol removal rate (71.6%) was observed in photocatalysis [HT] 130, and particular microbial responses were elicited in VPCB [HT] 130. Dehydrogenase activity exhibited the highest decrease (90.7%) in VPCB [HT] 130. In this treatment, large amounts of biofilm were detached from the exterior of the carrier but the biofilm remained well protected in the interior. Extracellular polymeric substances with decreases of 65.6% and 31.4% in protein and polysaccharide levels, respectively, were not stimulated in VPCB [HT] 130 but were evidently stimulated in the other two protocols, which could be due to lower phenol inhibition. These results indicated that the most efficient removal rates of phenol and dissolved organic carbon reached 99.8% and 67.1%, respectively, in VPCB [HT] 130.

Keywords: Coupling; Photocatalysis; Visible light; Microbial response; Biodegradation; Phenol

Olanike M. Buraimoh[a, b], Matthew O. Ilori[a], Olukayode O. Amund[a], Frederick C. Michel Jr.[b], Sukhbir K. Grewal[b]. ([a] Department of Microbiology, University of Lagos, Akoka, Yaba, Lagos, Nigeria, [b] Department of Food, Agricultural and Biological Engineering, The Ohio State University, Wooster, OH 44691, USA). **Assessment of bacterial degradation of lignocellulosic residues (sawdust) in a tropical estuarine microcosm using improvised floating raft equipment. International Biodeterioration & Biodegradation, Volume 104(2015): 186–193**

In situ and laboratory studies were carried out to determine the ability of bacterial strains isolated from a tropical lagoon to degrade lignin and carbohydrate components of sawdust, with a view to abating the impact of sawdust pollution on these ecosystem. A floating raft system was designed and fabricated to carry out the *in situ* biodegradation studies over a period of 24 weeks.

Nine bacterial strains identified by 16S rRNA gene sequencing as species of *Streptomyces*, *Bacillus* and *Paenibacillus* isolated from the lagoon were used as seed organisms. In the *in situ* study, 59.2% of sawdust was depleted at the rate of 1.175×10^{-4} g d^{-1} cm^{-3} by the bacterial isolates, whereas the lignin component of the sawdust decreased by up to 82.5% at the rate of 1.80×10^{-5} g d^{-1} cm^{-3}. The maximum decrease in carbohydrate content was 85% at the rate of 2.192×10^{-7} g d^{-1} cm^{-3}. In a similar experiment under laboratory conditions, total weight losses ranging from 26 to 51% in the wood residues were observed.

Keywords: Floating raft; Microcosm; Estuarine; Sawdust; Lignocellulose; Biodegradation

Paulina Siewiera, Przemysław Bernat, Sylwia Różalska, Jerzy Długoński. (Department of Industrial Microbiology and Biotechnology, Faculty of Biology and Environmental Protection, University of Lodz, Banacha 12/16, PL 90-237 Łódź, Poland). **Estradiol improves tributyltin degradation by the filamentous fungus *Metarhizium robertsii.* International Biodeterioration & Biodegradation, Volume 104(2015): 258–263**

Tributyltin chloride (TBT) is a toxic and persistent organic pollutant that is extensively employed in a variety of industrial products. TBT, an endocrine disrupting chemical, disturbs lipids homeostasis in living cells and is responsible for generating reactive oxygen species (ROS), which affect cell viability. The aim of this study was to test whether estradiol (E2), which exhibits antioxidant activity, could increase the TBT degradation efficiency by the filamentous fungus *Metarhizium robertsii*. After five days of incubation in Sabouraud growth medium, 27% of TBT (added at the initial concentration 2.5 mg l^{-1}) was converted to dibutyltin (DBT) and monobutyltin (MBT). The data obtained for fungal cultures incubated with TBT and E2 simultaneously demonstrated that, in the presence of estradiol, the TBT-induced growth inhibition was reduced and 44% of TBT was metabolised. Moreover, the determination of phospholipids and the assessment of propidium iodide influx showed a strong disturbance in the membrane integrity and the phosphatidylcholine (PC)/phosphatidylethanolamine (PE) ratio for TBT-stressed mycelia, whereas fungal cells treated with the mixture of TBT and E2 presented a lower level of membrane disintegration. It is suggested that E2 protects fungal cells against TBT toxicity and improves biocide degradation.

Keywords: Organotins; Tributyltin; Phospholipids; Degradation; Estradiol

Li Yao[a, 1], Xingjun Jia[a, 1], Jiadong Zhao[a], Qin Cao[c], Xiangting Xie[b], Linlu Yu[a], Jian He[a], Qing Tao[b]. ([a] Key Laboratory of Microbiological Engineering of Agricultural Environment, Ministry of Agriculture, Life Sciences College Laboratory Center, Life Sciences College of Nanjing Agricultural University, Nanjing, Jiangsu, 210095, China, [b] DBN Biotech Center, Beijing DBN Technology Group Co., Ltd., No. 2 Yuanmingyuan West Road, Haidian District, Beijing, 100193, China, [c] China National Center for Biotechnology Development, Building 4, No. 16, Xisihuanzhonglu, Haidian District, Beijing, 100039, China). **Degradation of the herbicide dicamba by two sphingomonads via different *O*-demethylation mechanisms. International Biodeterioration & Biodegradation, Volume 104(2015): 324–332**

Dicamba, a chlorinated benzoic acid herbicide, is widely used to control broadleaf weeds. In this study, two dicamba-degrading sphingomonads *Sphingobium* sp. Ndbn-10 and *Sphingomonas* sp. Ndbn-20 were isolated from activated sludge and compost samples, respectively. Both isolates could completely degrade and utilize dicamba, but strain Ndbn-10 possessed relatively higher dicamba degradation efficiency than strain Ndbn-20. The degradation of dicamba in both isolates was initiated by *O*-demethylation to generate 3,6-dichlorosalicylic acid (DCSA) but through different mechanisms. For *Sphingobium* sp. Ndbn-10, *O*-demethylation is catalyzed by a NADH-

dependent dicamba monooxygenase (DMO), whereas in *Sphingomonas* sp. Ndbn-20, a tetrahydrofolic acid (THF)-dependent *O*-demethylase is responsible for the *O*-demethylation. Our results suggest that sphingomonads can rapidly and efficiently adapt to degrading dicamba through the evolution of different metabolic pathway mechanisms and highlight a novel THF-dependent dicamba *O*-demethylation mechanism in bacteria.

Keywords: Dicamba; Microbial degradation; Sphingomonads; *O*-demethylation; Tetrahydrofolic acid-dependent *O*-demethylase

Michael Gatheru Waigi, Fuxing Kang, Carspar Goikavi, Wanting Ling, Yanzheng Gao. (Institute of Organic Contaminant Control and Soil Remediation, College of Resources and Environmental Sciences, Nanjing Agricultural University, Nanjing 210095, PR China). **Phenanthrene biodegradation by sphingomonads and its application in the contaminated soils and sediments: A review. International Biodeterioration & Biodegradation, Volume 104(2015): 333–349**

Polycyclic aromatic hydrocarbons (PAHs), a class of hazardous chemicals ubiquitous in many ecosystems, are of great concern due to their potential toxicity, carcinogenicity, teratogenicity, and mutagenicity. Phenanthrene, a low-molecular-weight hydrophobic PAH, binds to particulates in the soil and sediments, thus inhibiting biological uptake. In such PAH-contaminated environments, some well-adapted microorganisms, such as the sphingomonads (belonging to the Family *Sphingomonadaceae* in α-Proteobacteria) can degrade phenanthrene, whether in isolation or cometabolized with other PAHs. Some of the members of sphingomonads, consisting of the *Sphingomonas*, *Sphingobium*, *Novosphingobium*, and *Sphingopyxis* genera, have adjusted well to contaminated soil environments compared to most bacterial genera that degrade PAHs. This is manifested in phenanthrene, which has been found to induce strong up-regulation of extradiol cleavage pathway enzymes in sphingomonads with similar gene and enzyme homology to *Sphingobium yanoikuyae* B1, where enzymes like ring-hydroxylating dioxygenase, putative biphenyl-2,3-diol 1,2-dioxygenase, and catechol 2,3-dioxygenase are encoded by *bphA2cA1c*, *bphA1[a-e]A2[a-e]* (which both require *bphA3bphA4*) and *bphC* genes, respectively. With *meta*- and *ortho*-cleavage pathway routes, this has made sphingomonads a well-adapted group of microorganisms. This review will focus on taxonomic, autecological and genetic features of sphingomonads which impact on their ability to metabolize phenanthrene at different rates and under different conditions.

Keywords: Biodegradation; Polycyclic aromatic hydrocarbons; Phenanthrene; Sphingomonads

Imane Béchohra[a, b], Annabelle Couvert[a, b], Abdeltif Amrane[a, b, c]. ([a] Ecole Nationale Supérieure de chimie de Rennes, CNRS, UMR 6226, 11, Allée de Beaulieu, CS 50837, 35708 Rennes Cedex 7, France, [b] Université Européenne de Bretagne, 5 Boulevard Laennec, Rennes, France, [c] Université de Rennes 1, CNRS, UMR 6226, 3 rue du Clos-Courtel, BP 90433, 35704 Rennes Cedex 7, France). **Absorption and biodegradation of toluene: Optimization of its initial concentration and the biodegradable non-aqueous phase liquid volume fraction. International Biodeterioration & Biodegradation, Volume 104(2015): 350–355**

Di (2-EthylHexyl) Phthalate (DEHP) was selected as a biodegradable organic solvent to be implemented in a two-phase partitioning bioreactor (TPPB) dedicated to remove a model hydrophobic volatile organic compound (VOC), toluene. In a first step, the absorption capacity

of toluene in the selected organic solvent was examined according to the partition coefficients H. In a second step, toluene biodegradation in DEHP by non-acclimated activated sludge was carried out for different volume fractions of DEHP in water and five different toluene concentrations (4.3, 43, 106, 212 and 430 mg l^{-1}). Toluene showed high affinity for DEHP with H = 0.99 Pa m^3 $mole^{-1}$. Both toluene and DEHP were completely consumed for 4.3 mg l^{-1} (initial toluene concentration) and a volume ratio of 0.1% DEHP in water. For an initial toluene concentration of 106 mg l^{-1} and a volume ratio of 0.1%, total toluene consumption and 87% DEHP degradation yield were obtained after seven days of incubation.

Keywords: DEHP; Biodegradation; Activated sludge; VOC

Xing-Guang Xie, Chuan-Chao Dai. (Jiangsu Key Laboratory for Microbes and Functional Genomics, Jiangsu Engineering and Technology Research Center for Industrialization of Microbial Resources, College of Life Sciences, Nanjing Normal University, Nanjing, Jiangsu Province 210023, China). **Biodegradation of a model allelochemical cinnamic acid by a novel endophytic fungus *Phomopsis liquidambari.* International Biodeterioration & Biodegradation, Volume 104(2015): 498–507**

Cinnamic acid, as a model phenolic allelochemical, can be widely found in continuous cropping soils, and its accumulation often causes a decline in growth, yield and crop quality. In this study, endophytic fungus *Phomopsis liquidambari* could effectively degrade allelochemical cinnamic acid as its sole source of carbon and energy for growth, and glucose did not significantly affect its degradation efficiency. The degradation pathway of cinnamic acid was proposed based on metabolites identified by GC–MS and HPLC-MS. Cinnamic acid was initially transformed to styrene that was further degraded via benzaldehyde, benzoic acid, 4-hydroxybenzoic acid and protocatechuic acid, which included the involvement of phenolic acid decarboxylase, laccase, hydroxylase and protocatechuate 3,4-dioxygenase. Their activities and gene transcription dynamics were consistent with the changes in related intermediate product concentrations. Moreover, the generation of laccase significantly improved the degradation rate of cinnamic acid. Further study found that even in a complex soil environment, this strain could also efficiently degrade cinnamic acid and then improve the growth of peanut seedlings. Therefore, these results indicated that *P. liquidambari* could be considered a suitable candidate for practical application to mitigate the allelopathic stress caused by cinnamic acid in continuous cropping soils.

Keywords: Endophytic fungus; Cinnamic acid; Biodegradation; Enzymatic activity; Gene transcription; GC/HPLC-MS

Si Hui Chen, Adeline Su Yien Ting. (School of Science, Monash University Malaysia, Jalan Lagoon Selatan, Bandar Sunway, 46150 Petaling Jaya, Selangor, Malaysia). **Biosorption and biodegradation potential of triphenylmethane dyes by newly discovered *Penicillium simplicissimum* isolated from indoor wastewater sample. International Biodeterioration & Biodegradation, Volume 103(2015): 1–7**

Penicillium simplicissimum (isolate 10, KP713758), a contaminant from indoor wastewater was studied for biosorption and biodegradation activities towards triphenylmethane (TPM) dyes. This newly discovered isolate demonstrated strong decolorization activities towards Methyl Violet (MV, 100 mg l^{-1}), Crystal Violet (CV, 100 mg l^{-1}) and Cotton Blue (CB, 50 mg l^{-1}), with 98%, 95% and 82% removed within 13, 14 and 1 day(s). Malachite Green (MG, 100 mg l^{-1}), the most recalcitrant dye, was partially decolorized (54%) by day 14. The biodegradation potential of *P. simplicissimum* was detected by the reduction in dye spectra peaks. Induced lignin peroxidase and NADH-DCIP reductase activities further suggested biodegradation potential. Batch studies

revealed that decolorization activities of *P. simplicissimum* were influenced by the biomass used, initial dye concentrations, oxygen availability and cell viability, with optimum decolorization achieved using 2 g biomass, 100 mg l^{-1} dye concentration and in the absence of oxygen (except for CB).

Keywords: Biosorption; Biodegradation; Decolorization; *Penicillium simplicissimum*; Triphenylmethane dyes

Santanu Pailan[a], Debdoot Gupta[a], Snehal Apte[b], Srinivasan Krishnamurthi[b, 1], Pradipta Saha[a]. ([a]Department of Microbiology, Burdwan University, Golapbag, Burdwan 713104, West Bengal, India, [b] Biological Oceanography Division, NIO, Goa, India). **Degradation of organophosphate insecticide by a novel *Bacillus aryabhattai* strain SanPS1, isolated from soil of agricultural field in Burdwan, West Bengal, India. International Biodeterioration & Biodegradation, Volume 103(2015): Pages 191–195**

Organophosphate (OP) insecticides are widely used for controlling insect pests for better crop production in India. But indiscriminate use and lack of proper technical knowhow have resulted in contamination and pollution of large varieties of ecological niches. A novel bacterial strain designated as SanPS1, capable of utilizing chlorpyrifos and parathion, was isolated by enrichment culture from a soil sample of an agricultural field located at Narigram in Burdwan district of West Bengal, India. This novel Gram positive, endospore forming strain was identified as *Bacillus aryabhattai* based on 16S rDNA sequencing. The strain tolerated up to 500 µg mL^{-1} of chlorpyrifos and parathion and for both compounds optimal degradation was achieved at a concentration of 200 µg mL^{-1}. The metabolites were identified by high performance liquid chromatography and gas chromatography-mass spectrometry analyses. We propose a degradation pathway of parathion for this strain through formation of 4-nitrophenol and 4-nitrocatechol intermediates. The strain could degrade approximately 56% of parathion in liquid mineral medium within 24 h at 37 °C.

Keywords: Organophosphate (OP) insecticides; Chlorpyrifos; Parathion; Bioremediation; Burdwan district

Young-Hyun Song, Byung-Min An, Ja-Won Shin, Joo-Yang Park. (Department of Civil and Environmental Engineering, Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul, 133-791, Republic of Korea). **Ethanolamine degradation and energy recovery using a single air-cathode microbial fuel cell with various separators. International Biodeterioration & Biodegradation, Volume 102(2015): 392–397**

Ethanolamine (ETA) is commonly used for alkalinization to prevent corrosion of pipes in nuclear power plants. ETA, however, causes water to deteriorate, increasing the concentration of organic matter or nutrient salts in water systems. To generate power and degrade ETA at the same time, ETA was used as carbon source for microorganisms in a single air-cathode microbial fuel cell (MFC). Using a membrane as a separator in an MFC makes them costly to set-up. To reduce the expense and evaluate MFC performance, the experiments were conducted with three different separators: a proton exchange membrane (PEM), a cation exchange membrane (CEM), and polypropylene (PP) felt. The PP felt-MFC resulted in the most efficient COD (94%) and ammonium removal (52%). The CEM-MFC produced the highest power density of 583.7 mW m^{-2} at a current density of 0.15 mA cm^{-2}. The Coulombic efficiencies (CEs) were 25.1, 23.7, and 10.5% for PEM-, CEM-, and PP felt-MFCs, respectively. Although using PP felt decreased

the power generation compared with membrane MFCs in terms of energy recovery, it increased ETA degradation and reduced the cost of initial set-up.

Keywords: Ethanolamine; Single air-cathode microbial fuel cell; Energy recovery; Polypropylene felt; Separator

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Contamination by 2,4,6-trinitrotoluene (TNT), an explosive extensively used by the military, represents a serious environmental problem. In this study, whey has been selected as the most technologically and economically suitable primary substrate for anaerobic *in situ* biodegradation of TNT. Under laboratory conditions, various additions of whey, molasses, acetate and activated sludge as an inoculant were tested and the process was monitored using numerous chemical analyses including phospholipid fatty acid analysis. The addition of whey resulted in the removal of more than 90% of the TNT in real contaminated soil (7 mg kg^{-1} and 12 mg kg^{-1} of TNT). The final bioremediation strategy was suggested on the basis of the laboratory results and tested under real conditions at a TNT contaminated site in the Czech Republic. During the pilot test, three repeated injections of whey suspension into the sandy aquifer were performed over a 10-month period. In total, approximately 5 m^3 of whey were used. A substantial decrease in the TNT groundwater concentration from the original levels (equalling 1.49 mg l^{-1} to 8.58 mg l^{-1}) was observed in most of the injection wells, while the concentrations of the TNT biotransformation products were found to be elevated. Pilot-scale application results showed that the anoxic and/or anaerobic conditions in the aquifer were sufficient for TNT bio-reduction by autochthonous microorganisms. Whey application was not accompanied by undesirable effects such as a substantial decrease in the pH or clogging of the wells. The results of the study document the suitability of application of whey to bioremediate TNT contaminated sites *in situ*.

Juan Salvador Chin-Pampillo, Karla Ruiz-Hidalgo, Mario Masís-Mora, Elizabeth Carazo-Rojas, Carlos E. Rodríguez-Rodríguez. (Centro de Investigación en Contaminación Ambiental (CICA), Universidad de Costa Rica). **Design of an optimized biomixture for the degradation of carbofuran based on pesticide removal and toxicity reduction of the matrix. Environmental Science and Pollution Research, Volume 22(23) (2015): 19184-19193**

Pesticide biopurification systems contain a biologically active matrix (biomixture) responsible for the accelerated elimination of pesticides in wastewaters derived from pest control in crop fields. Biomixtures have been typically prepared using the volumetric composition 50:25:25 (lignocellulosic substrate/humic component/soil); nonetheless, formal composition optimization has not been performed so far. Carbofuran is an insecticide/nematicide of high toxicity widely employed in developing countries. Therefore, the composition of a highly efficient biomixture (composed of coconut fiber, compost, and soil, FCS) for the removal of carbofuran was optimized by means of a central composite design and response surface methodology. The volumetric content of soil and the ratio coconut fiber/compost were used as the design variables. The performance of the biomixture was assayed by considering the elimination of carbofuran, the mineralization of ^{14}C-carbofuran, and the residual toxicity of the matrix, as response

variables. Based on the models, the optimal volumetric composition of the FCS biomixture consists of 45:13:42 (coconut fiber/compost/soil), which resulted in minimal residual toxicity and ~99 % carbofuran elimination after 3 days. This optimized biomixture considerably differs from the standard 50:25:25 composition, which remarks the importance of assessing the performance of newly developed biomixtures during the design of biopurification systems.

Keywords: Biopurification system; Pesticides; Degradation; Coconut fiber; Optimization

Jiajin Liang[a, b], Xiang Peng[a], Dexing Yin[a], Beiyin Li[a], Dehan Wang[a], Yunqin Lin[a]. ([a]College of Natural Resources and Environment, South China Agricultural University, Guangzhou, Guangdong 510642, PR China, [b] State Key Laboratory of Pulp and Paper Engineering, South China University of Technology, Guangzhou 510640, PR China). **Screening of a microbial consortium for highly simultaneous degradation of lignocellulose and chlorophenols. Bioresource Technology, Volume 190(2015): 381–387**

In this work, spent mushroom substrates were utilized for screening a microbial consortium with highly simultaneous degradation of lignocellulose and chlorophenols. The desired microbial consortium OEM1 was gained through successive cultivation for about 50 generations and its stability of composition was verified by denaturing gradient gel electrophoresis (DGGE) during screening process. It could degrade lignocellulose and chlorophenols at around 50% and 100%, respectively, within 7 days. The diversity analysis and the growth characteristics of OEM1 during degradation process were investigated by PCR-DGGE combined with clone and sequence. The results indicated that OEM1 consisted of 31 strains. *Proteobacteria* and *Bacteroidetes* were the predominant bacterial groups. The dynamic change of OEM1 illustrated that consortium community structure was effected by pH and substrate alteration and tended to be stable after 6 days' cultivation. Furthermore, bacteria (11 strains) and actinomycetes (2 strains) were obtained based on plate isolation and identified via 16S rDNA sequence.

Keywords: Microbial consortium; Lignocellulose; Chlorophenols; Spent mushroom substrate; Biodegradation

Kamaldeen Nasrin Nisha[a], Venkatesan Devi[a], Perumal Varalakshmi[b], Balasubramaniem Ashokkumar[a]. ([a]Department of Genetic Engineering, School of Biotechnology, Madurai Kamaraj University, Madurai, Tamil Nadu, India, [b] Department of Molecular Microbiology, School of Biotechnology, Madurai Kamaraj University, Madurai, Tamil Nadu, India). **Biodegradation and utilization of dimethylformamide by biofilm forming *Paracoccus* sp. strains MKU1 and MKU2. Bioresource Technology, Volume 188(2015): 9–13**

Two bacterial strains capable of degrading N,N-dimethylformamide (DMF) were isolated from the effluent and sludge samples of textile and tyre industries. The 16S rRNA gene analysis revealed that bacterial strains belonged to the genera *Paracoccus* and named as *Paracoccus* sp. MKU1 and *Paracoccus* sp. MKU2. The DMF degradation experiments conducted at a DMF concentration of 1% v/v and HPLC analysis revealed that MKU1 and MKU2 degraded 55% and 46% of DMF after 120 h of growth. Biofilm quantification by microtiter plate assay revealed that both the bacterial isolates can form efficient biofilm on during DMF utilization. The presence of secondary carbon sources influenced the DMF degradation and biofilm formation where highest biofilm formation was observed in the presence of acetate and enhanced the DMF

degradation to a maximum of 86.59% with MKU1 whereas glucose and acetate enhanced DMF degradation by MKU2 to a maximum of 82.7% and 80% respectively.

Eric M. Adetutu[a, 1], Taylor D. Gundry[a, , 1], Sayali S. Patil[a, b], Aida Golneshin[a], Joy Adigun[c], Vijay Bhaskarla[a], Samuel Aleer[a], Esmaeil Shahsavari[a], Elizabeth Ross[d], Andrew S. Ball[a]. ([a]School of Applied Sciences, Royal Melbourne Institute of Technology, Bundoora, Melbourne, VIC 3083, Australia, [b] School of Biological Sciences, Flinders University of South Australia, Adelaide, SA 5042, Australia, [c] GeneDX, 207 Perry Parkway, Gaithersburg, MD 20877, USA, [d] The University of Melbourne, Faculty of Veterinary and Agricultural Sciences, Parkville, VIC, Australia). **Exploiting the intrinsic microbial degradative potential for field-based *in situ* dechlorination of trichloroethene contaminated groundwater. Journal of Hazardous Materials, Volume 300(2015): 48–57**

Bioremediation of trichloroethene (TCE) polluted groundwater is challenging, with limited next generation sequencing (NGS) derived information available on microbial community dynamics associated with dechlorination. Understanding these dynamics is important for designing and improving TCE bioremediation. In this study, biostimulation (BS), biostimulation–bioaugmentation (BS–BA) and monitored natural attenuation (MNA) approaches were applied to contaminated groundwater wells resulted in ≥95% dechlorination within 7 months. Vinyl chloride's final concentrations in stimulated wells were between 1.84 and 1.87 μg L^{-1}, below the US EPA limit of 2.0 μg L^{-1}, compared to MNA (4.3 μg L^{-1}). Assessment of the groundwater microbial community with qPCR showed up to ∼50-fold increase in the classical dechlorinators' (*Geobacter* and *Dehalococcoides* sp.) population post-treatment. Metagenomic assays revealed shifts from Gammaproteobacteria (pre-treatment) to Epsilonproteobacteria and Deltaproteobacteria (post-treatment) only in stimulated wells. Although stimulated wells were functionally distinct from MNA wells post-treatment, substantial dechlorination in all the wells implied some measure of redundancy. This study, one of the few NGS-based field studies on TCE bioremediation, provides greater insights into dechlorinating microbial community dynamics which should be useful for future field-based studies.

Keywords: Trichloroethene; Groundwater; Bioremediation; Metagenomics; Quantitative PCR

Mette Kristensen[a], Anders R. Johnsen[b], Jan H. Christensen[a]. ([a] Analytical Chemistry, Section for Environmental Chemistry and Physics, Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, 1871 Frederiksberg C, Denmark, [b] Geological Survey of Denmark and Greenland (GEUS), Department of Geochemistry, Øster Voldgade 10, 1350 Copenhagen K, Denmark). **Marine biodegradation of crude oil in temperate and Arctic water samples. Journal of Hazardous Materials, Volume 300(2015): 75–83**

Despite increased interest in marine oil exploration in the Arctic, little is known about the fate of Arctic offshore oil pollution. Therefore, in the present study, we examine the oil degradation potential for an Arctic site (Disko Bay, Greenland) and discuss this in relation to a temperate site (North Sea, Denmark). Biodegradation was assessed following exposure to Oseberg Blend crude oil (100 mg L^{-1}) in microcosms. Changes in oil hydrocarbon fingerprints of polycyclic aromatic hydrocarbons (PAHs), alkyl-substituted PAHs, dibenzothiophenes, *n*-alkanes and alkyltoluenes were measured by gas chromatography-mass spectrometry (GC–MS). In the Disko Bay sample, the degradation order was *n*-alkanes > alkyltoluenes (para- > meta- > ortho-isomers) > PAHs and dibenzothiophenes, whereas, the degradation order in the North Sea samples was PAHs and dibenzothiophenes > alkyltoluenes > *n*-alkanes. These differences in degradation patterns

significantly affect the environmental risk of oil spills and emphasise the need to consider the specific environmental conditions when conducting risk assessments of Arctic oil pollution.

Keywords: Oil hydrocarbon fingerprint; Polycyclic aromatic hydrocarbon; Biodegradation; Marine Arctic environment; Gas chromatography-mass spectrometry; TOC graphic

Juan Chen[a, b], Hai Chao Zhou[a, b], Chao Wang[c], Chun Quan Zhu[c], Nora Fung-Yee Tam[a, b]. ([a] Department of Biology and Chemistry, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, China, [b] State Key Laboratory in Marine Pollution, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, China, [c] State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing, China). **Short-term enhancement effect of nitrogen addition on microbial degradation and plant uptake of polybrominated diphenyl ethers (PBDEs) in contaminated mangrove soil. Journal of Hazardous Materials, Volume 300(2015): 84–92**

Effects of nitrogen (N) addition on the microbial degradation and uptake of a mixture of BDE-47 and -209 by *Aegiceras corniculatum*, a typical mangrove plant species were investigated. At the end of 3-month experiment, a significant dissipation of BDE-47 was observed in the planted soil, and this dissipation, particularly in rhizosphere soil, was significantly accelerated by the frequent addition of N in the form of ammonium chloride. The removal percentage of BDE-47 in the rhizosphere soil without N addition was 47.3% and increased to 58.2% with N. However, the unplanted soil only removed less than 25% BDE-47, irrespective to N supply. The N addition in planted treatments significantly increased soil N content, urease and dehydrogenase activities, and the abundances of total bacteria and dehalogenating bacteria, leading to more microbial degradation of BDE-47. The N addition also enhanced the root uptake and translocation of PBDEs to above-ground tissues of *A. corniculatum*. These results suggested that N addition could enhance the phytoremediation of BDE-47-contaminated soil within a short period of time. Different from BDE-47, BDE-209 in all contaminated soils was difficult to be removed due to its persistence and low bioavailability.

Keywords: Ammonium-N; Microbial degradation; Persistent toxic organic pollutant; Plant uptake; Translocation

Adnan Hossain Khan[a], Edward Topp[b, c], Andrew Scott[b], Mark Sumarah[b], Sheila M. Macfie[c], Madhumita B. Ray[a]. ([a]Department of Chemical and Biochemical Engineering, University of Western Ontario, London, ON N6A 5B9, Canada, [b] Agriculture and Agri-Food Canada, London, ON N5V 4T3, Canada, [c] Department of Biology, University of Western Ontario, London, ON N6A 5B7, Canada). **Biodegradation of benzalkonium chlorides singly and in mixtures by a *Pseudomonas* sp. isolated from returned activated sludge. Journal of Hazardous Materials, Volume 299(2015): 595–602**

Bactericidal cationic surfactants such as quaternary ammonium compounds (QACs) are widely detected in the environment, and found at mg kg^{-1} concentrations in biosolids. Although individual QACs are amenable to biodegradation, it is possible that persistence is increased for mixtures of QACs with varying structure. The present study evaluated the biodegradation of benzyl dimethyl dodecyl ammonium chloride (BDDA) singly and in the presence of benzyl dimethyl tetradecyl ammonium chloride (BDTA) using *Pseudomonas* sp., isolated from returned activated sludge. Growth was evaluated, as was biodegradation using ^{14}C and HPLC-MS methods. BDTA was more toxic to growth of *Pseudomonas* sp. compared to BDDA, and BDTA

inhibited BDDA biodegradation. The benzyl ring of [U-^{14}C-benzyl] BDDA was readily and completely mineralized. The detection of the transformation products benzyl methyl amine and dodecyl dimethyl amine in spent culture liquid was consistent with literature. Overall, this study demonstrates the antagonistic effect of interactions on biodegradation of two widely used QACs suggesting further investigation on the degradation of mixture of QACs in wastewater effluents and biosolids.

Keywords: Biodegradation; Benzalkonium chloride; Cationic surfactant; Benzyl dimethyl dodecyl ammonium chloride; Benzyl dimethyl tetradecyl ammonium chloride

Biosensor

Xu Yan[a], Hongxia Li[b], Xiaosong Han[c, d], Xingguang Su[a]. ([a] Department of Analytical Chemistry, College of Chemistry, Jilin University, Changchun 130012, China, [b] School of Pharmacy, Jilin University, Changchun 130021, China, [c] College of Computer Science and Technology, Jilin University, Changchun 130012, China, [d] Talent Development Institute, Daqing Oilfield Company, CNPC, 163000, China). **A ratiometric fluorescent quantum dots based biosensor for organophosphorus pesticides detection by inner-filter effect. Biosensors and Bioelectronics, Volume 74(2015): 277–283**

In this work, we develop a novel and sensitive sensor for the detection of organophosphorus pesticides based on the inner-filter effect (IFE) between gold nanoparticles (AuNPs) and ratiometric fluorescent quantum dots (RF-QDs). The RF-QDs has been designed by hybridizing two differently colored CdTe QDs, in which the red emissive QDs entrapped in the silica sphere acting as the reference signal, and the green emissive QDs covalently attached on the silica surface serving as the response signal.The fluorescence of RF-QDs could be quenched by AuNPs based on IFE. Protamine could effectively turn on the fluorescence due to the electrostatic attraction between protamine and AuNPs. Trypsin can easily hydrolyze protamine, leading to the quench of the fluorescence. Then, the fluorescence could be recovered again by the addition of parathion-methyl (PM) which could inhibit the activity of trypsin. By measuring the fluorescence of RF-QDs, the inhibition efficiency of PM to trypsin activity was evaluated. Under the optimized conditions, the inhibition efficiency was proportional to the logarithm of PM concentration in the range of 0.04–400 ng mL^{-1}, with a detection limit of 0.018 ng mL^{-1}. Furthermore, the simple and convenient method had been used for PM detection in environmental and agricultural samples with satisfactory results.

Keywords: Ratiometric fluorescent quantum dots; Gold nanoparticle; Organophosphorus pesticides; Inner-filter effect

Qiao Cao[a, b], Ye Teng[a, b], Xuan Yang[a, b], Jin Wang[a, b, c,] Erkang Wang[a, b]. ([a] State Key Laboratory of Electroanalytical Chemistry, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, China, [b] University of Chinese Academy of Sciences, Beijing 100039, China, [c] Department of Chemistry and Physics, State University of New York at Stony Brook, New York, NY 11794-3400, USA). **A label-free fluorescent molecular beacon based on DNA-Ag nanoclusters for the construction of versatile Biosensors. Biosensors and Bioelectronics, Volume 74(2015): 318–321**

In this paper, we developed a simple, low-cost and sensitive DNA sequences detection biosensor based on a label-free molecular beacon (MB) whose DNA hairpin structure terminal has a

guanine-rich sequence that can enhance fluorescence of silver nanoclusters (Ag NCs). Without hybridization between hairpin probe and target DNA, the Ag NCs presented bright fluorescence for the proximity of guanine-rich sequences (GRSs). After binding with target DNA, the hairpin shape was destroyed which results in a decrease of the Ag NCs fluorescence intensity. With this biosensor, we detected three disease-related genes that were the human immunodeficiency virus (HIV) gene, hepatitis B virus (HBV) gene and human T-lymphotropic virus type I (HTLV-I) gene. The detection limits based on S/N of 3 were 4.4 nM, 6.8 nM and 8.5 nM for HIV gene, HBV gene and HTLV-I gene, respectively. Our sensor was also of high selectivity and could distinguish even one nucleotide mismatched target.

Keywords: DNA detection; Silver nanoclusters; Molecular beacons

Qun Chen[a, b], Anneli Andersson[b, 1], Michael Mecklenburg[c], Bin Xie[b]. ([a] Institute of Endemic Diseases, School of Public Health, Xi'an Jiaotong University Health Science Center, Key Laboratory of Trace Elements and Endemic Diseases, National Health and Family Planning Commission, 710061 Xi'an, China, [b] Department of Pure and Applied Biochemistry, Lund University, P.O. Box 124, SE-22100 Lund, Sweden, [c] BT Biomedical Technology AB, SE-22738 Lund, Sweden). **A biosensing strategy for the rapid detection and classification of antibiotic resistance. Biosensors and Bioelectronics, Volume 73(2015): 251–255**

Antibiotic resistance (AR) poses an ever growing threat to global public health. Methods are urgently needed that simplify and accelerate the clinical detection and classification of AR. Here we describe a function-based antibiotic resistance assay (FARA) biosensing strategy. The scheme comprises three key components: i) FARA directly measures the thermal signal generated from the catalytic break-down of antibiotics by AR enzymes, ii) a sample specific AR profile is created by analyzing a panel of antibiotics which enhances informational content and iii) meta-analysis of the AR profile database to correlate profiles with diagnosis, treatments and outcomes. In order to test the ability of the scheme to identify and classify AR, two well-studied antibiotic resistance enzymes, penicillinase and metallo-beta-lactamase (MBL), were profiled using a panel of 5 antibiotics: penicillin G, penicillin V, ampicillin, oxacillin and imipenem. The results show that the profiles of the two enzymes could easily detect AR and differentially classified these enzymes. More importantly, both enzymes showed a significant and distinct secondary catalytic profile, which dramatically increases informational content. FARA profiles can be generated and analyzed in 1 h. FARA is a fast, simple, cost effective alternative for detecting and classifying AR. FARA will speed up AR detection and classification will allow more accurate individualized treatment. This will reduce the spread of resistance and personalized treatments will improve patient outcomes. Other potential applications of FARA technology are discussed, including the possibility of developing an *in vitro* blood model for studying AR.

Keywords: β-lactamase; Antibiotics; Antibiotic resistance; Thermal biosensor; Profiling

Qin Wang[a, b, c], Jiaru Fang[a, b, c], Duanxi Cao[a, b, c], Hongbo Li[a, b, c], Kaiqi Su[a, b, c], Ning Hu[a, b, c], Ping Wang[a, b, c]. ([a] Biosensor National Special Laboratory, Zhejiang University, Hangzhou 310027, PR China, [b] Key Laboratory of Biomedical Engineering of Ministry of Education, Zhejiang University, Hangzhou 310027, PR China, [c] Department of Biomedical Engineering, Zhejiang University, Hangzhou 310027, PR China). **An improved functional assay for rapid detection of marine toxins, saxitoxin and brevetoxin using a portable**

cardiomyocyte-based potential biosensor. Biosensors and Bioelectronics, Volume 72(2015): 10–17

Saxitoxin (STX) and brevetoxin (PbTX-2), which are produced by marine dinoflagellates, are highly-toxic marine toxins targeting separate sites of the α subunit of voltage-dependent sodium channels (VDSCs). In this work, a portable cardiomyocyte-based potential biosensor is designed for rapid detection of STX and PbTX-2. This potential biosensor is constructed by cardiomyocyte and microelectrode array (MEA) with a label-free and real-time wireless 8-channel recording system which can dynamically monitor the multisite electrical activity of cardiomyocyte network. The recording signal parameters, spike amplitude, firing rate and 50% of spike potential duration (SPD_{50}) extracted from extracelluar field potential (EFP) signals of the potential biosensor is analyzed to quantitatively evaluate toxicological risk of STX and PbTX-2. Firing rate of biosensor signals presents high sensitivity to STX with the detection limit of 0.35 ng/ml within 5 min. SPD_{50} shows high sensitivity to PbTX-2 with the detection limit of 1.55 ng/ml within 5 min. Based on the multi-parameter analysis, cardiomyocyte-based potential biosensor will be a promising tool for rapid detection of these two toxins.

Keywords: Saxitoxin (STX); Brevetoxin (PbTX-2); Cardiomyocyte-based potential biosensor; Multisite electrical activity of cardiomyocyte network; Extracelluar field potential (EFP) signals

Li-li Tong[a], Zhen-zhen Chen[a], Zhong-yao Jiang[a], Miao-miao Sun[a], Lu Li[a], Ju Liu[b], Bo Tang[a]. ([a] College of Chemistry, Chemical Engineering and Materials Science, Collaborative Innovation Center of Functionalized Probes for Chemical Imaging in Universities of Shandong, Key Laboratory of Molecular and Nano Probes, Ministry of Education, Shandong Provincial Key Laboratory of Clean Production of Fine Chemicals, Shandong Normal University, Jinan 250014, PR China, [b] Laboratory of Microvascular Medicine, Medical Research Center, Shandong Provincial Qianfoshan Hospital, Shandong University, Jinan 250014, PR China). **Fluorescent sensing of pyrophosphate anion in synovial fluid based on DNA-attached magnetic nanoparticles. Biosensors and Bioelectronics, Volume 72(2015): 51–55**

In this work, a new fluorescent method for sensitive detection of pyrophosphate anion ($P_2O_7^{4-}$, PPi) in the synovial fluid was developed using fluorophore labeled single-stranded DNA-attached Fe_3O_4 NPs. The sensing approach is based on the strong affinity of PPi to Fe_3O_4 NPs and highly efficient fluorescent quenching ability of Fe_3O_4NPs for fluorophore labeled single-stranded DNA. In the presence of PPi, the fluorescence would enhance dramatically due to desorption of fluorophore labeled single-stranded DNA from the surface of Fe_3O_4 NPs, which allowed the analysis of PPi in a very simple manner. The proposed sensing system allows for the sensitive determination of PPi in the range of 2.0×10^{-7}–4×10^{-6} M with a detection limit of 76 nM. Importantly, the protocol exhibits excellent selectivity for the determination of PPi over other phosphate-containing compounds. The method was successfully applied to the determination of PPi in the synovial fluid, which suggests our proposed method has great potential for diagnostic purposes.

Keywords: Pyrophosphate anion; Fe_3O_4 nanoparticles; Fluorescent sensing; Fluorophore labeled single-stranded DNA; Synovial fluid

Yun Kyung Jung[a, b], Hyun Gyu Park[a]. ([a] Department of Chemical and Biomolecular Engineering (BK21+Program), KAIST, 291 Daehak-ro, Yuseong-gu, Daejeon 305-701, Republic of Korea, [b] School of Natural Science, Ulsan National Institute of Science and Technology, Ulsan 689-798, Republic of Korea). **Colorimetric detection of clinical DNA**

samples using an intercalator-conjugated polydiacetylene sensor. Biosensors and Bioelectronics, Volume 72(2015): 127–132

We herein developed a novel colorimetric polydiacetylene (PDA) sensor for very convenient detection of clinical DNA samples based on the interaction between an intercalator and dsDNA. We modified the terminal carboxyl group of a diacetylene monomer (10,12-pentacosadiynoic acid; PCDA) with the intercalator 9-aminoacridine (9AA) and prepared 9AA-modified PDA liposomes containing PCDA-9AA/PCDA/phospholipid (1,2-dimyristoyl-rac-glycero-3-phosphocholine) at a molar ratio of 1.5:6.5:2.0. The PDA sensor underwent an obvious color transition from blue to red in the presence of dsDNA molecules that were PCR-amplified from genomic DNA due to the insertion of the 9AA head group of PDA into the dsDNA. DNA concentrations as low as 20 nM and relatively small molecules (around 100 base pairs) could be detected by the sensor within 1 h without DNA electrophoresis. This novel colorimetric method is simple, does not require any instrument, and is therefore appropriate for POCT or portable molecular diagnostic kit.

Keywords: Polydiacetylene (PDA); DNA detection; Colorimetric biosensor; Intercalation; 9-Aminoacridine

Peng Li[a, b], Bo Zhang[b], Tianhong Cui[b]. ([a] State Key Laboratory of Precision Measurement Technology and Instruments, Department of Precision Instruments, Tsinghua University, Beijing 100084, China, [b] Department of Mechanical Engineering, University of Minnesota, Minneapolis, MN 55455, USA). Towards intrinsic graphene biosensor: A label-free, suspended single crystalline graphene sensor for multiplex lung cancer tumor markers detection. Biosensors and Bioelectronics, Volume 72(2015): 168–174

Graphene biosensors reported so far are based on polycrystalline graphene flakes which are anchored on supporting substrates. The influence of grain boundary and the scattering from substrate drastically degrade the properties of graphene and conceal the performance of intrinsic graphene as a sensor. Here we report a label-free biosensor based on suspended single crystalline graphene (SCG), which can get rid of grain boundary and substrate scattering, revealing the biosensing mechanism of intrinsic graphene for the first time. Monolayer SCG flakes were derived from low pressure chemical vapor deposition (LPCVD) method. Multiplex detection of three different lung cancer tumor markers was realized. The suspended structure can largely improve the sensitivity and detection limit (0.1 pg/ml) of the sensor, and the single crystalline nature of SCG enable the biosensor to have superior uniformity compared to polycrystalline ones. The SCG sensors exhibit superb specificity and large linear detection range from 1 pg/ml to 1 μg/ml, showing the prominent advantages of graphene as a sensing material.

Keywords: Graphene; Single crystalline; Suspended beam; Cancer sensor; Label-free

S. Baby Gayathri, P. Kamaraj, M. Arthanareeswari, S. Devikala. (Department of Chemistry, SRM University, Kattankulathur 603203, India). DNA nanostructures based biosensor for the determination of aromatic compounds. Biosensors and Bioelectronics, Volume 72(2015): 191–196

Graphite electrode was modified using multi-walled carbon nanotubes (MWCNT), chitosan (CS), glutaraldehyde (GTA) and DNA nanostructures (nsDNA). DNA nanostructures of 50 nm in size were produced from single DNA template sequence using a simple two step procedure and were confirmed using TEM and AFM analysis. The modified electrode was applied to the

electrochemical detection of aromatic compounds using EIS. The modified electrode was characterized using differential pulse voltammetry (DPV), electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV). For comparison, electrochemical results derived from single stranded (50 bp length) and double stranded (50 bp length) DNA based biosensors were used. The results indicate that the modified electrode prior to nsDNA immobilization provides a viable platform that effectively promotes electron transfer between nsDNA and the electrode. The mode of binding between the nsDNA and aromatic compounds was investigated using EIS, indicating that the dominant interaction is non-covalent. nsDNA based biosensor was observed to act as an efficient biosensor in selective and sensitive identification of aromatic compounds.

Keywords: Aromatic compounds; Biosensor; DNA nanostructures; Multi-walled carbon nanotubes; Electrochemical characterization; Electrochemical impedance spectroscopy

Weibing Qiang, Xi Wang, Wei Li, Xiang Chen, Hui Li, Danke Xu. (State Key Laboratory of Analytical Chemistry for Life Science, School of Chemistry and Chemical Engineering, Nanjing University, 22 Hankou Road, Nanjing 210093, China). **A fluorescent biosensing platform based on the polydopamine nanospheres intergrating with Exonuclease III-assisted target recycling amplification. Biosensors and Bioelectronics, Volume 71(2015): 143–149**

Rapid, cost-effective, sensitive and specific analysis of biomolecules is important in the modern healthcare system. Here, a fluorescent biosensing platform based on the polydopamine nanospheres (PDANS) intergrating with Exonuclease III (Exo III) was developed. Due to the interaction between the ssDNA and the PDANS, the fluorescence of 6-carboxyfluorescein (FAM) labelled in the probe would been quenched by PDANS through FRET. While, in the present of the target DNA, the probe DNA would hybridize with the target DNA to form the double-strand DNA complex. Thus, Exo III could catalyze the stepwise removal of mononucleotides from 3′-terminus in the probe DNA, releasing the target DNA. As the FAM was released from the probe DNA, the fluorescence would no longer been quenched, led to the signal on. As one target DNA molecule could undergo a number of cycles to trigger the degradation of abundant probe DNA, Exo III-assisted target recycling would led to the amplification of the signal. The detection limit for DNA was 5 pM, which was 20 times lower than that without Exo III. And the assay time was largely shortened due to the faster signal recovery kinetics. What is more, this target recycling strategy was also applied to conduct an aptamer-based biosensing platform. The fluorescence intensity was also enhanced for the assay of adenosine triphosphate (ATP). For the Exo III-assisted target recycling amplification, DNA and ATP were fast detected with high sensitivity and selectivity. This work provides opportunities to develop simple, rapid, economical, and sensitive biosensing platforms for biomedical diagnostics.

Keywords: Polydopamine nanospheres (PDANS); DNA; Aptamer; Adenosine triphosphate (ATP); Exonuclease III (Exo III); Target recycling amplification

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An alternative strategy for surface tethering of DNA probes, where highly reactive glassy carbon (GC) substrates are prepared via electrochemical hydrogenation and electrochemical/chemical chlorination is reported. Thiolated DNA probes and alkanethiols were stably immobilised on the halogenated carbon, with electrochemical chlorination being milder, thus producing less damage to the surface. Electrochemical DNA sensors prepared using this surface chemistry on carbon with electrochemical chlorination providing an improved performance, producing a highly ordered surface and the use of lateral spacers to improve steric accessibility to immobilised probes was not required.

Keywords: Electrochemical hydrogenation; Electrochemical chlorination; Electrochemical DNA sensors; Surface chemistry; Lateral spacing

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Microbial fuel cells (MFCs) face major hurdles for real-world applications as power generators with the exception of powering small sensor devices. Despite tremendous improvements made in the last two decades, MFCs are still too expensive to build and operate and their power output is still too small. In view of this, in recently years, intensive researches have been carried out to expand the applications into other areas such as acid and alkali production, bioremediation of aquatic sediments, desalination and biosensors. Unlike power applications, MFC sensors have the immediate prospect to be practical. This review covers the latest developments in various proposed biosensor applications using MFCs including monitoring microbial activity, testing biochemical oxygen demand, detection of toxicants and detection of microbial biofilms that cause biocorrosion.

Keywords: Anaerobic digestion; Biocorrosion; Biofilms; Biosensors; Microbial fuel cell; Sensor; Wastewater treatment

Bioengineering

P. Gupta, S.C. Phulara. (National Institute of Technology, Raipur, Chhattisgarh, India. Correspondence : Pratima Gupta, PhD, Department of Biotechnology, National Institute of Technology, Raipur, Chhattisgarh 492010, India. E-mail: pguptabiotech@gmail.com). Metabolic engineering for isoprenoid-based biofuel production. Journal of Applied Microbiology, Volume 119(3) (2015): 605–619

Sustainable economic and industrial growth is the need of the hour and it requires renewable energy resources having better performance and compatibility with existing fuel infrastructure from biological routes. Isoprenoids (C ≥ 5) can be a potential alternative due to their diverse nature and physiochemical properties similar to that of petroleum based fuels. In the past decade, extensive research has been done to utilize metabolic engineering strategies in micro-organisms primarily, (i) to overcome the limitations associated with their natural and non-natural production and (ii) to develop commercially competent microbial strain for isoprenoid-based biofuel production. This review briefly describes the engineered isoprenoid biosynthetic pathways in well-characterized microbial systems for the production of several isoprenoid-based biofuels and fuel precursors.

Pollen Biotechnology

P. Brotto, B. Repetto, P. Formenti, E. Pangui, A. Livet, N. Bousserrhine, I. Martini, O. Varnier, J. F. Doussin, P. Prati. (Department of Physics (DIFI) and National Institute of Nuclear Physics (INFN), University of Genoa, Department of Surgery and Diagnostics Integrated Sciences (DISC), Institute of Microbiology, University of Genoa, LISA, UMR CNRS 7583, Institut Pierre-Simon Laplace, Université Paris Est Créteil et Université Paris Diderot, LISA, UMR CNRS 7583, Institut Pierre-Simon Laplace, Université Paris Est Créteil et Université Paris Diderot, Institut d'écologie et des sciences de l'environnement de Paris (IEES Paris), département SoléO (Sol et Eaux) équipe DIIM, Université Paris-Est).
Use of an atmospheric simulation chamber for bioaerosol investigation: a feasibility study. Aerobiologia, Volume 31(4)(2015): 445-455

Environmental simulation chambers (atmospheric/smog chambers) are small- to large-scale facilities (with volumes ranging between a few to several hundred cubic meters), where atmospheric conditions can be monitored in real time under control to reproduce realistic environments and to study interactions among their constituents. Up to now, they have been used mainly to study chemical and photochemical processes that occur in the atmosphere, such as ozone formation and cloud chemistry, but the high versatility of these facilities allows for a wider application covering all fields of atmospheric aerosol science. The biological component of atmospheric aerosol (bioaerosol) is a relevant subject of scientific investigation requiring expertise in both atmospheric science and biology. It raises a strong interest in the scientific community due to its link with human health and the relevant role that biological particles are supposed to play in ice nuclei formation and cloud condensation. Nevertheless, the mechanisms of interaction between bioaerosols and other aerosols, the behavior of airborne microorganisms in different atmospheric conditions and the impact of bioaerosols on radiation and clouds are still poorly known and require deeper investigation. In this work, we present the results of a feasibility study of the use of an atmospheric chamber facility to study bioaerosols under differing atmospheric conditions. Here, we present the experimental setup and the protocol to inject, analyze and extract *Bacillus subtilis* strain in the Experimental Multiphasic Atmospheric Simulation Chamber, and we investigate the sensitivity of this tool to possible changes in bacteria viability by varying the atmospheric conditions.

Keywords: Atmospheric aerosol; Atmospheric simulation chambers; *B. subtilis;* Bio aerosol; PBAP

Noelia Nuñez Otaño, Mercedes di Pasquo, Nadia Muñoz. (Laboratorio de Palinoestratigrafía y Paleobotánica, CICYTTP – CONICET). Airborne fungal richness: proxies for floral composition and local climate in three sites at the El Palmar National Park (Colón, Entre Ríos, Argentina). Aerobiologia, Volume 31(4) (2015): 537-547

The analysis of the content of the airborne mycofloras from three Tauber traps (monthly from March 2011 to March 2013) located at a dense palm (EP3), a grassland (EP2) and a mixed area (EP1, composed of grassland, palms and wetland communities) was carried out. Their affinity with the floral composition of each site and a possible influence of local atmospheric conditions on total fungal spore richness were tested. This analysis allowed the recognition of 82 fungal morphotypes as a whole. The cluster analysis (Jaccard index) showed that EP1 and EP3 are similar communities and separated from the EP2 community (with a similarity index <52 %). The principal component analysis showed a positive correlation between the affinities of fungi substrates preferences and the floral physiognomy and composition in EP1 and EP3, whereas the EP2 area revealed a community of fungal taxa typical of grassland environments. Three peaks of species richness per year were registered: (1) from January to April (summer to beginning of autumn), (2) in July (winter) and (3) from October to November (spring) each year. In this exploratory research these peaks are related to warmer and rainy conditions during summer and spring and of maximum accumulation of organic matter during the winter. In summary, aeromycoflora communities could be used as ecological proxies to infer the main floral composition of a study site and as indicative of the climate regime of the area.

Keywords: Fungi; Diversity; Aeropalynology; Vegetation; El Palmar National Park; Argentina

A. A. Abdel Hameed, T. Habeebuallah, B. Mashat, S. Elgendy, S. Elserougy, T. H. Elmorsy. (Department of Environmental and Health Research, The Custodian of the Two Holy Mosques Institute for Hajj and Umrah Research, Umm Al Qura University Department of Air Pollution, National Research Centre, Department of Air Pollution, National Research Centre, Department of Microbiology, National Organization for Drug Control and Research, Department of Environmental and Occupational Medicine, National Research Centre). Airborne fungal pollution at waste application facilities. Aerobiologia, Volume 31(3) (2015): 283-293

This study aims to evaluate airborne mesophilic and thermophilic fungal concentrations and types at a wastewater treatment plant (WWTP) and a biosolid landfill, in Egypt. Air samples were collected at 200 m upwind, and on-site and 300 m downwind by using liquid impinger sampler, calibrated to draw 12.5 *L*/min, for 20 min. Fungal concentrations ranged between 427–7 280 CFU/m^3 for mesophilic and 0–3,968 CFU/m^3 for thermophilic fungi. The concentrations exceeded the suggested occupational exposure limit value of 500 CFU/m^3. *Aspergillus fumigatus* represented ~34.9–55 % and 60.4–71.4 % of the total mesophilic and thermophilic fungi, respectively. Significant differences were observed between the upwind and downwind concentrations at both waste facilities, and between on-site and downwind fungal concentrations ($P \leq 0.01$) at the landfill, and only for thermophilic fungal concentrations at the WWTP ($P \leq 0.05$). Higher fungal diversity was found at the landfill site. *A. terreus*, *A. ochraceus*, *Acremonium*, *Geotrichum*, *Aureobasidium*, *Sepedomium*, and *Trichophyton* were only detected at the landfill sites. Fungal concentrations positively correlated with temperature. Higher concentrations were observed at wind speed <3 m/s at the WWTP and >3 m/s at the landfill. Wind speed positively affected concentrations at the landfill. The regression model showed that

relative humidity was a significant determinant of fungal concentrations 300 m downwind distances. Waste application facilities increase fungal concentrations on-site which may consequently deteriorate air quality in the nearby areas.

Keywords: *Aspergillus fumigatus;* Thermophilic fungi; Meteorological factors; Distance; Dispersion

Justyna Skóra, Beata Gutarowska, Katarzyna Pielech-Przybylska, Łukasz Stępień, Katarzyna Pietrzak, Małgorzata Piotrowska, Piotr Pietrowski. (Institute of Fermentation Technology and Microbiology, Lodz University of Technology, Institute of Plant Genetics, Polish Academy of Sciences, Department of Protective Equipment, Central Institute for Labour Protection – National Research Institute). Assessment of microbiological contamination in the work environments of museums, archives and libraries. Aerobiologia, Volume 31(3) (2015): 389-401

Museums, archives and libraries have large working environments. The goal of this study was to determine microbial contamination in these work places and estimate the influence of microclimatic parameters and total dust content on microbial contamination. In addition, research included evaluation of ergosterol concentration and fungal bioaerosol particle size distribution. Numbers of micro-organisms in the air and on the surfaces in museums were higher (2.1×10^2–7.0×10^3 cfu/m^3 and 1.4×10^2–1.7×10^4 cfu/100 cm^2, respectively) than in archives and libraries (3.2×10^2–7.2×10^2 cfu/m^3 and 8.4×10^2–8.8×10^2 cfu/100 cm^2, respectively). The numbers of micro-organisms detected in the tested museums, archives and libraries did not exceed occupational exposure limits proposed by Polish Committee for the Highest Permissible Concentrations and Intensities of Noxious Agents at the Workplace. The concentrations of respirable and suspended dust in museum storerooms were 2–4 times higher than the WHO-recommended limits. We found a correlation between microclimatic conditions and numbers of micro-organisms in the air in the tested working environments. In addition, a correlation was also found between ergosterol concentration and the number of fungi in the air. Fungi were the dominant micro-organisms in the working environments tested. Particles within the dominant fractions of culturable fungal aerosols sampled from museum storerooms had aerodynamic diameters between 1.1 and 2.1 μm.

Keywords: Micro-organisms at workplaces; Ergosterol; Bioaerosol; Microclimatic parameters; Museum; Archive; Library

Agricultural Biotechnology

M. Singh, P.K. Srivastava, P.C. Verma, R.N. Kharwar, N. Singh, R.D. Tripathi. (CSIR-National Botanical Research Institute, Lucknow, India, Department of Botany, Banaras Hindu University, Varanasi, India, CSIR-National Botanical Research Institute, Lucknow, India). Soil fungi for mycoremediation of arsenic pollution in agriculture soils. Journal of Applied Microbiology, Volume 119(5) (2015): 1278–1290

Soil arsenic (As) contamination of food-chains and public health can be mitigated through fungal bioremediation. To enumerate culturable soil fungi, soils were collected from the As-contaminated paddy fields (3–35 mg kg^{-1}) of the middle Indo-Gangetic Plains.

Total 54 fungal strains were obtained and identified at their molecular level. All strains were tested for As tolerance (from 100 to 10 000 mg l^{-1} arsenate). Fifteen fungal strains, tolerant to 10

000 mg l^{-1} arsenate, were studied for As removal *in-vivo* for 21 days by cultivating them individually in potato dextrose broth enriched with 10 mg l^{-1} As. The bioaccumulation of As in fungal biomass ranged from 0·023 to 0·259 g kg^{-1}. The biovolatilized As ranged from 0·23 to 6·4 mg kg^{-1}.

Higher As bioaccumulation and biovolatilization observed in the seven fungal strains, *Aspergillus oryzae* FNBR_L35; *Fusarium* sp. FNBR_B7, FNBR_LK5 and FNBR_B3; *Aspergillus nidulans* FNBR_LK1; *Rhizomucor variabilis* sp. FNBR_B9; and *Emericella* sp. FNBR_BA5. These fungal strains were also tested and found suitable for significant plant growth promotion in the calendula, withania and oat plants in a greenhouse based pot experiment. These fungal strains can be used for As remediation in As-contaminated agricultural soils.

Bioenergy

Zia Ul Islam, Yu Zhisheng, El Barbary Hassan, Chang Dongdong, Zhang Hongxun. (College of Resources and Environment, University of Chinese Academy of Sciences, Department of Sustainable Bioproducts, Mississippi State University). Microbial conversion of pyrolytic products to biofuels: a novel and sustainable approach toward second-generation biofuels. Journal of Industrial Microbiology & Biotechnology, Volume 42(12) (2015): 1557-1579

This review highlights the potential of the pyrolysis-based biofuels production, bio-ethanol in particular, and lipid in general as an alternative and sustainable solution for the rising environmental concerns and rapidly depleting natural fuel resources. Levoglucosan (1,6-anhydrous-β-d-glucopyranose) is the major anhydrosugar compound resulting from the degradation of cellulose during the fast pyrolysis process of biomass and thus the most attractive fermentation substrate in the bio-oil. The challenges for pyrolysis-based biorefineries are the inefficient detoxification strategies, and the lack of naturally available efficient and suitable fermentation organisms that could ferment the levoglucosan directly into bio-ethanol. In case of indirect fermentation, acid hydrolysis is used to convert levoglucosan into glucose and subsequently to ethanol and lipids via fermentation biocatalysts, however the presence of fermentation inhibitors poses a big hurdle to successful fermentation relative to pure glucose. Among the detoxification strategies studied so far, over-liming, extraction with solvents like (*n*-butanol, ethyl acetate), and activated carbon seem very promising, but still further research is required for the optimization of existing detoxification strategies as well as developing new ones. In order to make the pyrolysis-based biofuel production a more efficient as well as cost-effective process, direct fermentation of pyrolysis oil-associated fermentable sugars, especially levoglucosan is highlly desirable. This can be achieved either by expanding the search to identify naturally available direct levoglusoan utilizers or modify the existing fermentation biocatalysts (yeasts and bacteria) with direct levoglucosan pathway coupled with tolerance engineering could significantly improve the overall performance of these microorganisms.

Keywords: Pyrolysis oil, Pyrolytic sugars, Levoglucosan, Bio-ethanol, Levoglucosan kinase

Sabrina Gabardo, Gabriela Feix Pereira, Rosane Rech, Marco Antônio Záchia Ayub. (Biotechnology and Biochemical Engineering Laboratory (BiotecLab), Federal University of Rio Grande do Sul, Biotechnology and Biochemical Engineering Laboratory (BiotecLab), Federal University of Rio Grande do Sul, The modeling of ethanol production by *Kluyveromyces marxianus* using whey as substrate in continuous A-Stat bioreactors. Journal of Industrial Microbiology & Biotechnology, Volume 42(9) (2015): 1243-1253

We investigated the kinetics of whey bioconversion into ethanol by *Kluyveromyces marxianus* in continuous bioreactors using the "accelerostat technique" (A-stat). Cultivations using free and Ca-alginate immobilized cells were evaluated using two different acceleration rates (a). The kinetic profiles of these systems were modeled using four different unstructured models, differing in the expressions for the specific growth (μ) and substrate consumption rates (r_s), taking into account substrate limitation and product inhibition. Experimental data showed that the dilution rate (D) directly affected cell physiology and metabolism. The specific growth rate followed the dilution rate ($\mu \approx D$) for the lowest acceleration rate (a = 0.0015 h^{-2}), condition in which the highest ethanol yield (0.52 g g^{-1}) was obtained. The highest acceleration rate (a = 0.00667 h^{-2}) led to a lower ethanol yield (0.40 g g^{-1}) in the system where free cells were used, whereas with immobilized cells ethanol yields increased by 23 % (0.49 g g^{-1}). Among the evaluated models, Monod and Levenspiel combined with Ghose and Tyagi models were found to be more appropriate for describing the kinetics of whey bioconversion into ethanol. These results may be useful in scaling up the process for ethanol production from whey.

Keywords: Bioprocess modeling, Ethanol, *Kluyveromyces marxianus*, Continuous fermentation, A-stat control, Whey

Chiu-Shyan Soo, Wai-Sum Yap, Wei-Min Hon, Lai-Yee Phang. (Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, Faculty of Applied Sciences, UCSI University, KDU University College). Mini review: hydrogen and ethanol co-production from waste materials via microbial fermentation. World Journal of Microbiology and Biotechnology, Volume 31(10)(2015): 1475-1488

The simultaneous production of hydrogen and ethanol by microorganisms from waste materials in a bioreactor system would establish cost-effective and time-saving biofuel production. This review aims to present the current status of fermentation processes producing hydrogen accompanied by ethanol as a co-product. We outlined the microbes used and their fundamental pathways for hydrogen and ethanol fermentation. Moreover, we discussed the exploitation of renewable and sustainable waste materials as promising feedstock and the limitations encountered. The low substrate bioconversion rate in hydrogen and ethanol co-production is regarded as the primary constraint towards the development of large scale applications. Thus, microbes with an enhanced capability have been generated via genetic manipulation to diminish the inefficiency of substrate consumption. In this review, other potential approaches to improve the performance of co-production through fermentation were also elaborated. This review will be a useful guide for the future development of hydrogen and ethanol co-production using waste materials.

Keywords: Hydrogen; Ethanol; Co-production; Waste; Microbial fermentation

Prabuddha L. Gupta, Seung-Mok Lee, Hee-Jeong Choi. (Department of Energy and Environment Convergence, Catholic Kwandong University). A mini review: photobioreactors for large scale algal cultivation. World Journal of Microbiology and Biotechnology, Volume 31(9) (2015): 1409-1417

Microalgae cultivation has gained much interest in terms of the production of foods, biofuels, and bioactive compounds and offers a great potential option for cleaning the environment through CO_2 sequestration and wastewater treatment. Although open pond cultivation is most affordable option, there tends to be insufficient control on growth conditions and the risk of contamination. In contrast, while providing minimal risk of contamination, closed photobioreactors offer better control on culture conditions, such as: CO_2 supply, water supply, optimal temperatures, efficient exposure to light, culture density, pH levels, and mixing rates. For a large scale production of biomass, efficient photobioreactors are required. This review paper describes general design considerations pertaining to photobioreactor systems, in order to cultivate microalgae for biomass production. It also discusses the current challenges in designing of photobioreactors for the production of low-cost biomass.

Keywords: Photobioreactors; Biomass; Biofuels; Mass cultivation; Algal biotechnology

Ihuoma N. Anyanwu, Kirk T. Semple. (Lancaster Environment Centre, Lancaster UniversityDepartment of Biological Sciences, Federal University Ndufu-Alike Ikwo, Lancaster Environment Centre, Lancaster University). **Phytotoxicity of Phenanthrene and Its Nitrogen Polycyclic Aromatic Hydrocarbon Analogues in Ageing Soil. Water, Air, & Soil Pollution, Volume, 226(2015): 347**

The impacts of phenanthrene and its nitrogen-containing analogues (N-PAHs) on seedling emergence and plant biomass of two terrestrial plant species, *Lactuca sativa* (lettuce) and *Lolium perenne* (rye grass), were investigated in soil over a 21-day exposure period. The data over 0–90-day soil-chemical contact time revealed that seedling emergence and plant biomass were significantly affected by N-PAHs even at the lowest concentration of 10 mg/kg. N-PAH amended soils showed greater inhibitory effects on seedling emergence and early plant biomass than phenanthrene amendments with incubations overtime. The degree of inhibition (% inhibition) on seedling emergence over time was 33.3 % (lettuce) and 46.7 % (rye grass) for the phenanthrene, and 53.3 % (lettuce) and 93.3 % (rye grass) for the N-PAHs, respectively, suggesting greater sensitivity of seedling emergence and early plant biomass on N-PAH-contaminated soil. The results from this study will contribute to data gaps for poorly managed chemicals/chemical groups for environmental risk assessment and might be useful in the development of new approaches for hazard assessment of contaminated systems.

Keywords: Phytotoxicity; Bioavailability; Seedling emergence; Biomass; Nitrogen-containing PAHs

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Biological hydrogen production is being evaluated for use as a fuel, since it is a promising substitute for carbonaceous fuels owing to its high conversion efficiency and high specific energy content. The basic advantages of biological hydrogen production over other “green” energy sources are that it does not compete for agricultural land use, and it does not pollute, as

water is the only by-product of the combustion. These characteristics make hydrogen a suitable fuel for the future. Among several biotechnological approaches, photobiological hydrogen production carried out by green microalgae has been intensively investigated in recent years. A select group of photosynthetic organisms has evolved the ability to harness light energy to drive hydrogen gas production from water. Of these, the microalga *Chlamydomonas reinhardtii* is considered one of the most promising eukaryotic H_2 producers. In this model microorganism, light energy, H_2O and H_2 are linked by two excellent catalysts, the photosystem 2 (PSII) and the [FeFe]-hydrogenase, in a pathway usually referred to as direct biophotolysis. This review summarizes the main advances made over the past decade as an outcome of the discovery of the sulfur-deprivation process. Both the scientific and technical barriers that need to be overcome before H_2photoproduction can be scaled up to an industrial level are examined. Actual and theoretical limits of the efficiency of the process are also discussed. Particular emphasis is placed on algal biohydrogen production outdoors, and guidelines for an optimal photobioreactor design are suggested.

Keywords: Bio-hydrogen, bio-photolysis, *Chlamydomonas reinhardtii*, D1 protein mutants, photo-bioreactor

Asif H. Khoja*, Ehsan Ali, Kashaf Zafar, Abeera A. Ansari, Azra Nawar, Muneeb Qayyum. (Centre for Energy Systems, National University of Science and Technology (NUST), Islamabad Pakistan, Balochistan University of Information Technology, Engineering and Management Sciences (BUITEMS), Quetta, Pakistan). .Comparative study of bioethanol production from sugarcane molasses by using Zymomonas mobilis and Saccharomyces cerevisiae. African Journal of Biotechnology, Volume14(31)(2015): 2455-2462

The study was designed to compare the bioethanol production from *Zymomonas mobilis* and *Saccharomyces cerevisiae* using molasses as production medium. The focus was on the retention time at lab scale. Bioethanol and petroleum blend can be used in existing gasoline engines. Present study showed a more cost-effective procedure for production of ethanol from sugar-cane molasses by using bacterial strain "*Z. mobilis*". Laboratory scale unit was designed to perform the experiments through batch fermentation and to determine the impact of leading parameters, including fermentation temperature, pH, sugar concentration, and nutrients. *S. cerevisiae* produced 8.3% (v/v) bioethanol provided sugar concentration 14 g /100 ml with the fermentation efficiency of 92.5%. On the contrary, *Z. mobilis* produced 9.3% (v/v) bioethanol by utilizing 16 g/100 ml sugar with the fermentation efficiency of 90.5%. Effect of nutrients on fermentation was determined using molasses as feedstock. Thin layer chromatography was also performed to assess the possible impurities in molasses as compared to the pure sugar. The pH and fermentation temperature was optimized for the enhanced yield of bioethanol.

Keywords: Bioethanol, molasses, fermentation, *Zymomonas mobilis, Saccharomyces cerevisiae.*

Membere Edward, Stephen Edwards, Uchenna Egwu, Paul Sallis. (School of Civil and Geosciences, Newcastle University Upon Tyne, NE1 7RU, United Kingdom). Bio-methane potential test (BMP) using inert gas sampling bags with macroalgae feedstock. Biomass and Bioenergy, Volume 83(2015): 516–524

An approach to Bio-methane potential test (BMP) was carried out at mesophilic temperature of 35 °C with Supel™ inert gas sampling bags as biogas collection and storage bags, using selected seaweed (macroalgae) as substrate. Samples were given a range of pre-treatments from washing, drying and macerating. Dried laminaria digitata (DD) with 68.14% VS (%TS) produced the highest BMP of 141 ± 5.77 L CH_4/kg VS, with methane content increasing to about 70%, while

the lowest BMP of 93.35 ± 5.03 L CH_4/kg VS with methane content of about 65% was obtained for fresh laminaria digitata (FD) with 72.03% VS (%TS). Methane yields of 97.66 and 67.24 m^3 CH_4/t wet weight based on BMP results were obtained for DD and FD. Both DD and FD achieved within 28% and 38% of the theoretical BMP value based on the Buswell equation, respectively. The total methane *(V)* produced was computed based on;

$V = X1 + X2 – X3$ corrected to Standard temperature and pressure (STP).

where X_1 = daily calculated headspace methane volume, X_2 = daily measured volume of methane in gas bags, X_3 = previous day headspace methane volume. An advantage of this approach is the volumetric measurement of gas produced directly from the gas bags, hence it does not require liquid displacement or pressure transducers. Results from a second set of freshly collected sample seaweed sample showed it was in agreement with published BMP values. All analysis were carried out without mineral supplementation.

Keywords: Biogas; Biodegradability; BMP; Seaweed; Methane; Algae

Koen Wetser, Jia Liu, Cees Buisman, David Strik. (Wageningen University, Wageningen Campus, Building 118, Bornse Weilanden 9, 6708 WG Wageningen, The Netherlands). **Plant microbial fuel cell applied in wetlands: Spatial, temporal and potential electricity generation of *Spartina anglica* salt marshes and *Phragmites australis* peat soils. Biomass and Bioenergy, Volume 83(2015): 543–550**

The plant microbial fuel cell (PMFC) has to be applied in wetlands to be able to generate electricity on a large scale. The objective of this PMFC application research is to clarify the differences in electricity generation between a *Spartina anglica* salt marsh and*Phragmites australis* peat soil based on experimental data and theoretical calculated potential. PMFC in salt marsh generated more than 10 times more power than the same PMFC in peat soil (18 vs 1.3 mW m^{-2} plant growth area). The salt marsh reached a record power output for PMFC technology per cubic meter anode: 2.9 W m^{-3}. Most power is generated in the top layer of the salt marsh due to the presence of the plants and the tidal advection. The potential current generation for the salt marsh is 0.21–0.48 A $m^{-2}$and for peat soil 0.15–0.86 A m^{-2}. PMFC technology is potentially able to generate a power density up to 0.52 W m^{-2}, which is more than what is generated for biomass combustion or anaerobic digestion using the same plant growth area.

Keywords: Plant microbial fuel cell; Salt marsh; Peat soil; *Phragmites austrailis*; *Spartina anglica*; Bio-electricity

Kim Parmar[a, b], Aidan M. Keith[a], Rebecca L. Rowe[a], Saran P. Sohi[b], Claudia Moeckel[a], M. Gloria Pereira[a], Niall P. McNamara[a]. ([a] NERC Centre for Ecology & Hydrology, Lancaster Environment Centre, Library Avenue, Bailrigg, Lancaster, LA1 4AP, United Kingdom, [b] School of Geosciences, University of Edinburgh, Crew Building, The Kings Buildings, Edinburgh, EH9 3JN, United Kingdom). **Bioenergy driven land use change impacts on soil greenhouse gas regulation under Short Rotation Forestry. Biomass and Bioenergy, Volume 82(2015): 40–48**

Second-generation bioenergy crops, including Short Rotation Forestry (SRF), have the potential to contribute to greenhouse gas (GHG) emissions savings through reduced soil GHG fluxes and greater soil C sequestration. If we are to predict the magnitude of any such GHG benefits a better understanding is needed of the effect of land use change (LUC) on the underlying factors which

regulate GHG fluxes. Under controlled conditions we measured soil GHG flux potentials, and associated soil physico-chemical and microbial community characteristics for a range of LUC transitions from grassland land uses to SRF. These involved ten broadleaved and seven coniferous transitions. Differences in GHGs and microbial community composition assessed by phospholipid fatty acids (PLFA) profiles were detected between land uses, with distinctions between broadleaved and coniferous tree species. Compared to grassland controls, CO_2 flux, total PLFAs and fungal PLFAs (on a mass of C basis), were lower under coniferous species but unaffected under broadleaved tree species. There were no significant differences in N_2O and CH_4 flux rates between grassland, broadleaved and coniferous land uses, though both CH_4 and N_2O tended to have greater uptake under broadleaved species in the upper soil layer. Effect sizes of CO_2 flux across LUC transitions were positively related with effect sizes of soil pH, total PLFA and fungal PLFA. These relationships between fluxes and microbial community suggest that LUC to SRF may drive change in soil respiration by altering the composition of the soil microbial community. These findings support that LUC to SRF for bioenergy can contribute towards C savings and GHG mitigation.

Keywords: Land use change; Short Rotation Forestry; Greenhouse gases; Soil respiration; Bioenergy; Phospholipid fatty acids

Angelo Crocamo[a], Santino Di Bernardino[b], Raffaele Di Giovanni[a], Massimiliano Fabbricino[a], Susete Martins-Dias[c]. ([a] University of Naples Federico II, Department of Civil, Architectural and Environmental Engineering, Via Claudio 21, 80125 Naples, Italy, [b] Laboratório Nacional de Energia e Geologia, I.P., Estrada do Paço do Lumiar, 22, 1649-038 Lisbon, Portugal, [c] CERENA, Instituto Superior Técnico, Department of Bioengineering, Universidade de Lisboa, Avenida Rovisco Pais 1, 1049-001 Lisbon, Portugal). **An integrated approach to energy production and nutrient recovery through anaerobic digestion of *Vetiveria zizanoides.* Biomass and Bioenergy, Volume 81(2015): 288–293**

This paper reports on experimental results used to verify the applicability of *Vetiveria zizanoides* (VZ) as a virtuous energetic crop. VZ produces biogas through its anaerobic digestion, and its nutrient content can be recovered through reuse, after digestion, as an agricultural amendment. Biomethanation tests were conducted with fresh and pretreated VZ, and the results of these tests were compared with those from the anaerobic degradation of common garden grass. Specific methane production was found to be around 650 Nm^3 per ton of total organic carbon (TOC) for *Vetiveria zizanoides*, and around 510 Nm^3 per ton of TOC for common grass, with no significant improvement after thermal pretreatment. Germination tests conducted with the digested VZ showed that the produced digestate fulfills the requirements of a fertilizer.

Keywords: Anaerobic digestion; Energy production; Nutrient recovery; *Vetiveria zizanoides*

Irini Maltsoglou[a], Ana Kojakovic[a], Luis E. Rincón[a, b], Erika Felix[a], Giacomo Branca[c], Stefano Valle[c], Arturo Gianvenuti[c], Andrea Rossi[a], Andreas Thulstrup[a], Heiner Thofern[a]. ([a] Food and Agriculture Organization of the United Nations, Rome, Italy, [b] Universidad Nacional de Colombia, Sede Manizales, Colombia, [c] University of La Tuscia, Viterbo, Italy). **Combining bioenergy and food security: An approach and rapid appraisal to guide bioenergy policy formulation. Biomass and Bioenergy, Volume 79(2015): 80–95**

In the bioenergy discourse that ties energy and agricultural markets closely together, evidence based policy formulation is key to ensure integrated food and energy systems are developed when viable. Bioenergy is a particularly complex form of renewable energy as it covers a broad

range of disciplines thus requiring a multidisciplinary approach to ensure viability. If built in a specific manner it has the option to target and provide investments in agriculture, a key sector for a number of developing economies.

Due to the complexity of the issue, generating information, especially when resources are limited, can be cumbersome. We present a multidisciplinary approach, the Bioenergy and Food Security (BEFS) Rapid Appraisal, that can provide a first level of information within the decision making process.

The analysis within the BEFS Rapid Appraisal defines the country context, estimates the biomass available for bioenergy production and ties this amount to specific bioenergy supply chains. Available biomass originating from agriculture is calculated net of current and foreseen uses and needs, thus accounting for food security. The bioenergy production potential is evaluated by quantifying the feedstock available, identifying income and employment opportunities, and energy access options. We present an application of the BEFS Rapid Appraisal for rural electrification options in Malawi.

Keywords: Biomass potential; Bioenergy; Renewable energy; Food security; Rural electrification

Hui Zhang[a, b], Wenhao Cao[a, c], Zewen Wu[d], Xikun Song[b, e], Jianjun Wang[f], Tao Yan[a, b, c]. ([a] CAS Key Laboratory of Tropical Marine Bio-resources and Ecology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China, [b] University of Chinese Academy of Sciences, Beijing 100049, China, [c] Key Laboratory of Marine Environmental Corrosion and Bio-fouling, Institute of Oceanography, Chinese Academy of Sciences, Qingdao 266071, China, [d] State Key Laboratory of Tropical Oceanography, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China, [e] Department of Marine Organism Taxonomy & Phylogeny and Marine Biological Museum, Institute of Oceanography, Chinese Academy of Sciences, Qingdao 266071, China, [f] Third Institute of Oceanography, State Oceanic Administration, Xiamen 361005, China). Biofouling on deep-sea submersible buoy systems off Xisha and Dongsha Islands in the northern South China Sea. International Biodeterioration & Biodegradation, Volume 104(2015): 92–96

To understand the deep-sea characteristics of marine fouling communities off Xisha and Dongsha Islands in the northern South China Sea, an investigation was conducted. A submersible buoy system was moored for 12 months at northwest of Xisha Islands at a depth profile of 1667 m (Station B6). Another was deployed in waters east of Dongsha Islands and exposed for 2 months at a depth profile of 1223 m (Station B9). The fouling samples were collected from the sediment trap (about 410 m below sea water surface), float and the kevlar rope. At Station B6, only the hydroid, *Obelia* sp., was found at 410 m. As for station B9, the pedunculate barnacles *Lepas anatifera* Linnaeus, 1758 and *Conchoderma hunteri* (Owen, 1830) were collected and identified. The former mainly occurred at 15–30 m, the latter at 35–50 m. Moreover, factors affecting the distributions of fouling organisms are discussed.

Keywords: Biofouling; Submersible buoy; Deep-sea; South China Sea

Qu Sun, Anjie Li, Meixi Li, Baolian Hou. (Key Laboratory of Water and Sediment Sciences of Ministry of Education/State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University, Beijing 100875, PR China).

Effect of pH on biodiesel production and the microbial structure of glucose-fed activated sludge. International Biodeterioration & Biodegradation, Volume 104(2015): 224–230

With the goal of reutilizing excess sludge, and decreasing the cost of lipid feedstocks, the effect of pH on enhancing biodiesel production via culturing special microbial communities from municipal activated sludge was investigated. The results indicated that controlling pH around 7.5 made biomass production and lipid accumulation more quickly under high initial glucose loading (40 g COD L^{-1}) and COD:N ratio (90:1). Compared with the seed sludge (biodiesel yield of 5.2 ± 0.3 mg g^{-1} dry sludge), the cultivated sludge achieved higher biodiesel yields both with pH control and without. However, the biodiesel yield of the cultured sludge with pH control (69.3 ± 1.2 mg g^{-1} dry sludge) was higher than that of the sludge without (63.3 ± 0.4 mg g^{-1}). More unsaturated fatty acid esters (64%, w/w total FAMEs) were obtained from the cultured sludge without pH control, which could improve the cold flow properties of biodiesel. The pH control did not make an essential difference in the microbial community at the end of cultivation. However, it improved the accumulation of *Enterobacteriaceae* and *Shewanella* in the cultured sludge. The dominant bacteria of *Shewanella*, *Raoultella*, *Enterobacter*, *Kluyvera* and two unclassified genera clustered with *γ-proteobacteria* within the cultured sludge possibly contributed to enhancing biodiesel production.

Keywords: Wastewater sludge; pH; Biodiesel; Microbial community; Fatty acid methyl esters (FAMEs); High throughput pyrosequencing

Kenan Dalkılıc, Aysenur Ugurlu. (Hacettepe University, Environmental Engineering Department, Beytepe, 06800 Ankara, Turkey). Biogas production from chicken manure at different organic loading rates in a mesophilic-thermopilic two stage anaerobic system. Journal of Bioscience and Bioengineering, Volume 120(3) (2015): 315–322

This study investigates the biogas production from chicken manure at different organic loading rates (OLRs), in a mesophilic-thermophilic two stage anaerobic system. The system was operated on semi continuous mode under different OLRs [1.9 g volatile solids (VS)/L·d – 4.7 g VS/L·d] and total solid (TS) contents (3.0–8.25%). It was observed that the anaerobic bacteria acclimatized to high total ammonia nitrogen concentration (>3000 mg/L) originated as a result of the degradation of chicken manure. High volatile fatty acid concentrations were tolerated by the system due to high pH in the reactors. The maximum average biogas production rate was found as 554 mL/g VS_{feed} while feeding 2.2 g VS/L-d (2.3% VS – 3.8% TS) to the system. Average methane content of produced biogas was 74% during the study.

Keywords: Biogas production; Chicken manure; Two stage digestion; Anaerobic; Thermophilic

Jingjing Li[a], Ying Liu[a], Jay J. Cheng[a, b], Michal Mos[c], Maurycy Daroch[a]. ([a] School of Environment and Energy, Peking University Shenzhen Graduate School, Shenzhen 518055, China, [b] Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, NC 27695, USA, [c] Energene sp. z o.o., ul Wroblewskiego 38A, Lodz 93-578, Poland). Biological potential of microalgae in China for biorefinery-based production of biofuels and high value compounds. New Biotechnology, Volume 32(6) (2015): 588–596

Microalgae abundance and diversity in China shows promise for identifying suitable strains for developing algal biorefinery. Numerous strains of microalgae have already been assessed as feedstocks for bioethanol and biodiesel production, but commercial scale algal biofuel production is yet to be demonstrated, most likely due to huge energy costs associated with algae

cultivation, harvesting and processing. Biorefining, integrated processes for the conversion of biomass into a variety of products, can improve the prospects of microalgal biofuels by combining them with the production of high value co-products. Numerous microalgal strains in China have been identified as producers of various high value by-products with wide application in the medicine, food, and cosmetics industries. This paper reviews microalgae resources in China and their potential in producing liquid biofuels (bioethanol and biodiesel) and high value products in an integrated biorefinery approach. Implementation of a 'high value product first' principle should make the integrated process of fuels and chemicals production economically feasible and will ensure that public and private interest in the development of microalgal biotechnology is maintained.

Carolina Parra[1], **Fernando Dorta**[2], **Edra Jimenez**[2], **Ricardo Henríquez**[1], **Cristian Ramírez**[3], **Rodrigo Rojas**[4] and **Patricio Villalobos**[2*]. **([1] Departamento de Física, Universidad Técnica Federico Santa María, Avenida España 1680, Valparaíso, Chile, [2] Centro de Biotecnología Daniel Alkalay Lowitt, Universidad Técnica Federico Santa María, Avenida España 1680, Valparaíso, Chile, [3] Departamento de Ingeniería Química y Ambiental, Universidad Técnica Federico Santa María, Avenida España 1680, Valparaíso, Chile, [4] Laboratorio de Patología Acuática, Departamento de Acuicultura, Facultad de Ciencias del Mar, Universidad Católica del Norte, Larrondo 1281, Coquimbo, Chile).** **A nanomolecular approach to decrease adhesion of biofouling-producing bacteria to graphene-coated material. Journal of Nanobiotechnology, Volume13(2015)**: **82**

Biofouling, the colonization of artificial and natural surfaces by unwanted microorganisms, has an important economic impact on a wide range of industries. Low cost antifouling strategies are typically based on biocides which exhibit a negative environmental impact, affecting surrounding organisms related and not related to biofouling. Considering that the critical processes resulting in biofouling occur in the nanoscale/microscale dimensions, in this work we present a bionanotechnological approach to reduce adhesion of biofilm-producing bacteria *Halomonas spp.* CAM2 by introducing single layer graphene coatings. The use of this nanomaterial has been poorly explored for antifouling application.

Our study revealed that graphene coatings modify material surface energy and electrostatic interaction between material and bacteria. Such nanoscale surface modification determine an important reduction over resulting bacterial adhesion and reduces the expression levels of genes related to adhesion when bacteria are in contact with graphene-coated material.

Our results demonstrate that graphene coatings reduce considerably adhesion and expression levels of adhesion genes of biofilm-producing bacteria *Halomonas spp.* CAM2. Hydrophobic-hydrophilic interaction and repulsive electrostatic force dominate the interactions between *Halomonas spp.* CAM2 and material surface in saline media, impacting the final adhesion process. In addition no bactericide effect of graphene coatings was observed. The effect over biofilm formation is localized right at coated surface, in contrast to other antifouling techniques currently used, such as biocides.

Keywords: Graphene; Halomonas ; Biofilms; Bacterial adhesion; Antifouling

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Biosciences and Health Sciences, Faculty of Biosciences and Medical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia). Bioelectricity generation in microbial fuel cell using natural microflora and isolated pure culture bacteria from anaerobic palm oil mill effluent sludge. Bioresource Technology, Volume 190(2015): 458–465

A double-chambered membrane microbial fuel cell (MFC) was constructed to investigate the potential use of natural microflora anaerobic palm oil mill effluent (POME) sludge and pure culture bacteria isolated from anaerobic POME sludge as inoculum for electricity generation. Sterilized final discharge POME was used as the substrate with no addition of nutrients. MFC operation using natural microflora anaerobic POME sludge showed a maximum power density and current density of 85.11 mW/m^2 and 91.12 mA/m^2 respectively. Bacterial identification using 16S rRNA analysis of the pure culture isolated from the biofilm on the anode MFC was identified as *Pseudomonas aeruginosa* strain ZH1. The electricity generated in MFC using *P. aeruginosa* strain ZH1 showed maximum power density and current density of 451.26 mW/m^2 and 654.90 mA/m^2 respectively which were five times higher in power density and seven times higher in current density compared to that of MFC using anaerobic POME sludge.

Keywords: Microbial fuel cell; Renewable energy; Palm oil mill effluent; Anaerobic POME sludge; *Pseudomonas aeruginosa*

D.E. Leiva-Candia[a], S. Tsakona[b], N. Kopsahelis[b], I.L. García[a], S. Papanikolaou[b], M.P. Dorado[a, 1], A.A. Koutinas[b, 1]. ([a] Department of Physical Chemistry and Applied Thermodynamics, EPS, Edificio Leonardo da Vinci, Campus de Rabanales, Campus de Excelencia Internacional Agroalimentario ceiA3, 14071 Cordoba, Spain, [b] Department of Food Science and Human Nutrition, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece). Biorefining of by-product streams from sunflower-based biodiesel production plants for integrated synthesis of microbial oil and value-added co-products. Bioresource Technology, Volume 190(2015): 57–65

This study focuses on the valorisation of crude glycerol and sunflower meal (SFM) from conventional biodiesel production plants for the separation of value-added co-products (antioxidant-rich extracts and protein isolate) and for enhancing biodiesel production through microbial oil synthesis. Microbial oil production was evaluated using three oleaginous yeast strains (*Rhodosporidium toruloides*, *Lipomyces starkeyi* and *Cryptococcus curvatus*) cultivated on crude glycerol and nutrient-rich hydrolysates derived from either whole SFM or SFM fractions that remained after separation of value-added co-products. Fed-batch bioreactor cultures with *R. toruloides* led to the production of 37.4 g L^{-1} of total dry weight with a microbial oil content of 51.3% (w w^{-1}) when a biorefinery concept based on SFM fractionation was employed. The estimated biodiesel properties conformed with the limits set by the EN 14214 and ASTM D 6751 standards. The estimated cold filter plugging point (7.3–8.6 °C) of the lipids produced by *R. toruloides* is closer to that of biodiesel derived from palm oil.

Keywords: Integrated biorefinery; Crude glycerol; Sunflower meal; Oleaginous yeast; Bioprocess

B.S. Moraes[a], J.M. Triolo[b], V.P. Lecona[b], M. Zaiat[c], S.G. Sommer[b]. ([a] Brazilian Bioethanol Science and Technology Laboratory (CTBE), Brazilian Center for Research in Energy and Materials (CNPEM), Rua Giuseppe Máximo Scolfaro, 10000, Polo II de Alta Tecnologia, P.O. Box 6170, Campinas, São Paulo 13083 – 970, Brazil, [b] Department of Chemical Engineering, Biotechnology and Environmental Technology, Faculty of Engineering, University of Southern Denmark, Campusvej 55, DK-5230 Odense M, Denmark, [c]

Biological Processes Laboratory (LPB), Center for Research, Development and Innovation in Environmental Engineering (CPDI-EA), São Carlos Engineering School (EESC), University of São Paulo (USP), Av. João Dagnone, 1100, Santa Angelina, São Carlos, São Paulo 13563 – 120, Brazil). Biogas production within the bioethanol production chain: Use of co-substrates for anaerobic digestion of sugar beet vinasse. Bioresource Technology, Volume 190(2015): 227–234

Bioethanol production generates large amounts of vinasse, which is suitable for biogas production. In this study, the anaerobic digestion of sugar beet vinasse was optimised using continuous stirred-tank reactors (CSTR) supplemented either with lime fertiliser or with 3% cow manure. In both reactors, the C/N ratio was adjusted by adding straw. The biochemical methane potential (BMP) of vinasse was 267.4 ± 4.5 L CH_4 kg VS^{-1}. Due to the low content of macro- and micronutrients and low C/N ratio of vinasse, biogas production failed when vinasse alone was fed to the reactor. When co-substrate was added, biogas production achieved very close to the BMP of vinasse, being 235.7 ± 32.2 L CH_4 kg VS^{-1} from the fertiliser supplied reactor and 265.2 ± 26.8 L CH_4 kg VS^{-1} in manure supplied reactor at steady state. Anaerobic digestion was the most stable when cow manure was supplied to digestion of vinasse.

Keywords: Co-digestion; Sugar beet vinasse; Cow manure; C/N ratio; Continuous stirred tank reactor (CSTR)

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A coupled process combining microalgae production with direct supercritical biodiesel conversion using a reduced number of operating steps is proposed in this work. Two newly isolated native microalgae strains, identified as *Chlorella* sp. and *Nannochloris* sp., were cultivated in both batch and continuous modes. Maximum productivities were achieved during continuous cultures with 318 mg/l day and 256 mg/l day for *Chlorella* sp. and *Nannochloris* sp., respectively. Microalgae were further characterized by determining their photosynthetic performance and nutrient removal efficiency. Biodiesel was produced by catalyst-free *in situ* supercritical methanol transesterification of wet unwashed algal biomass (75 wt.% of moisture). Maximum biodiesel yields of 45.62 wt.% and 21.79 wt.% were reached for *Chlorella* sp. and *Nannochloris* sp., respectively. The analysis of polyunsaturated fatty acids of *Chlorella* sp. showed a decrease in their proportion when comparing conventional and supercritical transesterification processes (from 37.4% to 13.9%, respectively), thus improving the quality of the biodiesel.

Keywords: Biodiesel; Photobioreactor culture; Microalgae isolation; Wet unwashed paste; *In situ* supercritical transesterification

Carolina Bellido, Celia Infante, Mónica Coca, Gerardo González-Benito, Susana Lucas, María Teresa García-Cubero. (Department of Chemical Engineering and Environmental

Technology, University of Valladolid, Dr. Mergelina s/n, 47011 Valladolid, Spain). Efficient acetone–butanol–ethanol production by *Clostridium beijerinckii* from sugar beet pulp. Bioresource Technology, Volume 190(2015): 332–338

Sugar beet pulp (SBP) has been investigated as a promising feedstock for ABE fermentation by *Clostridium beijerinckii*. Although lignin content in SBP is low, a pretreatment is needed to enhance enzymatic hydrolysis and fermentation yields. Autohydrolysis at pH 4 has been selected as the best pretreatment for SBP in terms of sugars release and acetone and butanol production. The best overall sugars release yields from raw SBP ranged from 66.2% to 70.6% for this pretreatment. The highest ABE yield achieved was 0.4 g/g (5.1 g/L of acetone and 6.6 g/L butanol) and 143.2 g ABE/kg SBP (62.3 g acetone and 80.9 g butanol) were obtained when pretreated SBP was enzymatically hydrolyzed at 7.5% (w/w) solid loading. Higher solid loadings (10%) offered higher acetone and butanol titers (5.8 g/L of acetone and 7.8 g/L butanol). All the experiments were carried out under not-controlling pH conditions reaching about 5.3 in the final samples.

Keywords: Sugar-beet pulp; Autohydrolysis pretreatment; ABE fermentation; *Clostridium beijerinckii*

Yong Jiang[a], Peng Liang[a], Changyong Zhang[a], Yanhong Bian[a], Xufei Yang[b], Xia Huang[a], Peter R. Girguis[c]. ([a] State Key Joint Laboratory of Environment Simulation and Pollution Control School of Environment, Tsinghua University, Beijing 100084, PR China, [b] Division of Atmospheric Sciences, Desert Research Institute, Reno, NV 89512, USA, [c] Harvard University, Organismic and Evolutionary Biology, Cambridge, MA, USA). Enhancing the response of microbial fuel cell based toxicity sensors to Cu(II) with the applying of flow-through electrodes and controlled anode potentials. Bioresource Technology, Volume 190(2015): 367–372

The application of microbial fuel cell (MFC)-based toxicity sensors to real-world water monitoring is partly impeded by the limited sensitivity. To address this limitation, this study optimized the flow configurations and the control modes. Results revealed that the sensitivity increased by ~15–41 times with the applying of a flow-through anode, compared to those with a flow-by anode. The sensors operated in the controlled anode potential (CP) mode delivered better sensitivity than those operated in the constant external resistance (ER) mode over a broad range of anode potentials from −0.41 V to +0.1 V. Electrodeposition of Cu(II) was found to bias the toxicity measurement at low anode potentials. The optimal anode potential was approximately −0.15 V, at which the sensor achieved an unbiased measurement of toxicity and the highest sensitivity. This value was greater than those required for electrodeposition while smaller than those for power overshoot.

Keywords: Biosensor; Microbial fuel cell; Flow-through; Cu(II); Sensitivity

Nano Biotechnology

Shaheen Husain, Meryam Sardar, Tasneem Fatma. (Department of Biosciences, Jamia Millia Islamia, Central University). Screening of cyanobacterial extracts for synthesis of silver nanoparticles. World Journal of Microbiology and Biotechnology, Volume 31(8) (2015): 1279-1283

Improvement of reliable and eco-friendly process for synthesis of metallic nanoparticles is a significant step in the field of application nanotechnology. One approach that shows vast potential is based on the biosynthesis of nanoparticles using micro-organisms. In this study, biosynthesis of silver nanoparticles (AgNP) using 30 cyanobacteria were investigated. Cyanobacterial aqueous extracts were subjected to AgNP synthesis at 30 °C. Scanning of these aqueous extracts containing AgNP in UV–Visible range showed single peak. The λ max for different extracts varied and ranged between 440 and 490 nm that correspond to the "plasmon absorbance" of AgNP. Micrographs from scanning electron microscope of AgNP from cyanobacterial extracts showed that though synthesis of nanoparticles occurred in all strains but their reaction time, shape and size varied. Majority of the nanoparticles were spherical. Time taken for induction of nanoparticles synthesis by cyanobacterial extracts ranged from 30 to 360 h and their size from 38 to 88 nm. In terms of size *Cylindrospermum stagnale NCCU-104* was the best organism with 38 and 40 nm. But in terms of time *Microcheate* sp. *NCCU-342* was the best organism as it took 30 h for AgNP synthesis.

Keywords: AgNP; Cyanobactrial extracts; Scanning electron microscope (SEM); *Microchaete* sp.; N*CCU-342; Cylindrospermum stagnale ; NCCU-104*

Haytham M. M. Ibrahim. (Department of Radiation Microbiology, National Center for Radiation Research and Technology (NCRRT), Atomic Energy Authority). Photocatalytic degradation of methylene blue and inactivation of pathogenic bacteria using silver nanoparticles modified titanium dioxide thin films. World Journal of Microbiology and Biotechnology, Volume 31(7) (2015): 1049-1060

Titanium dioxide (TiO_2) is a well-studied photocatalyst that is known to break down organic molecules upon ultraviolet irradiation. TiO_2 thin films were fabricated on glass substrates using the doctor-blade procedure, the film surface was modified with silver nanoparticles to increase its visible light response. The Ag–TiO_2 films were characterized by transmission electron microscopy, scanning electron microscopy equipped with energy dispersive spectrometry and X-ray diffraction. The photocatalytic degradation of methylene blue (MB) and inactivation of Gram-negative bacteria *Escherichia coli* and Gram-positive bacteria *Staphylococcus aureus* were studied. The modified films presented enhanced photocatalytic efficiency and can decompose MB solution two-times faster than the unmodified TiO_2 films, under illumination of sunlight. A nominal degradation (15 %) was observed in control MB under sunlight. The degradation efficiency of Ag–TiO_2 films slightly decreased after five consecutive experiments. Ag–TiO_2 films revealed very effective bactericidal activity against both *E. coli* and *S. aureus.* The photocatalytic inactivation toward *E. coli* and *S. aureus* showed a similar trend with much higher effectiveness toward *E. coli* under the same experimental conditions. The inactivation efficiency was maximized and reached 95 % for *S. aureus* and 97 % for *E. coli*, after 180 min incubation. These results demonstrate the potential of application of Ag–TiO_2 photocatalysis as a method for treatment of diluted waste waters in textile industries.

Keywords: Titanium dioxide; Thin film; Silver deposition; Photocatalysis; Microbial inactivation

Dan-Lian Huang, Guo-Min Chen, Guang-Ming Zeng, Piao Xu, Ming Yan, Cui Lai, Chen Zhang, Ning-Jie Li, Min Cheng, Xiao-Xiao, Yan He. (College of Environmental Science and Engineering, Hunan UniversityKey Laboratory of Environmental Biology and Pollution Control, Hunan University, Ministry of Education). Synthesis and Application of

Modified Zero-Valent Iron Nanoparticles for Removal of Hexavalent Chromium from Wastewater. Water, Air, & Soil Pollution, Volume 226(2015): 375

Zero-valent iron nanoparticles (nZVI) modified with sodium dodecyl sulfate (SDS) as an anionic surfactant were successfully synthesized and applied to Cr (VI) removal. The prepared nanoparticles were characterized by field emission scanning electron microscope (FSEM), energy-dispersive spectrometry (EDS), and Fourier transform infrared spectrophotometer (FT-IR). Meanwhile, the surface charges of the stabilized nanoparticles were also determined. In this study, the kinetics of particle aggregation and sedimentation were investigated. It was found that the modified nanoparticles had great stabilization. Effects of pH, contact time, dosage of nanoparticles, and initial Cr(VI) concentrations on removal efficiency of the heavy metal ions were investigated and optimized. The maximum removal efficiency of Cr(VI) was obtained at pH 3.0 and 25 °C, at the value of 98.919 %. Cr(VI) removal occurred fast, and achieved equilibrium after 120 min. The maximum removal capacity reached up to 253.68 mg g^{-1} dry nanoparticles at a 300-mg L^{-1} Cr(VI)-containing sample. Kinetics study showed a rapid removal dynamics fitting pseudo-second-order kinetic model. The equilibrium data was nicely fit to the Freundlich model and indicates the adsorption of Cr(VI) was highly favorable. The obtained results indicated that nZVI modified by SDS could be used as an efficient alternative for removal of heavy metals with enhanced removal capacity and application stability.

Keywords: Adsorption; Cr(VI); Zero-valent iron nanoparticle; Sodium dodecyl sulfate; Kinetic

Fatma Yanık, Filiz Vardar. (Marmara University, Science and Arts Faculty, Department of Biology). Toxic Effects of Aluminum Oxide (Al_2O_3) Nanoparticles on Root Growth and Development in *Triticum aestivum*. Water, Air, & Soil Pollution, Volume, 226(2015): 296

The development of nanotechnology has increased the amount of nanoparticles in the environment inducing pollution. In view of increasing amounts, their toxicity assessment becomes important. Aluminum oxide nanoparticles (Al_2O_3 NPs) have a wide range of applications in industry. The present study aims to reveal the time-dependent (24, 48, 72, 96 h) and dose-dependent (0, 5, 25, 50 mg/ml) effects of 13-nm-sized Al_2O_3 NPs on an agronomic plant wheat (*Triticum aestivum* L.) roots correlating with the appearance of various cellular stress responses. Al_2O_3 NPs reduced the root elongation by 40.2 % in 5 mg/ml, 50.6 % in 25 mg/ml, and 54.5 % in 50 mg/ml after 96 h. Histochemical analysis revealed lignin accumulation, callose deposition, and cellular damage in root cortex cells correlating the root elongation inhibition. Although the nanoparticle application decreased the total protein content with respect to control after 96 h, the peroxidase activity increased significantly which is considered to be one of the oxidative stress factors. Moreover, agarose gel results revealed that Al_2O_3 NPs induced DNA fragmentation being one of the important markers of programmed cell death. In conclusion, direct exposure to Al_2O_3 NPs leads to phytotoxicity significantly in wheat roots culminating in morphological, cellular, and molecular alterations.

Keywords: Aluminum oxide nanoparticles; Wheat; Root; Peroxidase activity; DNA fragmentation

Sivashankar Krishnamoorthy. (Nano-Enabled Medicine and Cosmetics Group, Materials Research and Technology (MRT) Department, Luxembourg Institute of Science and Technology (LIST), 41, Rue du Brill, L-4422, Belvaux, Luxembourg). Nanostructured sensors for biomedical applications — a current perspective. Current Opinion in Biotechnology, Volume 34(2015): 118–124

Nanostructured sensors have unique capabilities that can be tailored to advantage in advancing the diagnosis, monitoring and cure of several diseases and health conditions. This report aims at providing a current perspective on, (a) the emerging clinical needs that defines the challenges to be addressed by nanostructured sensors, with specific emphasis on early stage diagnosis, drug-diagnostic combinations, and predictive models to design therapy, (b) the emerging industry trends in *in vitro* diagnostics, mobile health care, high-throughput molecular and cell-based diagnostic platforms, and (c) recent instances of nanostructured biosensors, including promising sensing concepts that can be enhanced using nanostructures that carry high promise towards catering to the emerging clinical needs, as well as the market/industry trends.

Pengcheng Zhang[1], Andrew G Cheetham[1], Lye Lin Lock[1], Yaping Li[2], Honggang Cui[1, 3]. ([1]Department of Chemical and Biomolecular Engineering, Institute for NanoBioTechnology, Johns Hopkins University, 3400 North Charles Street, Baltimore, MD 21218, United States, [2] State Key Laboratory of Drug Research & Center of Pharmaceutics, Shanghai Institute of Materia Medica, Chinese Academy of Sciences, 501 Haike Road, Shanghai 201203, China, [3] Department of Oncology and Sidney Kimmel Comprehensive Cancer Center, Johns Hopkins University School of Medicine, Baltimore, Maryland 21205, United States). Activatable nanoprobes for biomolecular detection. Current Opinion in Biotechnology, Volume 34(2015): 171–179

Precise detection of pathologically relevant biomolecules could provide essential information on important intercellular, cellular, and subcellular events for accurate disease diagnosis and staging, thus leading to appropriate treatment recommendation. Activatable nanoprobes are nanoscale objects that can be turned on through specific reactions or interactions with biomolecules of interest, and afford some advantageous properties for improved detection of biomolecules both *in vitro* and *in vivo*. In this brief review, we highlight several recent examples in the development of activatable nanoprobes for biomolecule detection.

Josiah D Smith[1], Logan D Morton[1], Bret D Ulery. (Department of Chemical Engineering, University of Missouri, Columbia, MO 65211, United States). Nanoparticles as synthetic vaccines. Current Opinion in Biotechnology, Volume 34(2015): 217–224

As vaccines have transitioned from the use of whole pathogens to only the required antigenic epitopes, unwanted side effects have been decreased, but corresponding immune responses have been greatly diminished. To enhance immunogenicity, a variety of controlled release vehicles have been proposed as synthetic vaccines, but nanoparticles have emerged as particularly impressive systems due to many exciting publications. In specific, nanoparticles have been shown capable of not only desirable vaccine release, but can also be targeted to immune cells of interest, loaded with immunostimulatory substances termed adjuvants, or even induce desirable immune activating effects on their own. In the present review, recent advances in the utilization of inorganic, polymeric, and biomolecular nanoparticles as synthetic vaccines are discussed.

Scott A Walper, Kendrick B Turner, Igor L Medintz. (Center for Bio/Molecular Science and Engineering, Code 6900, U.S. Naval Research Laboratory, 4555 Overlook Avenue, S.W., Washington, DC 20375, USA). Enzymatic bioconjugation of nanoparticles: developing specificity and control. Current Opinion in Biotechnology, Volume 34(2015): 232–241

Nanoparticles are finding increasing roles in biotechnology for applications as contrast agents, probes, sensors, therapeutics and increasingly new value-added hybrid materials such as molecular logic devices. In most cases these materials must be conjugated to different types of biologicals such as proteins or DNA to accomplish this. However, most traditional methods of bioconjugation result in heterogeneous attachment and loss of activity. Bioorthogonal chemistries and in particular enzymatic labeling chemistries offer new strategies for catalyzing specific biomolecular attachment. We highlight current enzymatic labeling methods available for bioconjugating nanoparticles, some materials they have been used with, and how the resulting bioconjugates were applied. A discussion of the benefits and remaining issues associated with this type of bioconjugation chemistry and a brief perspective on how this field will develop is also provided.

Xiaoqian Zhu[b], Jiao Li[b], Hanping He[a, b,], Min Huang[b], Xiuhua Zhang[a, b], Shengfu Wang[a, b]. ([a] Hubei Collaborative Innovation Center for Advanced Organic Chemical Materials, Ministry of Education Key Laboratory for the Synthesis and Application of Organic Functional Molecules, College of Chemistry and Chemical Engineering, Hubei University, Youyi Road 368, Wuchang, Wuhan, Hubei 430062, PR China, [b] Ministry-of-Education Key Laboratory for the Green Preparation and Application of Functional Materials, College of Materials Science and Engineering, Hubei University, Youyi Road 368, Wuchang, Wuhan, Hubei 430062, PR China). **Application of nanomaterials in the bioanalytical detection of disease-related genes. Biosensors and Bioelectronics, Volume 74(2015): 113–133**

In the diagnosis of genetic diseases and disorders, nanomaterials-based gene detection systems have significant advantages over conventional diagnostic systems in terms of simplicity, sensitivity, specificity, and portability. In this review, we describe the application of nanomaterials for disease-related genes detection in different methods excluding PCR-related method, such as colorimetry, fluorescence-based methods, electrochemistry, microarray methods, surface-enhanced Raman spectroscopy (SERS), quartz crystal microbalance (QCM) methods, and dynamic light scattering (DLS). The most commonly used nanomaterials are gold, silver, carbon and semiconducting nanoparticles. Various nanomaterials-based gene detection methods are introduced, their respective advantages are discussed, and selected examples are provided to illustrate the properties of these nanomaterials and their emerging applications for the detection of specific nucleic acid sequences.

Keywords: Nanomaterials; Gene detection; Biosensor; DNA; Disease

Daniel Quesada-González[a], Arben Merkoçi[a, b]. ([a] Nanobioelectronics & Biosensors Group, Institut Català de Nanociència i Nanotecnologia (ICN2), Campus UAB, 08193 Bellaterra, Barcelona, Spain, [b] ICREA, Institució Catalana de Recerca i Estudis Avançats, Barcelona 08010, Spain). **Nanoparticle-based lateral flow biosensors. Biosensors and Bioelectronics, Volume 73(2015): 47–63**

Lateral flow biosensors (LFBs) are paper-based devices which permit the performance of low-cost and fast diagnostics with good robustness, specificity, sensitivity and low limits of detection. The use of nanoparticles (NPs) as labels play an important role in the design and fabrication of a lateral flow strip (LFS). The choice of NPs and the corresponding detection method directly affect the performance of these devices. This review discusses aspects related to the application of different nanomaterials (e.g. gold nanoparticles, carbon nanotubes, quantum dots, up-converting phosphor technologies, and latex beads, between others) in LFBs. Moreover, different detection methods (colorimetric, fluorescent, electrochemical, magnetic, etc.) and

signal enhancement strategies (affording secondary reactions or modifying the architecture of the LFS) as well as the use of devices such as smartphones to mediate the response of LFSs will be analyzed.

Keywords: Lateral flow; Nanoparticle; Optical detection; Electrochemical detection; Immunoassay

Hui Cheng[a], Guosong Lai[a,*], Li Fu[b], Haili Zhang[a], Aimin Yu[a, b]. ([a] Hubei Collaborative Innovation Center for Rare Metal Chemistry, Hubei Key Laboratory of Pollutant Analysis & Reuse Technology, Department of Chemistry, Hubei Normal University, Huangshi 435002, PR China, [b] Department of Chemistry and Biotechnology, Faculty of Science, Engineering and Technology, Swinburne University of Technology, Hawthorn, VIC 3122, Australia). **Enzymatically catalytic deposition of gold nanoparticles by glucose oxidase-functionalized gold nanoprobe for ultrasensitive electrochemical immunoassay. Biosensors and Bioelectronics, Volume 71(2015): 353–358**

A novel ultrasensitive immunoassay method was developed by combination of the enzymatically catalytic gold deposition with the prepared gold nanoprobe and the gold stripping analysis at an electrochemical chip based immunosensor. The immunosensor was constructed through covalently immobilizing capture antibody at a carbon nanotube (CNT) modified screen-printed carbon electrode. The gold nanoprobe was prepared by loading signal antibody and high-content glucose oxidase (GOD) on the nanocarrier of gold nanorod (Au NR). After sandwich immunoreaction, the GOD-Au NR nanoprobe could be quantitatively captured onto the immunosensor surface and then induce the deposition of gold nanoparticles (Au NPs) via the enzymatically catalytic reaction. Based on the electrochemical stripping analysis of the Au NR nanocarriers and the enzymatically produced Au NPs, sensitive electrochemical signal was obtained for the immunoassay. Both the GOD-induced deposition of Au NPs by the nanoprobe and the sensitive electrochemical stripping analysis on the CNTs based sensing surface greatly amplified the signal response, leading to the ultrahigh sensitivity of this method. Using carcinoembryonic antigen as a model analyte, excellent analytical performance including a wide linear range from 0.01 to 100 ng/mL and a detection limit down to 4.2 pg/mL was obtained. In addition, this immunosensor showed high specificity and satisfactory reproducibility, stability and reliability. The relatively positive detection potential excluded the conventional interference from dissolved oxygen. Thus this electrochemical chip based immunosensing method provided great potentials for practical applications.

Keywords: Biosensors; Electrochemical immunoassay; Signal amplification; Gold nanoparticles; Glucose oxidase

Amal Abdulaziz Abdullah Al juraifani*. (Department of Biology, College of Science, University Of Dammam, P. O. Box 383 Dammam 31113, Kingdom of Saudi Arabia). **Biosynthesis of silver nanoparticles by Aspergillus niger, Fusarium oxysporum and Alternaria solani. African Journal of Biotechnology, Volume14(26)(2015): 2170-2174**

Recently, biosynthesis of nanoparticles has attracted scientist's attention because of the use of environmentally friendly nanoparticles that do not produce toxic wastes in their process of synthesis. In this study we investigated the biosynthesis of silver nanoparticles using three fungi: Aspergillus niger, Fusarium oxysporum and Alternaria solani. These silver nanoparticles were characterized by means of UV-vis spectroscopy, scanning electron microscope (SEM). Results

indicate the synthesis of silver nanoparticles in the reaction mixture. The synthesis of nanoparticles would be suitable for developing a microbial nanotechnology biosynthesis process for mass scale production.

Key words: Silver nanoparticles, biosynthesis, fungi, Aspergillus.

Vishwajeet Singh*, Ankita Shrivastava, Nitin Wahi. (Department of Botany, Raja Balwant Singh, College, Dr B.R. Ambedkar University, Agra-282002, U.P., India, New Era Research Foundation, Agra-282007, India, U.P., India). Biosynthesis of silver nanoparticles by plants crude extracts and their characterization using UV, XRD, TEM and EDX. African Journal of Biotechnology, Volume14(33)(2015): 2554-2567

Plant extracts are very cost effective and eco-friendly, thus, can be an economic and efficient alternative for the large-scale synthesis of nanoparticles. The preparation of stable, uniform silver nanoparticles by reduction of silver ions with *Emblica officinalis*, *Terminalia catappa* and *Eucalyptus hybrida* extract is reported in the present paper. It is a simple process of global research interest for obtaining silver nanoparticles in least amount of time. These nanoparticles were characterized with UV-Vis spectroscopy, X-ray diffraction (XRD), transmission electron microscopy (TEM) and energy diffraction X- ray (EDX analysis which revealed that the silver nanoparticles are polydisperse and of different morphologies ranging from 20 to 80 nm in size. XRD results reveal that these nanostructures exhibit a face-centered cubic crystal structure. The UV/Vis spectra absorption peak confirms their production. Pioneering of reliable and eco-friendly process for synthesis of metallic nanoparticles biologically is an important step in the field of application of nanobiotechnology. Thus, these silver nanoparticles (Ag-NPs) may prove as a better candidate for drugs and can potentially eliminate the problem of chemical agents because of their biogenic nature. The indiscriminate use of antibiotics has fuelled the development of drug resistance at an alarming rate. To overpower this burning problem, the Ag-NPs may prove to be a universal solution.

Keywords: Nanobiotechnology, silver nanoparticles (Ag-NPs), *Emblica officinalis*, *Terminalia catappa* and *Eucalyptus hybrida.*

Sumistha Das, Biswarup Sen, Nitai Debnath. (Amity Institute of Biotechnology, Amity University Haryana). Recent trends in nanomaterials applications in environmental monitoring and remediation. Environmental Science and Pollution Research, Volume 22(23) (2015): 18333-18344

Environmental pollution is one of the greatest problems that the world is facing today, and it is increasing with every passing year and causing grave and irreparable damage to the earth. Nanomaterials, because of their novel physical and chemical characteristics, have great promise to combat environment pollution. Nanotechnology is being used to devise pollution sensor. A variety of materials in their nano form like iron, titanium dioxide, silica, zinc oxide, carbon nanotube, dendrimers, polymers, etc. are increasingly being used to make the air clean, to purify water, and to decontaminate soil. Nanotechnology is also being used to make renewable energy cheaper and more efficient. The use of nanotechnology in agriculture sector will reduce the indiscriminate use of agrochemicals and thus will reduce the load of chemical pollutant. While remediating environment pollution with nanomaterials, it should also be monitored that these materials do not contribute further degradation of the environment. This review will focus broadly on the applications of nanotechnology in the sustainable development with particular emphasis on renewable energy, air-, water-, and soil-remediation. Besides, the review highlights the recent developments in various types of nanomaterials and nanodevices oriented toward pollution monitoring and remediation.

Keywords: Nanoparticles; Pollutants; Nanosensors; Sustainable development; Solar cell; Nanocides

Jakub Oprsal, Ludek Blaha, Miloslav Pouzar, Petr Knotek, Katerina Hrda, Milan Vlcek. (Faculty of Chemical Technology, Institute of Environmental and Chemical Engineering, University of Pardubice, Faculty of Science, Masaryk University, Faculty of Chemical Technology, Institute of Environmental and Chemical Engineering, University of Pardubice, Faculty of Chemical Technology, Department of General and Inorganic Chemistry, University of Pardubice, Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic). **Assessment of silver nanoparticle toxicity for common carp (*Cyprinus carpio*) fish embryos using a novel method controlling the agglomeration in the aquatic media. Environmental Science and Pollution Research, Volume 22(23)(2015): 19124-19132**

Formation of agglomerates and their rapid sedimentation during aquatic ecotoxicity testing of nanoparticles is a major issue with a crucial influence on the risk assessment of nanomaterials. The present work is aimed at developing and testing a new approach based on the periodic replacement of liquid media during an ecotoxicological experiment which enabled the efficient monitoring of exposure conditions. A verified mathematical model predicted the frequencies of media exchanges which checked for formation of agglomerates from silver nanoparticles AgNP with 50 nm average size of the original colloid. In the model experiments, embryos of common carp *Cyprinus carpio* were exposed repeatedly for 6 h to AgNPs (5–50 µm Ag L^{-1}) either under semistatic conditions (exchange of media after 6 h) or in variants with frequent media exchanges (varying from 20 to 300 min depending on the AgNP colloid concentration and the desired maximum agglomerate size of 200 or 400 nm). In contrast to other studies, where dissolved free metals are usually responsible for toxic effects, our 144-h experiments demonstrated the importance of AgNP agglomerates in the adverse effects of nanosilver. Direct adsorption of agglomerates on fish embryos locally increased Ag concentrations which resulted in pronounced toxicity particularly in variants with larger 400 nm agglomerates. The present study demonstrates the suitability of the novel methodology in controlling the conditions during aquatic nanomaterial toxicity testing. It further provided insights into the mechanisms underlying the effects of AgNP, which rank on a global scale among the most widely used nanomaterials.

Keywords: Nanosilver; Agglomeration; Fish embryo; *Cyprinus carpio;* Particle size distribution

Congcong Ding[a, b], Wencai Cheng[a], Yubing Sun[a, c, d], Xiangke Wang[a, c, d, e]. ([a] Institute of Plasma Physics, Chinese Academy of Science, P.O. Box 1126, Hefei 230031, PR China, [b] University of Science and Technology of China, Hefei 230000, PR China, [c] School for Radiological and Interdisciplinary Sciences (RAD-X), Soochow University and Collaborative Innovation Center of Radiation Medicine of Jiangsu Higher Education Institutions, 215123 Suzhou, PR China, [d] School of Environment and Chemical Engineering, North China Electric Power University, Beijing 102206, PR China, [e] Faculty of Engineering, King Abdulaziz University, Jeddah 21589, Saudi Arabia). **Novel fungus-Fe_3O_4 bio-nanocomposites as high performance adsorbents for the removal of radionuclides. Journal of Hazardous Materials, Volume 295(2015): 127–137**

The bio-nanocomposites of fungus-Fe_3O_4 were successfully synthesized using a low-cost self-assembly technique. SEM images showed uniform decoration of nano-Fe_3O_4 particles on fungus surface. The FTIR analysis indicated that nano-Fe_3O_4 was combined to the fungus surface by

chemical bonds. The sorption ability of fungus-Fe_3O_4 toward Sr(II), Th(IV) and U(VI) was evaluated by batch techniques. Radionuclide sorption on fungus-Fe_3O_4 was independent of ionic strength, indicating that inner-sphere surface complexion dominated their sorption. XPS analysis indicated that the inner-sphere radionuclide complexes were formed by mainly bonding with oxygen-containing functional groups (i.e., alcohol, acetal and carboxyl) of fungus-Fe_3O_4. The maximum sorption capacities of fungus-Fe_3O_4 calculated from Langmuir isotherm model were 100.9, 223.9 and 280.8 mg/g for Sr(II) and U(VI) at pH 5.0, and Th(IV) at pH 3.0, respectively, at 303 K. Fungus-Fe_3O_4 also exhibited excellent regeneration performance for the preconcentration of radionuclides. The calculated thermodynamic parameters showed that the sorption of radionuclides on fungus-Fe_3O_4 was a spontaneous and endothermic process. The findings herein highlight the novel synthesis method of fungus-Fe_3O_4 and its high sorption ability for radionuclides.

Keywords: Fe_3O_4; Bio-nanocomposites; Adsorbents; Radionuclides; Sorption

Name of Journals

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2. Aerobiologia
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4. Annual Review- Ecology and Systematics
5. Annual Review-Biochemistry
6. Annual Review-Biomedical Engineering
7. Annual Review-Biophysics and Biomolecular Structure
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