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on
ENVIRONMENTAL BIOTECHNOLOGY

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Prof. Ashis Kumar Panigrahi
Co-ordinator
ENVIS Centre on Environmental Biotechnology
Department of Environmental Science
University of Kalyani,
Kalyani –741235, Nadia,
West Bengal,
INDIA
Email: desku@envis.nic.in
Website: http://www.deskuenvis.nic.in

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 relevant national and international journals. Viewpoint of this abstract volume is to help the interested research workers, scientists, administrators and the general people.

This is the 36th 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 2020. 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 is 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 15 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 indicates 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 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 broad-based engineering disciplines 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 was 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. Biomasses, 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

Mark A.F.Gillingham[a], Fabrizio Borghesi[b], B. Karina Montero[ac], Francesca Migani[d], Arnaud Béchet[e], Manuel Rendón-Martos[f], Juan A.Amat[g], EnricoDinelli[b], SimoneSommer[a](a. University of Ulm, Institute of Evolutionary Ecology and Conservation Genomics, Albert-Einstein Allee 11, D-89069 Ulm, Germany, b. Bologna University, Department of Biological, Geological and Environmental Sciences (BiGeA), Operative Unit of Ravenna, Via Sant'Alberto, 163, 48123 Ravenna, Italy, c. Animal Ecology and Conservation, Hamburg University, Hamburg, Germany, d. Via Fenaria Vecchia, 99, 48123 Ravenna, Italy, e. Institut de Recherche de la Tour du Valat, Le Sambuc, 13200 Arles, France, f. R.N. Laguna de Fuente de Piedra, Consejería de Medio Ambiente y Ordenación del Territorio, Junta de Andalucía, Apartado 1, E-29520 Fuente de Piedra, Málaga, Spain, g. Department of Wetland Ecology, Estación Biológica de Doñana, (EBD-CSIC), calle Américo Vespucio s/n, E-41092 Sevilla, Spain), Science of The Total Environment(2020), 143250

Elevated concentrations of trace elements represent a major concern to wetland ecosystems, since river estuaries are geochemical endpoints that accumulate pollution. Although the negative impact of environmental exposure of highly toxic elements such as Pb and Hg has received substantial attention, we still lack a comprehensive understanding of the effects that these and other common trace elements have on natural populations. We used greater flamingos as a study system within three sites that represent a gradient of pollution. Controlling for environmental sediment exposure, we assessed if signatures of bioaccumulation in feathers for ten trace elements (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Sn and Zn) are associated with two known proxies of health: body condition and the gut bacterial microbiome. We found evidence of an adverse effect of Se, Hg, and Pb bioaccumulation on body condition. Furthermore, bioaccumulation of the elements As, Cu, Se, Pb and Zn influenced different aspects of the gut microbiome. Bioaccumulation of Se led to a shift in the microbiome composition, largely driven by an enrichment of Bacteroides plebeius, which is linked to the breakdown of sulphated polysaccharides of algae. Bacteroides plebeius was negatively associated with chick body condition, suggesting an adverse effect of a microalgae diet rich in Se. Pb bioaccumulation was linked with a decrease in microbial diversity (adjusted-R2 = 10.4%) and an increase in heterogeneity of the microbial community (adjusted-R2 = 10.5%), an indication of impaired gut homeostasis. As, Cu and Zn had more nuanced effects on gut microbiome heterogeneity according to breeding site and bioaccumulation concentration. Our results therefore suggest that in addition to well-studied elements, bioaccumulation of poorly studied elements also adversely affect health of natural populations.
Keywords: Environmental pollution, Trace elements, Heavy metals, Chick body condition, Gut microbiome, Feather bioaccumulation, Greater flamingos

Bo Ren[a], Bo Jia[a], Xiaodong Zhang[b], Ju Wang[a] Yanhong Li[a], Hanlin Liang[a] Hongwu Liang[a] (a. Inner Mongolia Key Laboratory of Environmental Pollution Control & Waste Resource Reuse, School of Ecology and Environment, Inner Mongolia University, Hohhot, 010021, China, b. Inner Mongolia Institute for Drug Control, Hohhot, Inner Mongolia, 010020, China) **Influence of multi-walled carbon nanotubes on enantioselective bioaccumulation**

and oxidative stress toxicity of indoxacarb in zebrafish(Danio rerio), Chemosphere(2020), 128872

Carbon nanotubes (CNTs) have been widely used in various fields with the rapid development of nanotechnology. Pesticides have an irreplaceable role in agricultural production, which leads to their massive utilization and their inevitably penetrate into the aquatic environment. However, limited information is available regarding the impact of CNTs on the toxicity and enrichment of chiral compounds to organisms. Using zebrafish as a model to study whether the enantioselective bioaccumulation and oxidative stress of chiral pollutants may be altered in the presence of MWCNTs. Significant enantioselective bioaccumulation was observed in zebrafish with the preferential accumulation of R-(−)-indoxacarb during the 28-day bioaccumulation. The combined exposure of MWCNTs does not affect the enantioselectivity of zebrafish bioaccumulation, but increase the bioaccumulation amount of R-(−)-indoxacarb by 65%. Moreover, the average degradation half-life of indoxacarb enantiomers was 1.30 days. The indoxacarb causes oxidative stress toxicity in zebrafish liver and exhibited enantioselectivity, while the addition of MWCNTs did not significantly change the enantioselectivity of oxidative stress toxicity of indoxacarb, but enhanced the toxicity 20% with increased MWCNTs concentrations. This study suggests that the risk of the co-presence of nanomaterials and chiral pesticides in aquatic environments should be taken into consideration.

Keywords: Indoxacarb, MWCNTs, Enantioselectivity, Bioaccumulation, Oxidative stress, Zebrafish

Babita Sharma[a], Pratyoosh Shukla[ab](a. Enzyme Technology and Protein Bioinformatics Laboratory, Department of Microbiology, Maharshi Dayanand University, Rohtak-124001, Haryana, India, b. School of Biotechnology, Institute of Science, Banaras Hindu University, Varanasi 221005, India) **A comparative analysis of heavy metal bioaccumulation and functional gene annotation towards multiple metal resistant potential by Ochrobactrum intermedium BPS-20 and Ochrobactrum ciceri BPS-26, Bioresource Technology, Volume 320(2021), 124330**

The present study describes the heavy metal bioaccumulation potential of Ochrobactrum intermedium BPS-20 and Ochrobactrum ciceri BPS-26. A total of 27 isolates were retrieved from the soils of industrial areas and these two were selected based on their maximum metal tolerance. They can resist up to 2400 mg/L and 2000 mg/L of Lead and 850 mg/L and 1200 mg/L of Nickel respectively. The atomic absorption spectroscopic analysis showed considerably good bioaccumulation by O. intermedium BPS-20 (85.34% and 74.87%) and O. ciceri BPS-26 (71.20% and 88.48%) for Lead and Nickel respectively. The growth rate studies also demonstrated no inhibitory effects of heavy metals in the medium. Further the SEM analysis showed the presence of extracellular polymeric substances around bacterial cells. Moreover, the functional gene annotation confirmed the presence of ATPase, ABC, and HoxN/HupN/NixA families of transporters. Thus, both the isolates provide a better solution for the removal of metal pollutants.

Keywords: Heavy metal, Bioaccumulation, Ochrobactrum intermedium, Ochrobactrum ciceri, Functional annotation

Yidian Sun[a], Liwen Zhang[a], Xun Zhang[b], Tianyi Chen[a], Deming Dong[a], Xiuyi Hua[a], Zhiyong Guo[a](a. Key Laboratory of Groundwater Resources and Environment, Ministry

of Education, Jilin Provincial Key Laboratory of Water Resources and Environment, College of New Energy and Environment, Jilin University, Changchun 130012, China, b. Changchun Customs District P.R. China, Changchun 130062, China) Enhanced bioaccumulation of fluorinated antibiotics in crucian carp (Carassius carassius): Influence of fluorine substituent, Science of The Total Environment, Volume 748(2020), 141567

The negative impact of residual fluorinated antibiotics on the ecosystem and human health are of great concern. However, only a few studies have been conducted on the factors that influence the bioaccumulation of fluorinated antibiotics in aquatic organisms. To investigate the effects of fluorine substituent, environmental concentration of antibiotics, and temperature on the bioaccumulation of florfenicol (FLO), thiamphenicol (TAP), ofloxacin (OFX), and pipemidic acid (PPA), crucian carp (Carassius carassius) were exposed to different concentrations of antibiotics and different temperatures for 21 days. The liver exhibited the highest antibiotic concentrations, with 315.4 ± 13.6 ng g−1 wet weight (ww), followed by the bile (279.4 ± 12.4 ng mL−1), muscle (53.1 ± 4.3 ng g−1 ww), and gills (37.1 ± 2.6 ng g−1 ww). The FLO and OFX containing the fluorine substituent were much easier to accumulate in crucian carp compared with their isonomic TAP and PPA, respectively. The fluorine substituent increased the bioaccumulation of the targeted antibiotics in crucian carp. In addition, the lower levels of antibiotics presented higher bioaccumulation potential, but the temperature had little effect on the bioaccumulation. These findings in the present study can provide further insight into the environmental behaviors and ecological risks of fluorinated antibiotics in the aquatic environment.

Keywords: Bioaccumulation, Fish, Emerging contaminant, Florfenicol, Ofloxacin, Temperature

Caide Huang[a], Yan Ge[a], Shizhong Yue[ab], Yuhui Qiao[ac], Longsheng Liu[abcd] (a. College of Resources and Environmental Science, China Agricultural University, Beijing 100193, China, b. Shandong Provincial Key Laboratory of Biophysics, Institute of Biophysics, Dezhou University, Dezhou 253023, China, c. Beijing Key Laboratory of Biodiversity and Organic Farming, China Agricultural University, Beijing 100193, China, d. Hengyang Academy of Agricultural Sciences, Hengyang 421151, China) Impact of soil metals on earthworm communities from the perspectives of earthworm ecotypes and metal bioaccumulation, Journal of Hazardous Materials(2020), 124738

The current study elucidates the impact of soil metal contamination on earthworm communities at the ecotype level. A total of 292 earthworms belonging to 13 species were collected in metal-contaminated soils from Wanshou (WSC), Daxing (DXC) and Lupu (LPC) plots (1.40-6.60, 29.4-126, 251-336 and 91.9-109 mg/kg for soil Cd, Cu, Zn and Pb, respectively) in Hunan Province, southern China. The results showed that the total earthworm density and biomass significantly decreased along the increasing metal-contaminated gradient while epigeic earthworms became more dominant than anecic and endogeic earthworms. Redundancy analysis (RDA) showed that soil pH, total nitrogen and Cd concentration were the primary factors influencing earthworm communities, explaining 33.7%, 29.1% and 26.7% of the total variance, respectively. In addition, epigeic earthworm Metaphire californica bioaccumulated more Cd (0.27-0.60 mmol/kg), while endogeic earthworm Amynthas hupeiensis and anecic earthworm Amynthas asacceus bioaccumulated more Cu (0.55-1.62 mmol/kg) and Zn (2.86-6.46 mmol/kg)

from soil, respectively, which were related to their habit soils and showed the species-specific bioaccumulation features. Our study discovered the diverse responses of earthworm ecotypes to metal contamination and their specific features of metal bioaccumulation, provide insight for soil risk assessments and for biodiversity conservation from a niche partitioning perspective.

Keywords: Field survey, Earthworm, Ecotypes, RDA analysis, Bioaccumulation

Di Du[acde], Yonglong Lu[abe], Yunqiao Zhou[fg], Qifeng Li[hi], Meng Zhang[ae], Guoxiang Han[ae], Haotian Cui[ae], Erik Jeppesen[djk] (a. State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, China, b. Key Laboratory of the Ministry of Education for Coastal Wetland Ecosystems, College of the Environment and Ecology, Xiamen University, Fujian 361102, China, c. Sino-Danish College, University of Chinese Academy of Sciences, Beijing 100049, China, d. Sino-Danish Center for Education and Research, Beijing 100190, China, e. University of Chinese Academy of Sciences, Beijing 100049, China, f. Key Laboratory of Tibetan Environment Changes and Land Surface Processes, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100101, China, g. CAS Center for Excellence in Tibetan Plateau Earth Sciences, Chinese Academy of Sciences, Beijing 100101, China, h. Innovation Academy for Green Manufacture, Chinese Academy of Sciences, Beijing 100190, China, i. Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, China, j. Department of Bioscience, Aarhus University, Vejlsøvej 25, DK-8600 Silkeborg, Denmark, k. Limnology Laboratory, Department of Biological Sciences and Centre for Ecosystem Research and Implementation, Middle East Technical University, Ankara, Turkey) **Bioaccumulation, trophic transfer and biomagnification of perfluoroalkyl acids (PFAAs) in the marine food web of the South China Sea, Journal of Hazardous Materials (2020), 124681**

Knowledge about bioaccumulation and trophic transfer in food webs is of tremendous importance in contaminant hazards evaluation. Perfluoroalkyl acids (PFAAs) are widely distributed, and its emissions to coastal areas have posed a threat to the health of marine organisms and consumers. In this study, 15 species were sampled from Qinzhou Bay of the South China Sea. The concentrations of PFAAs in organisms were detected by liquid chromatography-mass spectrometry, and the trophic positions of organisms were constructed based on nitrogen isotope analysis. PFAAs were found in all organisms. The contents of PFOS in all organisms were higher than of PFOA, and the proportions of short-chain PFAAs were higher in the low trophic positioned organisms, while long-chain PFAAs were higher in the high trophic positioned organisms. Moreover, the bioaccumulation factors (BAFs) increased with the increasing number of fluorocarbon atoms. The trophic magnification factor (TMF) and the biomagnification factors (BMFs), calculated from the constructed food webs, together suggested potential biomagnification effects of PFOS, while less clear results were found for PFOA. Our results further indicate that previously banned long-chain PFAAs had persistent residuals in this coastal marine ecosystem, and that emerging short-chain PFAAs had high concentrations in some species but showed no biomagnification.

Keywords: PFAAs, marine organisms, bioaccumulation, trophic transfer, biomagnifications

Sebastian Kuehr[ab], R.Kaegi[c], D.Maletzki[d], C.Schlechtriem[abe] (a. Fraunhofer Institute for Molecular Biology and Applied Ecology IME, Schmallenberg, Germany, b. Department

Chemistry and Biology, “Ecotoxicology” Work Group, University of Siegen, Germany, c. Eawag, Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland, d. German Environment Agency, 12307, Berlin-Marienfelde, Germany, e. Institute of Environmental Research (Biology V), RWTH Aachen University, Aachen, Germany) Testing the bioaccumulation potential of manufactured nanomaterials in the freshwater amphipod Hyalella azteca, Chemosphere (2021), 127961

Standardized experimental approaches for the quantification of the bioaccumulation potential of nanomaterials in general and in (benthic) invertebrates in particular are currently lacking. We examined the suitability of the benthic freshwater amphipod Hyalella azteca for the examination of the bioaccumulation potential of nanomaterials. A flow-through test system that allows the generation of bioconcentration and biomagnification factors was applied. The feasibility of the system was confirmed in a 2-lab comparison study. By carrying out bioconcentration and biomagnification studies with gold, titanium dioxide and silver nanoparticles as well as dissolved silver (AgNO3) we were able to assess the bioaccumulation potential of different types of nanomaterials and their exposure pathways. For this, the animals were examined for their total metal body burden using inductively coupled mass spectroscopy (ICP-MS) and for the presence of nanoparticulate burdens using single-particle ICP-MS. The role of released ions was highlighted as being very important for the bioavailability and bioaccumulation of metals from nanoparticles for both examined uptake paths examined (bioconcentration and biomagnification). In 2018 a tiered testing strategy for engineered nanomaterials was proposed by Handy et al. that may allow a waiver of bioaccumulation fish studies using inter alia invertebrates. Data gained in studies carried out with invertebrates like the developed Hyalella azteca test may be included in this proposed tiered testing strategy.

Keywords: Bioaccumulation, Nanomaterials, Nanoparticles, Hyalella azteca, Risk assessment

Gualberto Rosado Rodríguez, Ernesto Otero Morales(Department of Marine Sciences, University of Puerto Rico, Mayagüez Campus, P.O. Box 9000, 00681 Mayagüez, Puerto Rico) Assessment of heavy metal contamination at Tallaboa Bay (Puerto Rico) by marine sponges' bioaccumulation and fungal community composition, Marine Pollution Bulletin Volume 161, Part B(2020) 111803

The water filtering capacity, and the potential to accumulate contaminants such as heavy metals, make marine sponges suitable candidates for biomonitoring of marine ecosystems. Sponges also harbor a variety of endosymbionts, including fungi, which could be affected by the accumulation of contaminants. This work examined the bioaccumulation factors of heavy metals by sponges from coastal waters from Puerto Rico. Fungal communities associated with marine sponges were assessed to determine if their composition co-varied with heavy metals in sponge tissue. All sponges in our study where found to bioaccumulate arsenic, cadmium and copper. Fungi associated with the sponges showed variations in community composition among localities and sponge species. Our results suggest that sponges, specially Tedania ignis, could be used as a complementary component for biomonitoring of arsenic, cadmium and copper; and that members of the harbored fungal communities could be negatively affected by the accumulation of heavy metals in the sponges.

Keywords: Marine sponges, Heavy metals, Bioaccumulation, Fungi, Bioindicators

Bioremediation

Die Dong[a], Haoyu Sun[ab], Zhengliang Qi[b], XinliLiu[ab] (a. State Key Laboratory of Bio-based Material and Green Papermaking (LBMP), Qilu University of Technology (Shandong Academy of Sciences), Jinan, Shandong, PR China, b. Key Laboratory of Shandong Microbial Engineering, College of Bioengineering, Qilu University of Technology (Shandong Academy of Sciences), Jinan, Shandong, PR China) **Improving microbial bioremediation efficiency of intensive aquacultural wastewater based on bacterial pollutant metabolism kinetics analysis, Chemosphere Volume 265(2021), 129151**

How to effectively bioremediate aquacultural wastewater using microbes is an urgent issue for the application of aquaculture beneficial microorganisms. Purple non-sulfur bacteria (PNSB) are beneficial in preventing related pollution in aquaculture applications. An autochthonous PNSB Rhodobacter sphaeroides was employed in this study to explore an effective bioremediation strategy of aquacultural wastewater. The test bacterium showed high performance in the removal of ammonium (97.50% ± 0.78% of 42 mg L−1 NH4+-N) and phosphate (93.24% ± 0.71% of 50 mg L−1 PO43--P) in the synthetic wastewater, which are the two crucial indicators of the aquacultural wastewater bioremediation. The study also unveiled that the imbalanced ratio of nutrients in water was the principal reason for limiting the efficient bioremediation of shrimp-culture wastewater. Therefore, an effective microbial bioremediation strategy was proposed by comprehensively considering bacterial pollutant metabolism kinetics constants such as specific consumption yields of chemical oxygen demand (COD)/phosphorous and nitrogen/phosphorous. Finally, COD, total nitrogen (TN), total phosphorus (TP), and ammonium (NH4+-N) in the wastewater were examined, and the results showed that they all decreased to the acceptable values. In conclusion, this study suggested a novel method for improved bioremediation efficiency of aquacultural wastewater, and the findings revealed that this strategy is promising due to its characteristics to be used in various aquaculture wastewater types.

Keywords: Microbial bioremediation, Aquaculture wastewater, R. sphaeroides, Bacterial pollutant metabolism kinetics, Bioremediation efficiency

Bhaskar Sinha[a], Supriyo Roy[b], Kaushik Kumar[b] (a. Middle East Oil & Gas sector, Doha, Qatar, b. Birla Institute of Technology, Mesra, Ranchi, India) **Bioremediation of oily sludge: A case base analysis to sustainable supply chain, Resources, Environment and Sustainability, Volume 2(2020) 100008**

Sustainability as an important topic has drawn considerable attention across the globe. Any business environment concentrated on maintaining a delicate balance between 3P's of people, planet, and profit. In today's globalized business environment, firms make every effort to keep the environment protected within their chain of operations. Petrochemicals are hazardous items creating pollution for the planet earth. A traditional solution like the banishment of unlined soak ways or evaporation of ponds is tough to implement; thus take significant time, resources, and money. Bioremediation seems to be an alternate solution of the sustainable reverse chain towards the restoration of resources over traditional methods like Incineration or Landfilling. Here, an experimental (pilot) study has been undertaken with a Middle East Oil and Gas company for evaluation of the bioremediation process for getting rid of oily sludge of unlined

soak ways. In line with this, the application of Oil Spill Eater II and its successful adoption towards the successful implementation of bioremediation is discussed. The outcome of the study explores the efficacy of using OSE-II over traditional methods in line with techno-economic viability to sustainability.

Keywords: Sustainable reverse chain, Petrochemicals, Bioremediation, Oily sludge, Environment protection

Ihsanullah Ihsanullah[a], Arshad Jamal[b], Muhammad Ilyas[a], Mukarram Zubair[c], Gulraiz Khan[c], Muataz Ali Atieh[de] (a. Center for Environment and Water, Research Institute, King Fahd University of Petroleum and Minerals, Dhahran, 31261, Saudi Arabia, b. Department of Civil and Environmental Engineering, King Fahd University of Petroleum and Minerals, KFUPM Box 5055, Dhahran, 31261, Saudi Arabia, c. Department of Environmental Engineering, College of Engineering, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31451, Saudi Arabia, d. College of Engineering, University of Sharjah, PO Box 27272, Sharjah, United Arab Emirates, e. Desalination Research Group, Research Institute of Sciences and Engineering, University of Sharjah, Sharjah, P.O. Box 27272, United Arab Emirates) Journal of Water Process Engineering, Volume 38 (2020) 101680

Environmental pollution associated with the discharge of textile industries is becoming a global concern. There is an imperative need for developing efficient, environmentally friendly, and cost-effective techniques for treating the wastewater containing dyes. Bioremediation of dyes is a fascinating approach to treat the textile effluents as it offers many advantages over the conventional treatment techniques. This review critically evaluates the latest advancements in applications of bioremediation techniques for the removal of various dyes from wastewater. The applications of various microorganisms such as bacteria, algae, fungi, yeast, and enzymes for the uptake of dyes are portrayed in detail. The current advancements in the bioremediation of textile effluents, research opportunities, challenges, and future outlook are emphasized. It also highlights the progress in bioremediation of dyes using bioreactors and microbial fuel cells. This review is beneficial in understanding the current status of bioremediation in water purification and accelerating the research focusing the role of bioremediation in water purification applications in future.

Keywords: Bioremediation, Dyes, Wastewater, Water treatment, textile effluent

PengLiu[a], Yu Zhang[bc], Qiang Tang[b], Shenjie Shi[b] (a. School of Civil Engineering, Nanjing Forestry University, Nanjing 210037, China, bSchool of Rail Transportation, Soochow University, Suzhou, 215131, China, c. Graduate School of Global Environmental Studies, Kyoto University, Sakyo-ku, Kyoto 606-8501, Japan) Bioremediation of metal-contaminated soils by microbially-induced carbonate precipitation and its effects on ecotoxicity and long-term stability, Biochemical Engineering Journal (2020), 107856

Bioremediation using microorganisms is a promising technique to remediate soil contaminated with heavy metals. In this study, Sporosarcina pasteurii (S. pasteurii) bioremediation by mixing method was used to remediate soils contaminated with lead (Pb), zinc (Zn) and cadmium (Cd). A

significant reduction of heavy metal leaching concentrations was observed in S. pasteurii bio-treated samples. Furthermore, urease hydrolyzing bacteria have additional advantages of accelerating metal precipitation by increasing pH. The soluble-exchangeable Pb, Zn and Cd was reduced by 33.3 % ~ 85.9 %, 21.4 % ~ 66.0 %, 13.6 % ~ 29.9 % respectively after bioremediation. The primary objective of metal stabilization was achieved by reducing the bioavailability through immobilizing the Pb, Zn and Cd in the urease-driven carbonate precipitation. Luminescent bacteria toxicity experiments revealed that the metal toxicity of contaminated soil was reduced after bioremediation using S. pasteurii. When subjected to severe environmental conditions, S. pasteurii bioremediation was superior to chemical precipitation technology in terms of long-term stability.

Keywords: Microbial mineralization, Heavy metals, Carbonate precipitation

E.Morillo, F.Madrid, A.Lara-Moreno, J.Villaverde (Institute of Natural Resources and Agrobiology of Seville (IRNAS-CSIC), Av. Reina Mercedes, 10, Sevilla E-41012, Spain) **Soil bioremediation by cyclodextrins. A review, International Journal of Pharmaceutics (2020) 119943**

Remediation of soils contaminated by organic pollutants has become an urgent necessity worldwide. A wide variety of techniques have been developed but many of them are associated with drawbacks (complexity, high costs, environmental risks, etc.). Bioremediation, the use of living organisms to remediate polluted sites, is an alternative approach considered a cost-effective and more environmentally friendly technique, but the low bioavailability of the organic pollutants in soils is its main limitation. Cyclodextrins have been proposed as a greener alternative to organic solvents or synthetic surfactants for increasing organics bioavailability in soils. Cyclodextrins can form inclusion complexes with hydrophobic pollutants increasing their aqueous solubility and enhancing their bioremediation in soils. This review gives an overview on the use of cyclodextrins for this purpose, highlighting the advantages and disadvantages and perspectives of this technology for future research. The effect of those cyclodextrins more commonly used is analyzed, particularly hydroxypropyl-β-cyclodextrin (HPBCD) and randomly methylated-β-cyclodextrin (RAMEB), as well as some of the more common contaminants treated (almost 80% are industrial chemicals and the rest are pesticides) and the bioremediation strategies used (by microorganisms and/or phytoremediation). The review also provides a critical view on knowledge gaps and limitations of this technology which must be overcome to bring it for field-scale application.

Keywords: Bioremediation, Organic pollutants, Soil contamination, Cyclodextrins, Bioavailability

Qiqian Li[abc], Jibing Li[a], Longfei Jiang[a], Yingtao Sun[a], Chunling Luo[ad], Gan Zhang[a] (a. State Key Laboratory of Organic Geochemistry and Guangdong-Hong Kong-Macao Joint Laboratory for Environmental Pollution and Control, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou, 510640, China, b. College of Chemical and Biological Engineering, Hechi University, Yizhou, 546300, China, c. University of Chinese Academy of Sciences, Beijing, 100039, China, d. College of Natural Resources and Environment, South China Agricultural University, Guangzhou, 510642, China)**Diversity and structure of phenanthrene degrading bacterial communities**

associated with fungal bioremediation in petroleum contaminated soil, Journal of Hazardous Materials (2021) 123895

Fungal bioremediation is a promising technique for the cleanup of sites contaminated with polycyclic aromatic hydrocarbons (PAHs). However, due to limited understanding of the composition and dynamics of the native PAH-degrading microorganisms in contaminated sites, its application has been difficult. In the present study, DNA stable-isotope probing was performed to identify indigenous phenanthrene (PHE)-degrading bacteria and determine their diversity during the fungal bioremediation process. The results showed a total of 14 operational taxonomic units (OTUs) enriched in the heavy DNA fractions, which were related to seven genera (Sphingomonas, Sphingobacterium, Acidovorax, Massilia, Flavobacterium, Cupriavidus, Aeromicrobium, and unclassified Chitinophagaceae). Along with enhanced efficiency of PHE removal, the number and diversity of indigenous PHE-degrading bacteria in soil bioaugmented with fungi were significantly increased. Furthermore, based on the results of linear model analysis, we found that PHE degraders affiliated with the genus Sphingomonas were significantly enriched during fungal bioremediation. Moreover, fungal bioaugmentation promoted indigenous functional Proteobacteria involved in PAH degradation through co-metabolism, suggesting that PAH biodegradation was attributable to cooperative metabolism by fungi and indigenous bacteria. Our findings provide new insights into the diversity of PHE-degrading communities and support a more comprehensive view of the fungal bioremediation process.

Keywords: Stable-isotope probing, Fungal bioremediation, Phenanthrene (PHE) degradation, Sphingomonas

Gokhan Onder Erguven[a], Ulas Demirci[b] (a. Munzur University, Tunceli Vocational School, Department of Chemistry and Chemical Process Technologies, Laboratory Technology Pr, Tunceli, Turkey, b. Munzur University, Institude of Science, Department of Environmental Engineering, Tunceli, Turkey) Using Ochrobactrum thiophenivorans and Sphingomonas melonis for bioremediation of Imidacloprid, Environmental Technology & Innovation (2020) 101236

To solve the environmental problems of the pesticides, bioremediation methods are commonly useful for their environment friendly properties. These methods are more cheap, useful and have more advantages for remediate receiving environments In this study, imidacloprid which is one of the selective insecticide in all over the world is chosenfor bioremediation studies with two soil bacteria. The imidacloprid used in the Mediterranean climate for cotton, pistachios, tomatoes, peppers and eggplant cultivation. The bioremediation of this insecticide was investigated via the performance of O.thiophenivorans and S. melonis in agitated culture media. The agricultural soil used for the isolation of these two bacteria was taken from the cotton cultivated agricultural area in Adana province in Turkey. For this purpose, the isolated and enriched bacteria were added to the recommended insecticide concentrations, and the Imidacloprid active material, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD5), Total Organic Carbon (TOC), pH and dissolved oxygen (DO) parameters were determined for two weeks on each day of the study. O. thiophenivorens and S. melonis bioremediate the Imidacloprid insecticide with high efficiency (over 90%). According to these results, it is understood that these bacteria can be

preferred in the bioremediation of receiving environments that are contaminated with such pesticides and can be useful for scientists to handle the opposite effects of such persistent organic pollutants and COD, BOD5 and TOC parameters can easily give opinions about decreasing of pesticides like the active materials

Keywords: Imidacloprid, Ochrobactrum thiophenivorans, Sphingomonas melonis, Bioremediation, Active material

Hao Li[ac], Jie Li[b], Qiang Wan[a], Mengdong Wang[a], Jiayi Zhao[a], Huan Li[a], Weiwei Sun[a], Baoliang Pan[a] (a. College of Veterinary Medicine, China Agricultural University, No. 2 Yuan Ming Yuan West Road, Hai Dian District, Beijing 100094, China, b. Sino-Norway Joint Lab on Fish Gut Microbiota, Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China, c. Lab of Hi-Tech Processing for Sericultural Resources, School of Biotechnology, Jiangsu University of Science and Technology, Zhenjiang 212018, China) **Bioremediation mechanism of Monensin contaminated chicken manure by a combination of housefly larvae and Stenotrophomonas sp. DM-2, Environmental Technology & Innovation, Volume 21(2021) 101269**

There is an urgent need to find efficient methods to remediate polluted manure by ionophore antibiotics (IPAs). In the present study, we tried a novel bioremediation strategy for monensin (MON, one of IPAs) contaminated chicken manure through a combined bioaugmentation-vermicomposting approach with housefly larvae and MON-degrading bacteria. Under aerobic conditions, 31.37% of MON was degraded over 12 days through bioaugmentation using only Stenotrophomonas sp. DM-2, while the degradation rate of MON was 88.15% under the combined action of the larvae and Stenotrophomonas sp. DM-2. It was found that housefly larvae activity could change the pH and temperature of chicken manure and then reshaped the microbial community structure of chicken manure substrates. This activity of larvae enhanced the abundance of MON-degrading bacterial genera (Stenotrophomonas and Alcaligenes), making the genera Pseudogracilibacillus, Pseudomonas, Oligella, and Stenotrophomonas dominant after a 12-day bioremediation period, which contributed to the marked reduction of MON in manure. A novel potential degradation pathway of MON in chicken manure was also speculated based on the identification and characterization from LC-QToF/MS spectral data of two new MON metabolic intermediates. The present study provided a novel efficient method to remediate IPAs contaminated manure and provide new insights into the microbial molecular ecological mechanisms for bioremediation of MON contaminated chicken manure.

Keywords: Monensin, Chicken manure, Bioaugmentation, Remediation, Housefly larvae, Metabolites

Biotransformation

David M.Kennes-Veiga[a], Lorena Gonzalez-Gil[b], Marta Carballa[a], Juan M.Lema[a](a. CRETUS Institute, Department of Chemical Engineering, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Galicia, Spain, b. Defence University Centre, Spanish Naval Academy, Plaza de España, 36920 Marín, Spain) **The organic loading rate affects organic micropollutants' cometabolic biotransformation kinetics under heterotrophic conditions in activated sludge, Water Research, Volume 189(2021) 116587**

Several studies have shown that organic micropollutants (OMPs) are biotransformed cometabolically in activated sludge systems. However, the individual role of heterotrophs in the microbial consortium is still not clear, i.e., there is still a gap regarding the influence of the heterotrophic activity on the cometabolic biotransformation kinetics and yield of the OMPs. Aiming to answer these questions, experiments with increasing primary substrate concentrations were performed under aerobic heterotrophic conditions in a continuous stirred tank reactor operated at several organic loading rates (OLR) with fixed hydraulic retention time. Moreover, the individual kinetic parameters were determined in batch assays with different initial substrate concentrations using the sludges from the continuous reactor. A set of 15 OMPs displaying a variety of physicochemical properties were spiked to the feeding in the ng L−1 - µg L−1 range. Results reveal that the biodegradation of the primary carbon source and the biotransformation of the OMPs occur simultaneously, in clear evidence of cometabolic behavior. Moreover, we conclude that the OMPs biotransformation kinetic constant (kbiol) shows a linear dependence with the OLR of the primary substrate for most of the compounds studied, suggesting that the heterotrophic activity seriously affects the OMPs biotransformation kinetics. However, under typical activated sludge systems operating conditions (hydraulic retention times above 8 h), their biotransformation yield would not be significantly affected.

Keywords: Biotransformation kinetic constant, Heterotrophs, Pharmaceuticals, Wastewater treatment plant, Yield

Leslie J.Saunders[a], Patrick N.Fitzsimmons[b], John W.Nichols[b], Frank A.P.C.Gobas[ac] (a. Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, Canada, b. United States Environmental Protection Agency, Duluth, MN, USA, c. School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada) **In vitro-in vivo extrapolation of hepatic and gastrointestinal biotransformation rates of hydrophobic chemicals in rainbow trout, Aquatic Toxicology, Volume 228 (2020), 105629**

Hepatic in vitro biotransformation assays, in combination with in vitro-in vivo extrapolation (IVIVE) and bioaccumulation modeling, can be used to support regulatory bioaccumulation assessments. In most applications, however, these methods ignore the possibility of extrahepatic metabolism. Here we evaluated intestinal biotransformation in rainbow trout using S9 fractions prepared from the upper intestinal (GIT) epithelium. Measured levels of activity determined using standard substrates for phase I and phase II biotransformation enzymes were within 2-fold of activities measured in hepatic S9 fractions. In vitro intrinsic clearance rates for 2-ethylhexyl-4-methoxycinnamate (EHMC; an organic sunscreen agent) and two polycyclic aromatic hydrocarbons (pyrene [PYR] and benzo(a)pyrene [BAP]) were significantly higher in liver S9 fractions than in GIT S9 fractions. For octocrylene (OCT; a second sunscreen agent), however, in vitro intrinsic clearance rates were higher in GIT S9 fractions compared to liver S9 fractions. An existing 'liver only' IVIVE model was expanded to consider biotransformation in both the liver and GIT. Relevant IVIVE scaling factors were developed by morphological, histological, and biochemical evaluation of trout intestines. For chemicals biotransformed at higher rates by hepatic S9 fractions (i.e., BAP, PYR, EHMC), the 'liver & GIT' model yielded whole-body biotransformation rate constants (kMET) that were within 1.2 to 1.4-fold of those estimated using the 'liver only' model. In contrast to these findings, the mean kMET for OCT obtained

using the ‘liver & GIT’ model was 3.3 times higher than the mean kMET derived using the ‘liver only’ model and was in good agreement with empirical kMET estimates determined previously for trout (<20 % difference). The results of this study suggest that current ‘liver only’ IVIVE approaches may underestimate in vivo biotransformation rates for chemicals that undergo substantial biotransformation in the GIT.

Keywords: Bioaccumulation, Biotransformation, Animal alternatives, In vitro-in vivo extrapolation, Intestinal metabolism, Rainbow trout

Wenping Zhang[ab], Shimei Pang[ab], Ziqiu Lin[ab], Sandhya Mishra[ab], Pankaj Bhatt[ab], Shaohua Chen[ab] (a. State Key Laboratory for Conservation and Utilization of Subtropical Agro-bioresources, Guangdong Province Key Laboratory of Microbial Signals and Disease Control, Integrative Microbiology Research Centre, South China Agricultural University, Guangzhou, 510642, China, b. Guangdong Laboratory for Lingnan Modern Agriculture, Guangzhou, 510642, China) **Biotransformation of perfluoroalkyl acid precursors from various environmental systems: advances and perspectives, Environmental Pollution (2020), 115908**

Perfluoroalkyl acids (PFAAs) are widely used in industrial production and daily life because of their unique physicochemical properties, such as their hydrophobicity, oleophobicity, surface activity, and thermal stability. Perfluorosulfonic acids (PFSAs) and perfluorocarboxylic acids (PFCAs) are the most studied PFAAs due to their global occurrence. PFAAs are environmentally persistent, toxic, and the long-chain homologs are also bioaccumulative. Exposure to PFAAs may arise directly from emission or indirectly via the environmental release and degradation of PFAA precursors. Precursors themselves or their conversion intermediates can present deleterious effects, including hepatotoxicity, reproductive toxicity, developmental toxicity, and genetic toxicity. Therefore, exposure to PFAA precursors constitutes a potential hazard for environmental contamination. In order to comprehensively evaluate the environmental fate and effects of PFAA precursors and their connection with PFSAs and PFCAs, we review environmental biodegradability studies carried out with microbial strains, activated sludge, plants, and earthworms over the past decade. In particular, we review perfluorooctyl-sulfonamide-based precursors, including perfluroooctane sulfonamide (FOSA) and its N-ethyl derivative (EtFOSA), N-ethyl perfluorooctane sulfonamido ethanol (EtFOSE), and EtFOSE-based phosphate diester (DiSAmPAP). Fluorotelomerization-based precursors are also reviewed, including fluorotelomer alcohols (FTOH), fluorotelomer sulfonates (FTSA), and a suite of their transformation products. Though limited information is currently available on zwitterionic PFAS precursors, a preliminary review of data available for 6:2 fluorotelomer sulfonamide betaine (FTAB) was also conducted. Furthermore, we update and refine the recent knowledge on biotransformation strategies with a focus on metabolic pathways and mechanisms involved in the biotransformation of PFAA precursors. The biotransformation of PFAA precursors mainly involves the cleavage of carbon-fluorine (C–F) bonds and the degradation of non-fluorinated functional groups via oxidation, dealkylation, and defluorination to form shorter-chained PFAAs. Based on the existing research, the current problems and future research directions on the biotransformation of PFAA precursors are proposed.

Keywords: Perfluoroalkyl acid precursors, Toxicity, Biotransformation, Degradation pathways, Bioremediation

Rimana Islam Papry[a], Shogo Fujisawa[a], Yinghan Zai[a], Okviyoandra Akhyar[ab], Asami Suzuki Mashio[c], Hiroshi Hasegawa[c] (a. Graduate School of Natural Science and Technology, Kanazawa University, Kakuma, Kanazawa, 920-1192, Japan, b. Department of Chemistry Education, Islamic University of Kalimantan Muhammad Arsyad Al Banjari, Jl. Adhyaksa No. 2 Kayu Tangi, Banjarmasin, 70123, Indonesia, c. Institute of Science and Engineering, Kanazawa University, Kakuma, Kanazawa, 920-1192, Japan) **Freshwater phytoplankton: Salinity stress on arsenic biotransformation, Environmental Pollution (2020), 116090**

Salinity stress affects aquatic microalgal growth and their physiological responses have been studied extensively. However, arsenic (As) accumulation and biotransformation by freshwater phytoplankton under a salinity gradient have never been addressed. This study reports a distinctive pattern of As uptake, accumulation, and biotransformation by four axenic freshwater phytoplankton species, i.e., Scenedesmus acutus, Closterium aciculare, Staurastrum paradoxum, and Pediastrum duplex. Phytoplankton cells were incubated in sterilised C medium modified with varying salinity levels (0–5‰) in association with arsenate and phosphate concentrations. The biotransformation of arsenate (i.e., As(V)) to arsenite (As(III)) and to further methylated species decreased with increasing salinity in the culture medium whereas As accumulation increased. Among the four strains, only S. acutus and S. paradoxum converted As(V) to As(III), with no detected methylated species. In contrast, C. aciculare and P. duplex biotransformed As(V) to As(III) and further to methyl arsenic species, such as DMAA. S. acutus and S. paradoxum exhibited higher accumulation tendency than the other two species. S. paradoxum showed the lowest As reduction rate (i.e., As(V) to As(III)) compared to other species, although, without significant variations. The morphological changes were observed in phytoplankton cells in response to increased salinity stress. Moreover, As(V) concentrations in the culture medium significantly decreased by day 7–14. Thus, this study presents a conceptual model of the As biotransformation pattern by axenic freshwater phytoplankton.

Keywords: Freshwater phytoplankton, Arsenic biotransformation, Salinity stress, Toxicity

Rui Tang[ab], Yulan Wang[a], Shoujun Yuan[a], Wei Wang[ad], Zhengbo Yue[b], Xinmin Zhan[c], Zhen-Hu Hu[ad](a. School of Civil Engineering, Hefei University of Technology, Hefei 230009, China, b. School of Resources and Environmental Engineering, Hefei University of Technology, Hefei 230009, China, c. Civil Engineering, College of Engineering and Informatics, National University of Ireland, Galway, Ireland, d. Anhui Provincial Engineering Laboratory for Rural Water Environment and Resources, Hefei University of Technology, Hefei 230009, China) **Organoarsenic feed additives in biological wastewater treatment processes: Removal, biotransformation, and associated impacts, Journal of Hazardous Materials (2020) 124789**

Aromatic organoarsenicals are widely used in animal feeding operations and cause arsenic contamination on livestock wastewater and manure, thereby raising the risk of surface water pollution. Biological wastewater treatment processes are often used for livestock wastewater treatment. Organoarsenic removal and biotransformation under aerobic and anaerobic conditions, and the associated impacts have received extensive attention due to the potential threat to water security. The removal efficiency and biotransformation of organoarsenicals in

biological treatment processes are reviewed. The underlying mechanisms are discussed in terms of functional microorganisms and genes. The impacts associated with organoarsenicals and their degradation products on microbial activity and performance of bioreactors are also documented. Based on the current research advancement, knowledge gaps and potential research in this field are discussed. Overall, this work delivers a comprehensive understanding on organoarsenic behaviors in biological wastewater treatment processes, and provides valuable information on the control of arsenic contamination from the degradation of organoarsenicals in biological wastewater treatment processes.

Keywords: Organoarsenic, arsenic, biotransformation, livestock wastewater, biological wastewater treatment process

Laura Peeters[a], Philippe Vervliet[b], Kenn Foubert[a], Nina Hermans[a], Luc Pieters[a], Adrian Covaci[b](a. Natural Products & Food Research and Analysis (NatuRA), Department of Pharmaceutical Sciences, University of Antwerp, Universiteitsplein 1, 2610, Antwerp, Wilrijk, Belgium, b. Toxicological Centre, Department of Pharmaceutical Sciences, University of Antwerp, Universiteitsplein 1, 2610, Antwerp, Wilrijk, Belgium) **A comparative study on the in vitro biotransformation of medicagenic acid using human liver microsomes and S9 fractions, Chemico-Biological Interactions Volume 328(2020) 109192**

Many natural products are prodrugs which are biotransformed and activated after oral administration. The investigation of gastrointestinal and hepatic biotransformation can be facilitated by in vitro screening methods. This study compares two widely used in vitro models for hepatic biotransformation: 1) human S9 fractions and 2) human liver microsomes and cytosolic fractions in a two-step sequence, with the purpose of identifying differences in the biotransformation of medicagenic acid, the putative precursor of active metabolites, responsible for the medicinal effects of the herb Herniaria hirsuta. The combination of liquid chromatography coupled to high-resolution mass spectrometry with subsequent suspect and non-target data analysis allowed the identification of thirteen biotransformation products, four of which are reported here for the first time. Eight biotransformation products resulting from oxidative Phase I reactions were identified. Phase II conjugation reactions resulted in the formation of three glucuronidated and two sulfated biotransformation products.
No major differences could be observed between incubations with human liver S9 or when utilizing human microsomal and cytosolic fractions. Apart from two metabolites, both methods rendered the same qualitative metabolic profile, with minor quantitative differences. As a result, both protocols applied in this study can be used to study in vitro human liver biotransformation reactions.

Keywords: In vitro liver biotransformation, Medicagenic acid, Non-target screening, Human liver microsomes, Human liver S9

Te-Sheng Chang[1], Tzi-Yuan Wang[2], Chien-Min Chiang[3], Yu-Ju Lin[1], Hui-Lien Chen[1], Yu-Wei Wu45, Huei-Ju Ting[1], Jiumn-Yih Wu[6] (1. Department of Biological Sciences and Technology, National University of Tainan, Tainan 700, Taiwan,2 . Biodiversity Research Center, Academia Sinica, Taipei 115, Taiwan, 3. Department of Biotechnology, Chia Nan University of Pharmacy and Science, No. 60, Sec. 1, Erh-Jen Rd., Jen-Te District, Tainan 717, Taiwan, 4. Graduate Institute of Biomedical Informatics, College of Medical Science and Technology, Taipei Medical University, Taipei 106, Taiwan, 5. Clinical Big Data

Research Center, Taipei Medical University Hospital, Taipei 110, Taiwan, 6. Department of Food Science, National Quemoy University, Kinmen County 892, Taiwan) Biotransformation of celastrol to a novel, well-soluble, low-toxic and anti-oxidative celastrol-29-O-β-glucoside by Bacillus glycosyltransferases, Journal of Bioscience and Bioengineering (2020) 09.017

Celastrol is a quinone-methide triterpenoid isolated from the root extracts of Tripterygium wilfordii (Thunder god vine). Although celastrol possesses multiple bioactivities, the potent toxicity and rare solubility in water hinder its clinical application. Biotransformation of celastrol using either whole cells or purified enzymes to form less toxic and more soluble derivatives has been proven difficult due to its potent antibiotic and enzyme-conjugation property. The present study evaluated biotransformation of celastrol by four glycosyltransferases from Bacillus species and found one glycosyltransferase (BsGT110) from Bacillus subtilis with significant activity toward celastrol. The biotransformation metabolite was purified and identified as celastrol-29-O-β-glucoside by mass and nuclear magnetic resonance spectroscopy. Celastrol-29-O-β-glucoside showed over 53-fold higher water solubility than celastrol, while maintained 50% of the free radical scavenging activity of celastrol. When using zebrafish as the in vivo animal model, celastrol-29-O-β-glucoside exhibited 50-fold less toxicity than celastrol. To our knowledge, the present study is not only the first report describing the biotransformation of celastrol, but also the first one detailing a new compound, celastrol-29-O-β-glucoside, that is generated in the biotransformation process. Moreover, celastrol-29-O-β-glucoside may serve as a potential candidate in the future medicine application due to its higher water solubility and lower toxicity.

Keywords: Celastrol, Glycosyltransferase, Bacillus, Triterpenoid, Biotransformation

Shaofeng Rong, Xinhui Guan, Qianqian Li, Shimin Guan, Baoguo Cai, Shuo Zhang (Department of Biological Engineering, Shanghai Institute of Technology, No.100 Haiquan Road, Fengxian District, Shanghai 201418, PR China) Biotransformation of 12-hydroxystearic acid to gamma-decalactone: Comparison of two separation systems, Journal of Microbiological Methods, Volume 178(2020) 106041

Biotransformation of natural products to the natural flavoring, gamma-decalactone (GDL), has attracted considerable attention. However, improving its yield is challenging due to its high feedback inhibition of yeast cells, which lowers the productivity of the biotransformation process. In this study, we compared two in situ separation processes established by adding either resin (HZ-816) or cyclopentasiloxane (DC345) to a biotransformation medium and investigated their efficiency and effect on yeast metabolism. Compared with a control, yields from the medium with HZ-816 and DC345 increased by 140% and 175%, respectively. However, after 84 h of biotransformation, the protein leakage in the medium with HZ-816 and DC345 was respectively 2.04 times and 1.43 times that of the control. Meanwhile, the mortality of yeast cells was 32.8% and 24.0% in the medium with HZ-816 and DC345, respectively, whereas that in the control was 20.1%. Our findings indicate that a cyclase is involved in the final step of the biotransformation. The activity of the yeast cyclase in the DC345 system was 3.33 times greater than that in the HZ-816 system. The DC345 system was superior to the HZ-816 resin system in this separation process because its yield was 30.8% greater and it had less cellular damage. Thus,

we showed that the DC345 system has potential as a new separation system for the production of GDL by biotransformation.

Keywords: Materials and microorganisms, Biotransformation

Biomarker

Lorenzo Gaetani[12], Federico Paolini Paoletti[12], Giovanni Bellomo[1], Andrea Mancini[1], Simone Simoni[1], Massimiliano Di Filippo[1], Lucilla Parnetti[1](1. Section of Neurology, Department of Medicine, University of Perugia, Perugia, Italy) CSF and Blood Biomarkers in Neuroinflammatory and Neurodegenerative Diseases: Implications for Treatment, Trends in Pharmacological Sciences, Volume 41(2020) Pages 1023-1037

Neuroinflammatory and neurodegenerative diseases are characterized by the interplay of a number of molecular pathways that can be assessed through biofluids, especially cerebrospinal fluid and blood. Accordingly, the definition and classification of these disorders will move from clinical and pathological to biological criteria. The consequences of this biomarker-based diagnostic and prognostic approach are highly relevant to the field of drug development. Indeed, in view of the availability of disease-modifying drugs, fluid biomarkers offer a unique opportunity for improving the quality and applicability of results from clinical trials. Herein, we discuss the benefits of using fluid biomarkers for patient stratification, target engagement, and outcome assessment, as well as the most recent developments in neuroinflammatory and neurodegenerative diseases.

Keywords: biomarkers, cerebrospinal fluid, neuroinflammation, neurodegenerative, therapeutics

Ryan H.Kirkpatrick[ab], Douglas P.Munoz[abcd], Sarosh Khalid-Khan[abde], Linda Booij[dfgh] (a. Centre for Neuroscience Studies, Queen's University, Kingston, Canada, b. School of Medicine, Queen's University, Kingston, Canada, c. Department of Biomedical and Molecular Sciences, Queen's University, Kingston, Canada, d. Department of Psychology, Queen's University, Kingston, Canada, e. Department of Psychiatry, Queen's University, Kingston, Canada, f. Department of Psychology, Concordia University, Montréal, Canada, g. CHU Sainte-Justine Hospital, University of Montréal, Montréal, Canada, h. Department of Psychiatry, McGill University, Montréal, Canada) Methodological and clinical challenges associated with biomarkers for psychiatric disease: A scoping review, Journal of Psychiatric Research, (2020) 11.023

Over the past decade, psychiatric research has been on an important hunt for biomarkers of psychiatric disease. In psychiatry, the term “biomarker” is a broad umbrella term used to identify any biological variable that can be objectively measured and applied to a diagnosis; this includes genetic and epigenetic assessments, hormone levels, measures of neuro-anatomy and many other scientific modalities. However, despite hundreds of studies on the topic being published yearly and other medical specialties having success in discovering biomarkers, clinical psychiatric practice has not had the same success. This paper aims to consolidate the many opinions on the search for psychiatric biomarkers to suggest key methodological and clinical challenges that psychiatric biomarker research faces. Psychiatry as a specialty has many fundamental differences compared to other medical specialties in methods of diagnosing, underlying etiology and disease pathologies that may be limiting the success of biomarker research in itself and puts strict requirements on the research being conducted. The academic and clinical environment in

which the research is being conducted also heavily influences the translation of the findings. Finally, once biomarkers are identified, more often than not they are inapplicable to clinical settings, unable to integrate into clinical practice and fail to outperform current diagnostic practices and guidelines. We also make six recommendations for more promising future research in psychiatric biomarkers.

Keywords: Psychiatry, Biomarker, Translational research, mental health, Genetics, Brain-imaging

Omar Cruz-Santiago[a], Iván Nelinho Pérez-Maldonado[b], Donaji JosefinaGonzález-Mille[c], Guillermo Espinosa-Reyes[b], Ángeles Martínez-Toledo[b], César Arturo Ilizaliturri-Hernández[b] (a. Programa Multidisciplinario de Posgrado en Ciencias Ambientales (PMPCA), Agenda Ambiental, Universidad Autónoma de San Luis Potosí, Av. Manuel Nava 201, Zona Universitaria, 78210, San Luis Potosí, Mexico, b. Centro de Investigación Aplicada en Ambiente y Salud (CIAAS), CIACyT – Facultad de Medicina, Universidad Autónoma de San Luis Potosí, Sierra Leona 550, Lomas 2ª. Sección, 78210, San Luis Potosí, Mexico, c. Cátedras Consejo Nacional de Ciencia y Tecnología (CONACYT), Universidad Autónoma de San Luis Potosí, Sierra Leona 550, Lomas 2ª. Sección, 78210, San Luis Potosí, Mexico) **Nondestructive biomarkers in giant toad (Rhinella marina) to assess the effect of complex mixture of pollutants in Coatzacoalcos River, Mexico, Environmental Toxicology and Pharmacology, (2020) 103558**

In this study, we evaluated the usefulness of nondestructive biomarkers approach in giant toads (Rhinella marina). We obtained blood samples and the residual condition index of toads from rural and industrial zones from Coatzacoalcos River, Mexico (COA). In the blood samples, we determined the activity of enzymes, lipid peroxidation, and the presence of cell death (apoptosis). We found that the activity of the enzyme delta-aminolevulinic dehydratase was lower. Still, the glutathione s-transferase activity and the percentage of apoptosis in erythrocytes were higher in the toads of COA than laboratory toads. Meanwhile, some biomarkers in toads showed differences when compared between Industrial and Rural zones. These results and correlations between biomarkers showed how the response changed in the toads living near the industrial zones. We demonstrate that a nondestructive biomarkers approach can be useful in environmental studies with anuran amphibians.

Keywords: Amphibian, biomonitoring, ecotoxicology, multiple biomarkers, pollution

Monika I.Roydeva[a], Antje A.T.S.Reinders[b] (a. Department of Psychosis Studies, Institute of Psychiatry, King's College London, London, UK, b. Centre for Affective Disorders, Department of Psychological Medicine, Institute of Psychiatry, Psychology & Neuroscience, King's College London, United Kingdom) **Biomarkers of Pathological Dissociation: A Systematic Review, Neuroscience & Biobehavioral Reviews, (2020) 11.019**

Pathological dissociation is a severe, debilitating and transdiagnostic psychiatric symptom. This review identifies biomarkers of pathological dissociation in a transdiagnostic manner to recommend the most promising research and treatment pathways in support of the precision medicine framework. A total of 205 unique studies that met inclusion criteria were included.

Studies were divided into four biomarker categories, namely neuroimaging, psychobiological, psychophysiological, and genetic biomarkers. The dorsomedial and dorsolateral prefrontal cortex, bilateral superior frontal regions, (anterior) cingulate, posterior association areas, and basal ganglia were identified as neurofunctional biomarkers of pathological dissociation and decreased hippocampal, basal ganglia, and thalamic volumes as neurostructural biomarkers. Increased oxytocin and prolactin and decreased tumor necrosis factor alpha (TNF-α) were identified as psychobiological markers. Psychophysiological biomarkers, including blood pressure, heart rate and skin conductance, were inconclusive. For the genetic biomarker category studies related to dissociation were limited and no clear directionality of effect was found to warrant identification of a genetic biomarker. Recommendations for future research pathways and possible clinical applicability are provided.

Keywords: dissociation, biomarker, precision medicine, transdiagnostic, neuroimaging, psychobiology, psychophysiology, genetics, brain, human

Yuqing Wang[ac], Tengteng Shao[ac], Jialin Wang[ac], Xiaoting Huang[ac], Xiaofei Deng[a], Yemin Cao[a], Mingmei Zhou[ab], Cheng Zhao[a] (a. Shanghai Traditional Chinese Medicine Integrated Hospital, Shanghai University of Traditional Chinese Medicine, Shanghai, 200082, China, b. Center for Chinese Medicine Therapy and Systems Biology, Institute for Interdisciplinary Medicine Sciences, Shanghai University of Traditional Chinese Medicine, Shanghai, 201203, China, c. Graduate School, Shanghai University of Traditional Chinese Medicine, Shanghai, 201203, China) **An update on potential biomarkers for diagnosing diabetic foot ulcer at early stage, Biomedicine & Pharmacotherapy, (2021) 110991**

As one of major chronic complications of diabetes, diabetic foot ulcer (DFU) is the main cause of disability and death. The clinical diagnosis and prognosis of DFU is inadequate. For clinicians, if the risk stratification of DFU can be obtained earlier in diabetic patients, the hospitalization, disability and mortality rate will be reduced.
In addition to the inflammatory biomarkers that have been widely concerned and used, e.g., procalcitonin, pentraxin-3, C-reactive protein (CRP), interleukins (ILs), and tumor necrosis factor-α (TNF-α), etc., a more comprehensive prediction of the risk and severity of DFU is needed to reflect new biomarkers for therapeutic intervention effects. Along with the development of systems biology technology, genomics, proteomics, metabolomics and microbiome have been used in the studies on DFU for better understanding of the disease. In this review, new biomarkers that are expected to assist in the accurate diagnosis and risk stratification of DFU will be discussed and summarized in detail.

Keywords: Diabetic foot ulcer (DFU), Diabetes mellitus, Biomarkers, Diabetic complications, Inflammatory biomarkers, Systems biology

Bizhong Ch[ea], Zhengbao Zhu[ab], Xiaoqing Bu[ac], Jieyun Yin[a], Liyuan Han[d], Tan Xu[a], Zhong Ju[e], Jiale Liuf, Jintao Zhang[g], Jing Chen[bh], Jiang He[bh], Yonghong Zhang[a], Chongke Zhong[a] (a. Department of Epidemiology, School of Public Health and Jiangsu Key Laboratory of Preventive and Translational Medicine for Geriatric Diseases, Medical College of Soochow University, 199 Renai Road, Industrial Park District, Suzhou, Jiangsu Province, 215123, China, b. Department of Epidemiology, Tulane University School of Public Health and Tropical Medicine, New Orleans, LA, USA, c. Department of Epidemiology, School of Public Health, Chongqing Medical University, Chongqing, China,

d. Department of Global Health, Ningbo Institute of Life and Health Industry, University of Chinese Academy of Sciences, Ningbo, Zhejiang, PR China, e. Department of Neurology, Kerqin District First People's Hospital of Tongliao City, Inner Mongolia, China, f. Department of Neurology, Jilin Central Hospital, Jilin, China, g. Department of Neurology, the 88th Hospital of PLA, Taian, Shandong, China, h. Department of Medicine, Tulane University School of Medicine, New Orleans, LA, USA) **Multiple biomarkers covering several pathways for the prediction of depression after ischemic stroke, Journal of Affective Disorders, (2021) Pages 442-449**

Background
To assess the potential incremental utility of multiple biomarkers reflecting several pathological pathways for the risk prediction of depression after stroke.
Methods
We used data from the China Antihypertensive Trial in Acute Ischemic Stroke, and a panel of 13 circulating biomarkers were measured. The study outcome was depression (24-item Hamilton Depression Rating Scale score≥8) at 3 months after ischemic stroke. Logistic regression models were performed to evaluate the risk of depression associated with multiple biomarkers. Discrimination and risk reclassification for depression were analyzed.
Results
Among 631 included ischemic stroke patients, elevated growth differentiation factor-15, anticardiolipin antibodies, antiphosphatidylserine antibodies and matrix metalloproteinase-9 were individually associated with increased risks of depression after stroke. The multiple biomarker analysis showed a clear gradient in the risk of depression with increasing numbers of elevated biomarkers, and multivariate adjusted odds ratio (95% confidence interval) of patients with 4 elevated biomarkers was 6.52 (2.24-18.95) compared with those without elevation in any of 4 biomarkers. The simultaneous inclusion of all 4 biomarkers to the conventional model significantly improved discrimination (C statistic increased from 0.702 to 0.748, P=0.004) and risk reclassification (net reclassification improvement 45.0%; integrated discrimination improvement 6.2%; both P<0.001) for depression after stroke.
Limitations
We selected biomarkers that had previously been reported to be promising predictors of depression after stroke, while other novel biomarkers not tested might have additional predictive value.
Conclusions
Simultaneously adding multiple biomarkers from several pathophysiological pathways to traditional risk factors provided substantial incremental utility of the risk stratification for depression after stroke.

Keywords: Multiple biomarkers, Risk prediction, Depression, Acute ischemic stroke

Leila Jafarzadeh[a], Mohammad Khakpoor-Koosheh[a], Hamed Mirzaei[b], Hamid RezaMirzaei[a] (a. Department of Medical Immunology, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran, b. Research Center for Biochemistry and Nutrition in Metabolic Diseases, Institute for Basic Sciences, Kashan University of Medical Sciences, Kashan, Iran) **Biomarkers for predicting the outcome of various cancer immunotherapies, Critical Reviews in Oncology/Hematology (2021) 103161**

Cancer immunotherapy has appeared as a well-known therapeutic modality for different cancers. Yet, only a subset of patients derives clinical benefit. It is thus critical to understand the determinants driving response, resistance and adverse effects.Predictive biomarkers in different modalities of cancer immunotherapy offer novel information about the effect of a therapeutic intervention. These biomarkers and their patterns may not only operate similarly across different tumor types that are amenable to these therapies but also assist to identify patients who will benefit from the treatment and subsequently leading to tailored immunotherapy with the wider-successfully-targeted patient population. In this review, we will outline a variety of predictive biomarkers in various cancer immunotherapies and their clinical utility. It is anticipated that the incorporation of biomarker studies in the clinical practice will help optimize therapeutic decision making and realize the potential clinical benefit of biomarker-guided therapy.

Keywords: Predictive biomarkers, Cancer immunotherapy, Clinical outcome, CAR T cell therapy, NK cell therapy, Check point inhibitors, Cancer vaccine

Devon Gorry[a], Sita Nataraj Slavov[b] (a. Department of Economics, Clemson University, Clemson, SC 29634, United States, b. Schar School of Policy and Government, George Mason University, Arlington, VA 22201, United States) **The effect of retirement on health biomarkers, Economics & Human Biology (2021) 100949**

We utilize panel data from the English Longitudinal Study of Ageing to investigate the impact of retirement on objective health measures. In contrast to many previous studies, which focus on subjective self-reported health and life satisfaction measures, we focus on objective health biomarkers, such as diabetes indicators and cholesterol. Because poor health can induce retirement, we instrument for retirement using eligibility for state and employer sponsored pensions. Overall, there are few significant impacts of retirement on health biomarkers. The direction of effects is also mixed. Some biomarkers improve upon retirement, while others deteriorate. This contrasts with the consistently positive and significant improvements that are found in self-reported measures from the same dataset.

Keywords: Retirement, Health, Biomarkers, Instrumental variables

Biofertilizer

Adekunle Raimi[abc], Ashira Roopnarain[ab], George J.Chirima[de], Rasheed Adeleke[abc] (a. Department of Environmental Sciences, College of Agriculture and Environmental Sciences, University of South Africa, Johannesburg 1709, South Africa, b. Microbiology and Environmental Biotechnology, Institute for Soil, Climate and Water, Agricultural Research Council, Private Bag X79, Pretoria, 0001, South Africa, c. Unit for Environmental Sciences and Management, North-West University, Potchefstroom, 2520, South Africa, d. Centre for Geoinformation Science, Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa, e. Centre for African Ecology, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Wits 2050, Private Bag 3, South Africa) **Insights into the microbial composition and potential efficiency of selected commercial biofertilisers, Heliyon (2020) e04342**

This study investigated 13-commercial biofertilisers for their microbial contents and potential functional capabilities using a culture-based approach. Isolates obtained were identified by sequencing the partial I6S rRNA gene and ITS 1 and 2 regions and screened for plant growth-promoting capabilities. A total of 58 bacterial and three fungal isolates were obtained from all biofertilisers, with major genera being Bacillus, Rhizobium, Pseudomonas, Candida and Aspergillus. Five of the biofertilisers had the microbes (all or some) listed in the label detected while eight products had none detected. All the products had more microbes than that declared in the labels, suggesting the presence of potential contaminants. Generally, all the identified microbes, including the potential contaminants, had different beneficial capabilities. Approximately 40% of the isolates showed potential for nitrogen-fixation, while 27% exhibited high phosphate-solubilisation ability. Additionally, 87% of the isolates produced indole acetic acid in the range of 0.1–114.4 μg/mL. High levels of siderophore production were mainly observed amongst Bacillus and Pseudomonas genera. The potential of the microbes, including those not listed in the label, to fix nitrogen and produce acid phosphatase, indole acetic acid and siderophore, was highest in four products. This suggests the products have multiple functional abilities in improving crop productivity. However, other qualities of biofertiliser, such as viable cell count and level of contamination, must always be within the acceptable standards. This will guarantee high product quality as well as efficiency when applied in the field. Overall, the results show that there is a high correlation between microbial compositions and potential capability of biofertilisers for plant-growth promotion.

Keywords: Agricultural sciences, Ecology, Microbiology, Environmental science, Biotechnology, Commercial biofertiliser, Efficiency, Crop productivity, Correlation, Nitrogen-fixation, Sequencing

Biocomposting

Viviane Priscila Barrosde Medeiros[a], Tatiana Colombo Pimentel[b], Roberta Conceição RibeiroVarandas[c], Silvana Alvesdos Santos[d], Geany Targino de Souza Pedrosa[a], Cristiane Francisca da Costa Sassi[c], Marta Maria da Conceição[e], Marciane Magnani[a] (a. Laboratório de Processos Microbianos em Alimentos – LPMA, Centro de Tecnologia, Universidade Federal da Paraíba, Campus I, João Pessoa, Paraíba 58051-900, Brazil, b. Instituto Federal do Paraná, Campus Paranavaí, Paranavaí, Paraná 87703-536, Brazil, c. Laboratório de Ambientes Recifais e Biotecnologia com Microalgas – LARBIM, Centro de Ciências Exatas e da Natureza, Universidade Federal da Paraíba, Campus I, João Pessoa, Paraíba 58051-900, Brazil, d. Empresa Paraibana de Abastecimento e Serviços Agrícolas – EMPASA, João Pessoa, Paraíba 58071-000, Brazil, e. Departamento de Tecnologia de Alimentos/Centro de Tecnologia e Desenvolvimento Regional/IDEP, João Pessoa, Paraíba 58058-600, Brazil) **Exploiting the use of agro-industrial residues from fruit and vegetables as alternative microalgae culture medium, Food Research International, (2020) 109722**

There is a need for searching new microalgae species, and the most suitable strategy to increase the cost-effectiveness of a microalgae culture system is to use resources of low costs, such as residues. This study aimed to evaluate the cultivation of microalgae isolated from the Brazilian Northeast region (Lagerheimia longiseta, Monoraphidium contortum, and Scenedesmus quadricauda) in an alternative medium of low cost (biocompost of discarded fruits and

vegetables) with a view to possible applications in the food industry. Microalgae cultivated in the conventional synthetic medium were used as control. The cultivation of microalgae in the alternative medium allowed suitable cell growth, and improved the antioxidant activity and the levels of monounsaturated fatty acid and polyunsaturated fatty acid compared to the synthetic medium. The cultivation of S. quadricauda and L. longiseta species in the alternative medium resulted in increased protein content and/or total phenolic content, and improved health indices (lower levels of atherogenic, thrombogenic, and hypercholesterolemic saturated fatty acids indices, and higher levels of desired fatty acids index) compared to cultivation in synthetic medium. The cultivation of M. contortum in the alternative medium contributed to the production of higher lipid content, mainly saturated fatty acid (palmitic acid), which contributed negatively to the health indices. This study proved that S. quadricauda and L. longiseta microalga species from freshwaters have significant potential for distinct applications in functional food industries, and the biocompost of discarded fruits and vegetables is a suitable medium for microalgae cultivation.

Keywords: Photosynthetic organisms, Biocompost, Biomass, Fatty acid profile, Food industry

Biopesticide

Wafa Jallouli[a], Fatma Driss[a], Luc Fillaudeau[b], Souad Rouis[a] (a. Laboratory of Biopesticides, Centre of Biotechnology of Sfax, University of Sfax, P.O. Box. "1177", 3018, Sfax, Tunisia, b. Toulouse Biotechnology Institute, Bio & Chemical Engineering, University of Toulouse - CNRS 5504 - INRAE 792 – INSA, TBI - INSA Toulouse, 135 avenue de Rangueil, 31077 Toulouse CEDEX 04, France) **Review on biopesticide production by Bacillus thuringiensis subsp. kurstaki since 1990: Focus on bioprocess parameters, Process Biochemistry, (2020) Pages 224-232**

Irrespective use of chemical pesticides has led, over the last decades, to several problems such as soil, water and food sources pollution, and generation of a selective pressure causing the emergence of pest resistance. Consequently, researchers have been focusing more on the use of biological control as an alternative strategy. Bacillus thuringiensis (BT) is one of the most widely studied bacteria in industrial biotechnology and commercialized as an environmentally sustainable biopesticide. Therefore, a huge interest has been allocated for research on this bacterium and several scientific studies have been published on the issue. In this review, we tried to evaluate the scientific production over the last thirty years, for the first time, in terms of number and geographical origin, focusing particularly on B. thuringiensis kurstaki (Btk). It is worth emphasizing that the Btk process engineering involving factors affecting growth, sporulation and toxin formation yields by BT has not been fully investigated in previous reviews. To this end, the second section of this review provided an updated survey about these conditions, such as nutritional requirements, culture media and fermentation technologies. Relevant information was collected in comparative tables that could be very useful for the scientific community interested in Btk-based biopesticides.

Keywords: Bacillus thuringiensis, kurstaki, Bioprocess, Bioinsecticide, δ-endotoxins

HikmatGhosson[ab], Delphine Raviglione[ab], Marie-Virginie Salvia[ab], Cédric Bertrand[abc] **(Online Headspace-Solid Phase Microextraction-Gas Chromatography-Mass**

Spectrometry-based untargeted volatile metabolomics for studying emerging complex biopesticides: A proof of concept) Analytica Chimica Acta, (2020) Pages 58-74

This work introduces a novel online Headspace-Solid Phase Microextraction-Gas Chromatography-Mass Spectrometry-based untargeted metabolomics approach, suggested as an alternative tool to study the environmental fate of volatile xenometabolites in emerging complex biopesticides, e.g. the Myrica gale methanolic extract herbicide containing several unknown metabolites. A "living" microcosm sample was designed for non-destructive analysis by a 35-min HS-SPME automated extraction and a 36-min GC-MS run. A 38-day kinetics study was then applied on two groups of soil samples: control and spiked. Statistical tools were used for the comparative kinetics study. The Principal Component Analysis revealed and explained the evolution and the dissipation of the herbicide volatile xenometabolome over time. The time-series Heatmap and Multivariate Empirical Bayes Analysis of Variance allowed the prioritization of 101 relevant compounds including 22 degradation by-products. Out of them, 96 xenometabolites were putatively identified. They included 63 compounds that are identified as herbicide components for the first time. The Orthogonal Projections to Latent Structures Discriminant Analysis and its Cross-Validation test were used to assess the total dissipation of the herbicide volatile residues and method detection limit. The reproducibility of the method was also assessed. The highest inter-samples (n = 3) Peak Area RSD was 7.75 %. The highest inter-samples (n = 3) and inter-days (n = 8) Retention Time SD were 0.43 sec and 3.44 sec, respectively. The work presents a green, non-laborious and high-throughput approach. It required a small number of environmental samples (6 microcosms) that were analyzed 8 times and were not destroyed during the study.

Keywords: Untargeted Metabolomics, Complex Biopesticides, Solid Phase Microextraction, Headspace, Gas Chromatography-Mass Spectrometry

Karolína Ranglová[ab], Gergely Ernö Lakatos[a], João Artur Câmar[a] Manoel[ac], Tomáš Grivalský[a], Francisca Suárez Estrella[d], Francisco Gabriel Acién Fernández[e], Zoltán Molnár[f], Vince Ördögfg, Jiří Masojídek[ac](a. Institute of Microbiology of the Czech Academy of Sciences, Centre Algatech, Laboratory of Algal Biotechnology, Novohradská, 237 Třeboň, Czech Republic, b. University of South Bohemia, Faculty of Agriculture, České Budějovice, Czech Republic, c. University of South Bohemia, Faculty of Science, České Budějovice, Czech Republic, d. University of Almería, Department of Biology and Geology, Almería, Spain, e. University of Almería, Department of Engineering, Almería, Spain, f. Department of Plant Science, Faculty of Agricultural and Food Sciences, Széchenyi István University, Mosonmagyaróvár, Hungary, g. Research Centre for Plant Growth and Development, School of Life Sciences, University of KwaZulu-Natal, Pietermaritzburg Campus, South Africa) **Growth, biostimulant and biopesticide activity of the MACC-1 Chlorella strain cultivated outdoors in inorganic medium and wastewater, Algal Research (2020) 102136**

The use of wastewater (WW) for cultivation contributes to the sustainability of microalgae production due to the reduced costs of cultivation. The main objective of this work was to study growth, physiological performance and bioactivity of the microalgae strain Chlorella vulgaris MACC-1 grown in two nutrient sources – inorganic BG-11 medium and centrate from municipal

WW. For the comparison, two thin-layer cultivation units – thin-layer cascade and a novel, thin-layer raceway pond – were used. The cultures grew well in both units showing good photosynthetic activity. The germination index of watercress seeds, as well as the auxin-like activity in mung bean and cytokinin-like activity in wheat growth tests were used to evaluate the biostimulant potential. The slight increase on the germination index was determined in C. vulgaris cultures grown in BG-11, but the biomass revealed no biostimulant activity when cultivated in WW. On the other hand, the antibacterial and antifungal activities determined by antagonism bioassay using dual cultures were significantly higher when grown in WW. We expect that the antimicrobial activities may be induced by WW-microbes and the biostimulating effect could probably be suppressed by the presence of some inhibiting substances. The results revealed a clear interplay among ambient irradiance intensity, growth rate, maximum quantum yield of PSII, Fv/Fm and oxygen production/respiration.

Keywords: Bioactivity, Chlorella, Chlorophyll fluorescence, Outdoor cultivation, Pathogens, Wastewater

Aline S.P.Dornelas[a], Renato A.Sarmento[a], Althiéris S.Saraiv[ab], Rone S.Barbosa[a], Mayane M.Vieira[c], Carlos Gravato[d], Amadeu M.V.M.Soares[ae] (a. Programa de Pós-graduação em Produção Vegetal, Universidade Federal do Tocantins, Campus Universitário de Gurupi, 77402-970 Gurupi, Tocantins, Brazil, b. Instituto Federal de Educação, Ciência e Tecnologia Goiano - Campus Campos Belos (Laboratório de Conservação de Agroecossistemas e Ecotoxicologia), Campos Belos, 73840-000 Goiás, Brazil, c. Curso de Química Ambiental, Universidade Federal do Tocantins, 77410-530 Gurupi, Tocantins, Brazil, d. Faculdade de Ciências & CESAM, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal, e. Departamento de Biologia & CESAM, Universidade de Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal) **Effects of two biopesticides and salt on behaviour, regeneration and sexual reproduction of the freshwater planarian Girardia tigrina, Journal of Hazardous Materials (2021) 124089**

Microbial insecticides are being used as ecologically-friendly alternatives to traditional insecticides. However, their effects have been poorly investigated on non-target freshwater species, with exception of a few insect species. Moreover, combined effects of microbial insecticides with other environmental stressors, such as salinity, have never been investigated. Thus, our goal was to assess the effects of Bac-Control® (based in Bacillus thuringiensis - Btk) and Boveril® (based in Beauveria bassiana - Bb) with increasing salinities (NaCl) on freshwater planarian Girardia tigrina. It has been reported that increased salinity levels affect freshwater organisms compromising their survival by triggering adaptation processes to cope with osmotic stress. Our results showed delayed regeneration, decreased locomotion and feeding on planarians exposed to NaCl, whereas their sexual reproduction was not affected. Both microbial insecticides impaired feeding, locomotor activity, regeneration, and sexual reproduction of planarians. Planarians exposed to microbial insecticides compromised their progeny. Therefore, microbial insecticides might not be ecologically friendly alternatives to chemical insecticides. Interestingly, harmful effects of microbial insecticides with increasing salinities showed an inadequate response of planarians to cope with induction of their immune response and osmoregulation.

Keywords: Microbial insecticides, Tropical ecotoxicology, Freshwater invertebrates, Behavioral ecotoxicology, Regeneration

Belén Guijarro[a], Carla Casals[b], Neus Teixidó[b], Inmaculada Larena[a], Paloma Melgarejo[a], Antonieta De Cal[a] (a. Department of Plant Protection, INIA, Ctra. de La Coruña Km. 7, 28040, Madrid, Spain, b. IRTA, XaRTA-Postharvest, Edifici Fruitcentre, Parc Científic i Tecnologic Agroalimentari de Lleida, 25003 Lleida, Spain) **Balance between resilient fruit surface microbial community and population of Monilinia spp. after biopesticide field applications of Penicillium frequentans, International Journal of Food Microbiology (2020) 108788**

The microbial variability on the host plant surface must be maintained because population diversity and quantity are essential to avoid disease development. It would be necessary to examine the patterns and mechanisms associated with the massive and reiterative introduction of a microbial pest control agent. The effect of inundative releases of biopesticide formulations containing Penicillium frequentans for the control of Monilinia spp. populations, and the effect on fruit surface microbiota on 18 stone fruit field experiments located in four European countries for more than two crop seasons against brown rot were studied. P. frequentans was monitored after application in order to assess whether it was persistent or not in the environment. Hydrolysis of fluorescein diacetate and denaturing gradient gel electrophoresis were used to study the effects of P. frequentans on fungal and bacterial non-target populations on fruit surface. The effect of P. frequentans formulations on the populations of Monilinia spp. on fruit was also assessed in different orchards. P. frequentans population on stone fruit surfaces showed ranged from 100 to 10,000 CFU cm−2, and postharvest recovered populations were more than 10–100-fold higher than preharvest recovered populations. The population of P. frequentans varied among orchards and years, rather than by the type of formulation. P. frequentans formulation reduced Monilinia spp. population and brown rot and latent infections caused by this pathogen both before and at harvest, while stabilizing or increasing antagonist populations and avoiding non-target microorganisms. However, fungicides reduced significantly the microbial activity on nectarine surfaces.

Keywords: Non-target effects, Risk assessment, Biocontrol, Microbiota, Penicillium frequentans

Biodegradation

Giovanna Pagnozzi[a], Sean Carroll[b], Danny D.Reible[a], Kayleigh Millerick[a] (a. Civil, Environmental, and Construction Engineering, Texas Tech University, Lubbock, TX, 79409, USA, b. Haley and Aldrich, Inc., 100 Corporate Place, Suite 105, Rocky Hill, CT, 06067, USA) **Powdered activated carbon (PAC) amendment enhances naphthalene biodegradation under strictly sulfate-reducing conditions, Environmental Pollution (2021) 115641**

Capping represents an efficient and well-established practice to contain polycyclic aromatic hydrocarbons (PAHs) in sediments, reduce mobility, and minimize risks. Exposure to PAHs can encourage biodegradation, which can improve the performance of capping. This study investigates biodegradation of naphthalene (a model PAH) in highly reducing, sediment-like environments with amendment of different capping materials (PAC and sand). Microcosms were prepared with sediment enrichments, sulfate as an electron acceptor, and naphthalene. Results

show that PAC stimulates naphthalene biodegradation and mineralization, as indicated by production of 14CO2 from radiolabeled naphthalene. Mineralization in PAC systems correlates with the enrichment of genera (Geobacter and Desulfovirga) previously identified to biodegrade naphthalene (Spearman's, $p < 0.05$). Naphthalene decay in sand and media-free systems was not linked to biodegradation activity (ANOVA, $p > 0.05$), and microbial communities were correlated to biomass yields rather than metabolites. Naphthalene decay in PAC systems consists of three stages with respect to time: latent (0–88 days), exponential decay (88–210 days), and inactive (210–480 days). This study shows that PAC amendment enhances naphthalene biodegradation under strictly sulfate-reducing conditions and provides a kinetic and metagenomic characterization of systems demonstrating naphthalene decay.

Keywords: Sediments, PAC, Capping, Biodegradation, PAH, Sulfate-reduction

Hernando P.Bacosa[ab], Andrew Kang[ac], Kaijun Lu[a], Zhanfei Liu[a] (a. Marine Science Institute, The University of Texas at Austin, 750 Channel View Drive, Port Aransas, TX 78373, USA, b. Department of Biological Sciences, Mindanao State University-Iligan Institute of Technology, Iligan City 9200, Philippines, c. University of Guam Marine Laboratory, UOG Station, Mangilao, Guam 96923, USA) **Initial oil concentration affects hydrocarbon biodegradation rates and bacterial community composition in seawater, Marine Pollution Bulletin (2021) 111867**

During oil spills in the field or for laboratory incubation studies, different oil concentrations are often encountered or applied, yet how initial oil concentration affects biodegradation rates of hydrocarbons and the development of oil degraders remains unclear. We incubated seawater for 50 d with different oil concentrations (0, 50, 100, 200, 400 and 800 ppm). n-Alkanes and polycyclic aromatic hydrocarbons (PAHs), and the bacterial community were analyzed periodically. Results show that the biodegradation rates of alkanes, derived from first order kinetics, decreased with increasing oil concentration, but percent residual was ~50% regardless of the initial concentration. In contrast, the biodegradation rates of PAHs increased with concentration, and the percent residual increased with oil concentration. Increasing oil concentration resulted in increased abundances of Rhodobacterales, Altererythrobacter, and Neptuniibacter. However, Alcanivorax abundance was barely detected in 400 and 800 ppm. Overall, oil concentration critically affected the degradation of hydrocarbons and the bacterial community.

Keywords: Oil concentration, Biodegradation, Bacterial community, Oil spill, Alkane, PAH

Emma M.N.Polman[a], Gert-Jan M.Gruter[b], John R.Parsons[a], Albert Tietema[a] (a. Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, Science Park 904, 1098 XH Amsterdam, the Netherlands, b. Van 't Hoff Institute for Molecular Sciences (HIMS), University of Amsterdam, Science Park 904, 1098 XH Amsterdam, the Netherlands) **Comparison of the aerobic biodegradation of biopolymers and the corresponding bioplastics: A review, Science of The Total Environment (2021) 141953**

Biodegradable plastics made from biopolymers (made in nature) or from bio-based polymers (made in a factory) are becoming increasingly important in replacing the massive amounts of conventional, non-degradable fossil-based plastics that have been produced and disposed over the past decades. In this review we compare the biodegradation rates and mechanisms of the

bioplastics thermoplastic starch, cellulose acetate and lignin based bioplastics with the biodegradation rates and mechanisms of starch, cellulose and lignin, which are the unmodified biopolymers from which these bioplastics are produced. With this comparison we aim to determine to what extent the extensive knowledge on unmodified biopolymer biodegradation can be applied to the biodegradation of bioplastics (modified biopolymers) in the terrestrial environment. This knowledge is important, since it can be of great help in giving direction to the future research and development of bioplastics and for the development of bioplastic waste assessments and policies. We found that the similarities and differences in biodegradation are dependent on the structural changes imposed on a biopolymer during the bioplastic production process. A change in higher level structure, as found in thermoplastic starch, only resulted in a limited number of differences in the biodegradation process. However, when the chemical structure of a polymer is changed, as for cellulose acetate, different microorganisms and enzymes are involved in the biodegradation. Based on the cellulose acetate biodegradation process, a conceptual model was proposed that can be used as a starting point in predicting biodegradation rates of other chemically modified biopolymers used as bioplastics. Future bioplastic biodegradation research should focus on conducting long-term field experiments, since most studies are conducted in a laboratory setting and do not capture all processes occurring in the field situation. This applies even more to lignin based bioplastics, since very little experimental data were available on modified lignin biopolymer biodegradation.

Keywords: Biodegradation, Thermoplastic starch, Biopolymers, Cellulose acetate, Lignin, Terrestrial environment

Jiang Liu[ab], Jian Liang[ac], Andrea G.Bravo[d], Shiqiang Wei[a], Caiyun Yang[e], Dingyong Wang[a], Tao Jiang[af] (a. Interdisciplinary Research Centre for Agriculture Green Development in Yangtze River Basin, College of Resources and Environment, Southwest University, Chongqing 400716, China, b. State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550002, China, c. College of Chemistry and Environmental Engineering, Baise University, Guangxi 533000, China, d. Department of Environmental Chemistry, Institute of Environmental Assessment and Water Research (IDAEA), Spanish National Research Council (CSIC), Barcelona, Spain, e. Research Center of Bioenergy and Bioremediation, College of Resources and Environment, Southwest University, Chongqing 400716, China, f. Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå SE-90183, Sweden) **Anaerobic and aerobic biodegradation of soil-extracted dissolved organic matter from the water-level-fluctuation zone of the Three Gorges Reservoir region, China, Science of The Total Environment, (2020) 142857**

The biodegradation of dissolved organic matter (DOM) in natural environments is determined by its molecular composition and reactivity. Redox oscillations are common in the water-level-fluctuation zone (WLFZ) of the Three Gorges Reservoir (TGR). As a consequence, the soil DOM released is degraded under both anaerobic and aerobic conditions. The DOM compounds available for degradation under contrasting redox conditions and the resulting DOM composition still need to be elucidated. By combining laboratory experiments with an in-depth characterization of DOM optical properties, we show that different pathways controlled the depletion and enrichment of the DOM optical components under different oxygen regimes. In

particular, 28-day dark biodegradation assays showed that up to 39.5 ± 4% DOM was degraded under anaerobic conditions, while 55.5 ± 6% DOM was biodegraded under aerobic conditions. Aerobic biodegradation resulted in a higher aromaticity and degree of humification of the DOM compared to anaerobic degradation. The specific UV absorbance at a wavelength of 254 (SUVA254) and biological index (BIX) could be used to track DOM biodegradation under anaerobic conditions. Under aerobic conditions, the SUVA254, BIX and concentration of coloured DOM (CDOM, reflected by a (355)) could track DOM biodegradation, and significant amounts of CDOM could be aerobically biodegraded.

Keywords: Dissolved organic matter, Biodegradation, Optical properties, Anaerobic, Water level fluctuation zone

Zuotao Zhang, Jiao Sun, Haijiao Guo, Xiaoqiang Gong, Chongyang Wang, Hui Wang (State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Tsinghua University, Beijing 100084, China) **Investigation of anaerobic biodegradation of phenanthrene by a sulfate-dependent Geobacter sulfurreducens strain PheS2, Journal of Hazardous Materials, (2020) 124522**

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous and harmful contaminants, which can be degraded aerobically. However, the persistence of PAHs in anoxic environments indicates that anaerobic biodegradation of PAHs should also be investigated. Pure-culture and biotransformation processes for anaerobic phenanthrene biodegradation with sulfate as a terminal electron acceptor remains in its infancy. In this study, we investigated anaerobic biodegradation of PAHs by PheS2, an isolated phenanthrene-utilizing sulfate-reducer, using phenanthrene as a model compound. PheS2 was phylogenetically closely related to Geobacter sulfurreducens and reduced sulfate to sulfide during anaerobic phenanthrene biodegradation. Phenanthrene biodegradation processes were detected using gas chromatography-mass spectrometry, genome, and reverse transcription quantitative PCR analyses. Carboxylation was the initial step of anaerobic phenanthrene biodegradation based upon detection of 2- and 4-phenanthroic acid, its isotopically labeled analogs when using 13C-labeled bicarbonate and fully deuterated-phenanthrene (C14D10), and genes encoding enzymes putatively involved in the biodegradation. Further, ring-system reducing and cleavage occurred, and substituted benzene series and cyclohexane derivatives were detected in downstream biotransformation metabolites. Additionally, PheS2 can degrade benzene, naphthalene, anthracene, and benz[a]anthracene, but not pyrene and benz[a]pyrene. This study describes the isolation of an anaerobic phenanthrene-degrading sulfate-reducer, the first pure-culture evidence of phenanthrene biotransformation processes with sulfate as an electron acceptor.

Keywords: Anaerobic phenanthrene biodegradation, Sulfate-reducing, Pure-culture,, Biotransformation process

Fang Yang[a], Hongxian Jian[a], Cuiping Wang[a], Yu Wang[a], Erhu Li[b], Hongwen, Sun[a] (a. Key Laboratory of Pollution Processes and Environmental Criteria, Ministry of Education, Tianjin Key Laboratory of Environmental Remediation and Pollution Control, College of Environmental Science and Engineering, Nankai University, Tianjin 300071, China, b. Tianjin Agriculture Ecological Environment Monitoring and Agricultural Product Quality Testing Centre, Tianjin 300191, China) **Effects of biochar on biodegradation of sulfamethoxazole and chloramphenicol by Pseudomonas stutzeri and Shewanella**

putrefaciens: Microbial growth, fatty acids, and the expression quantity of genes, Journal of Hazardous Materials, (2020) 124311

An incubation experiment was conducted to investigate whether different biochar could enhance the biodegradation of sulfamethoxazole (SMX) and chloramphenicol (CAP). During incubation in nutrient medium solution, the degradation efficiencies of SMX by P. stutzeri and S. putrefaciens obtained 61.79% and 68.67% respectively, while CAP was 85.75% and 85.70%. The biodegradation efficiencies of SMX and CAP increased for P. stutzeri cultured with biochar and increased for S. putrefaciens cultured with high-concentration biochar (500, 1,000, 2,000 mg L−1). Additionally, TOC and TN contents were significantly decreased during the biodegradation process. Hence, the effects of biochar on microbial growth, fatty acids and expression genes, biodegradation products were studied. The content of bacteria, saturated fatty acids and expression genes showed a positive correlation with the content of TOC released from biochar, while the biodegradation products would not change when bacteria was cultured with biochar. These indicated that biochar improved the antibiotics biodegradation efficiencies via involvement in the bacterial growth, changing the components of fatty acids, increasing the expression quantity of genes. This research suggests that micro-biological degradation with biochar is a promising technology to treat specific antibiotics in the environment.

Keywords: Biodegradation, Biochar, Antibiotics, Pseudomonas stutzeri, Shewanella putrefaciens

Mengsha Yin[ab], Haiping Huang[ab], Thomas B.P.Oldenburg[a] (a. PRG group, Department of Geosciences, University of Calgary, Calgary, Canada T2N 1N4, b. Department of Energy and Resources, China University of Geosciences (Beijing), Beijing, China 100083) An application of exploratory factor analysis in the deconvolution of heavy oil biodegradation, charging and mixing history in southeastern Mexico, Organic Geochemistry, (2020) 104161

Forty-seven heavy oil samples of three genetic types and similar maturity levels (early oil window) reflect that oils in the southeastern Mexico Basin have experienced complex oil biodegradation, charging and mixing processes. Strong oil fingerprinting signatures from the non- to slightly biodegraded, later charged oils discourage effective determination of biodegradation levels using the existing biodegradation scales. The later charges are recognized by accumulation of n-alkanes, peak/hump ratios and abundant diamondoids. Bicyclic sesquiterpanes show systematic changes caused by biodegradation, whereas very similar hopane and sterane distribution patterns indicate no microbial alteration of hopanes and steranes. Distributions of 2–5 ring aromatic hydrocarbons display regular trends caused by biodegradation, based on which a biodegradation parameter was derived. It shows a higher resolution than an adapted Manco score (Larter, S.R., Huang, H., Adams, J., Bennett, B., Snowdon, L.R., 2012. A practical biodegradation scales for use in reservoir geochemical studies of biodegraded oils, Organic Geochemistry 45, 66–76.). Biodegradation parameters were also derived based on systematic changes in NSO compound distributions. However, deconvolution of oil biodegradation, charging and mixing history is not achievable from a univariate or bivariate perspective. Hence, a multivariate method, exploratory factor analysis (EFA) was applied, incorporating biodegradation ratios and concentrations of compounds chiefly from the fresh charges. The EFA results categorize the studied oils into three broad biodegradation level

ranges along with different amounts of the later fresh charge. Our study highlights that chemometric methods might be used to unravel complex oil biodegradation, charging and mixing history of petroleum systems worldwide.

Keywords: heavy oil, adapted Manco score, oil biodegradation, oil charging and mixing, exploratory factor analysis

Miguel Fernandes, Andreia Salvador, Madalena M.Alves, António A.Vicente (Centre of Biological Engineering, University of Minho, Campus de Gualtar, Braga 4710-057, Portugal) **Factors affecting polyhydroxyalkanoates biodegradation in soil, Polymer Degradation and Stability, (2020) 109408**

Polyhydroxyalkanoates (PHAs) are polymers with widespread applications, from medical devices to packaging. PHAs can be biodegradable in natural environments, such as soil, but the blend of PHA with other materials can change the polymer properties and consequently affect the biodegradation process. The composition of the microbial communities in soil also significantly affects the biodegradation, but other factors such as temperature, pH, and soil moisture, can also be determinant. These ecological and physic/chemical factors change in different seasons and in different soil layers. It is essential to know how these factors influence the PHAs' biodegradation to understand the impact of PHAs in nature. This review compiles the results on PHA polymers and PHA blends biodegradation, with focus on laboratory tests. The main factors affecting PHA's biodegradation in soil, both in laboratory tests and in the environment are also discussed.

Keywords: Soil biodegradation, Polyhydroxyalkanoates, Biodegradable plastics, PHA degraders

Biosensor

Kihyeun Kim[a], Hyeonghun Kim[b], Eun-Jung Jo[a], Hyungjun Jang[a], Jiyoon Park[b], Gun Young Jung[b], Min-Gon Kim[a] (a. Department of Chemistry, Gwangju Institute of Science and Technology (GIST), Gwangju 61005, Republic of Korea, b. School of Materials Science and Engineering, Gwangju Institute of Science and Technology (GIST), Gwangju 61005, Republic of Korea) **Reactant/polymer hybrid films on p-n junction photodetectors for self-powered, non-invasive glucose biosensors, Biosensors and Bioelectronics, (2020) 112855**

The portability of electronic-based biosensors is limited because of the use of batteries and/or solutions containing reactants such as enzymes for assay, which limits the utility of such biosensors in point-of-care (POC) testing. In this study, we report on the development of a self-powered biosensor composed of only portable components: a reactant-containing poly (ethylene glycol) (PEG) film for the colorimetric assay, and a self-powered n-InGaZnO/p-Si photodetector. The PEG film containing enzymes and color-developing agents was formed on a glass slide by spin coating. The self-powered biosensor was fabricated by placing the hybrid film on the p-n junction photodetector, and applied in non-invasive glucose detection (salivary glucose). Injection of the target-containing solution dissolved the PEG that led to the release of enzymes and color-developing agents, resulting in a colorimetric assay. The colorimetric assay could attenuate the light reaching the photodetector, thus facilitating target concentration verification by measuring the photocurrent. Our self-powered biosensor has two main advantages: (i) all components of the biosensor are portable and (ii) dilution of target

concentration is avoided as the reagents are in the PEG film. Therefore, the self-powered biosensor, without solution-phase components, could be highly beneficial for creating portable, sensitive biosensors for POC testing.

Keywords: Self-powered biosensor, Portable biosensor, Glucose detection, Photodetector, Colorimetric assay

Lukasz Oldak[a], Anna Sankiewicz[b], Beata Żelazowska-Rutkowsk[ac], Bogdan Cylwik[c], Zenon Lukaszewski[d], Marcin Skoczylas[e], Ewa Gorodkiewicz[b] (a. Doctoral School of Exact and Natural Science, Faculty of Chemistry, Bioanalysis Laboratory, University of Bialystok, Ciolkowskiego 1K, 15-245 Bialystok, Poland, b. Bioanalysis Laboratory, Faculty of Chemistry, University of Bialystok, Ciolkowskiego 1K, 15-245 Bialystok, Poland, c. Department of Pediatric Laboratory Diagnostics, Medical University of Bialystok, Waszyngtona 17, 15-274 Bialystok, Poland, d. Faculty of Chemical Technology, Poznan University of Technology, pl. Sklodowskiej-Curie 5, 60-965 Poznan, Poland, e. Faculty of Computer Science, Bialystok University of Technology, Wiejska 45A, 15-351 Bialystok, Poland) **Two SPRi biosensors for the determination of cathepsin S in blood plasma, Talanta, (2020) 121900**

Cathepsin S is an emerging marker for ovarian cancer. Two ‘analytically specific’ SPRi biosensors for the determination of Cath S have been developed. The reception part of one of the biosensors consists of the rat monoclonal antibody specific for cathepsin S attached to the gold surface via covalent bonds with cysteamine linker, while the second biosensor consists of the inhibitor LY3000328 attached via hydrophobic interaction with the 1-octadecanothiol linker. Under optimized conditions, in terms of pH and receptor concentration, both biosensors have linear response ranges between LOQ (1.5 ng mL-1) and 2.5 ng mL-1, which is suitable for the determination of Cath S in blood plasma samples of ovarian cancer patients and healthy individuals, after corresponding dilution with 0.15 M PBS buffer.
Precision and recoveries are quite acceptable: below 7% and 98–101% respectively for the biosensor with antibody, and below 12% and 101–103% for the biosensor with inhibitor. The biosensors were validated by the determination of Cath S in series of plasma from ovarian cancer patients and healthy volunteers using both biosensors and ELISA, giving Pearson coefficients close to 1. Plasma Cath S concentration can be used as an ovarian cancer marker, in view of the highly elevated concentrations detected.

Keywords: cancer markers, ovarian cancer, inhibitor LY3000328, antibody, array of measuring points

Xiang Qi[a], Shuyi Wang[a], Tian Li[b], Xin Wang[b], Yong Jiang[c], Yuexi Zhou[d], Xiaohong Zhou[a], Xia Huang[a], Peng Liang[a] (a. State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Tsinghua University, Beijing, 100084, PR China, b. MOE Key Laboratory of Pollution Processes and Environmental Criteria, Tianjin Key Laboratory of Environmental Remediation and Pollution Control, College of Environmental Science and Engineering, Nankai University, No. 38 Tongyan Road, Jinnan District, Tianjin, 300350, China, c. Fujian Provincial Key Laboratory of Soil Environmental Health and Regulation, College of Resources and Environment, Fujian

Agriculture and Forestry University, Fuzhou, Fujian, 350002, China, d. State Key Laboratory of Environmental Criteria and Risk Assessment, Chinese Research Academy of Environmental Sciences, Beijing, 100012, China) An electroactive biofilm-based biosensor for water safety: Pollutants detection and early-warning, Biosensors and Bioelectronics (2021) 112822

Besides serving in wastewater treatment and energy generation fields, electroactive biofilm (EAB) has been employed as a sensitive bio-elements in a biosensor to monitor water quality by delivering electrical signals without additional mediators. Increasing studies have applied EAB-based biosensor in specific pollutant detection, typically biochemical oxygen demand (BOD) detection, as well as in early-warning of composite pollutants. Based on a comprehensive review of literatures, this study reveals how EAB outputs electrical signal, how we can evaluate and improve this performance, and what information we can expect from EAB-based biosensor. Since BOD detection and early-warning are normally confusing, this study manages to differentiate these two applications through distinguished purposes and metrics. Based on the introductions of progresses and applications of EAB-based biosensors so far, several novel strategies toward the future development of EAB-based biosensors are proposed.

Keywords: Electroactive biofilm, Comprehensive biosensor, Water quality, BOD detection, Early-warning

Pawel Falkowski[a], Zenon Lukaszewski[b], Ewa Gorodkiewicz[a] (a. Faculty of Chemistry, Bioanalysis Laboratory, University of Bialystok, Ciolkowskiego 1K, 15-245, Bialystok, Poland, b. Poznan University of Technology, Faculty of Chemical Technology, Poland) Potential of surface plasmon resonance biosensors in cancer detection, Journal of Pharmaceutical and Biomedical Analysis, (2020) 113802

A review is made of 71 papers on surface plasmon resonance biosensors, published between 2005 and 2020, mostly in the last decade. The reviewed papers are divided into two groups, depending on the validation of the developed biosensor. Validated biosensors are briefly characterized, while those that are not validated are listed in a table. Focus is placed on applications of SPR biosensors in testing the effectiveness of cancer markers and in the discovery of new cancer markers. Seven new markers are proposed, two of them having high sensitivity and diagnostic selectivity as determined by ROC curves. Papers concerning the determination of micro RNA and large particles such as vesicles, exosomes and cancer cells are also reviewed.

Keywords: Surface plasmon resonance, Circulating cancer markers, Biosensors, Liquid biopsy, Body fluids, Validation, ROC curves

BurcuÖZCAN, MustafaKemal SEZGİNTÜRK (Çanakkale Onsekiz Mart University, Faculty of Engineering, Bioengineering Department, Çanakkale, Turkey) A novel and disposable GP- based impedimetric biosensor using electropolymerization process with PGA for highly sensitive determination of leptin: Early diagnosis of childhood obesity, Talanta (2020) 121985

This study presents a novel, single-use electrochemical biosensor for the leptin biomarker, which may have potential use for early diagnosis of childhood obesity. The graphite paper working

electrode was used for the first time in impedimetric biosensors. All immobilization procedure, investigation of the optimal parameters and characterization of biosensors were followed and evaluated using Electrochemical Impedance Spectroscopy (EIS) and Cyclic Voltammetry (CV). The Scanning Electron Microscope (SEM) was utilized to visualize the morphology of the electrode surface during the immobilization steps of the immunosensor. Moreover, the characterization of the interactions between anti-leptin and leptin was investigated by using Single Frequency Technique (SFI). The applicability of the designed biosensor for real serum samples was tested for clinical use. It was observed that the biosensor allows high sensitivity in the analyte detection (leptin) in real serum samples. Moreover, it was suggested that the developed biosensor presents advantages such as long shelf life (5% loss of activity after 8 weeks and 60% loss after 10 weeks), ability to determine analyte concentrations at picogram level (0.2 pg mL-1 -20 pg mL-1), low limit of detection (0.00813 pg mL- 1), reproducibility, reusability (12 times) and high sensitivity.

Keywords: leptin, childhood obesity, biosensor, graphite paper electrode

Joydip Sengupta[1], Chaudhery Mustansar Hussain[2] (1. Department of Electronic Science, Jogesh Chandra Chaudhuri College (Affiliated to University of Calcutta), Kolkata 700 033, W.B., India, 2. Department of Chemistry and Environmental Science, New Jersey Institute of Technology, Newark, New Jersey, USA) **Graphene-based field-effect transistor biosensors for the rapid detection and analysis of viruses: A perspective in view of COVID-19, Carbon Trends, (2020) 100011**

Current situation of COVID-19 demands a rapid, reliable, cost-effective, facile detection strategy to break the transmission chain and biosensor has emerged as a feasible solution for this purpose. Introduction of nanomaterials has undoubtedly improved the performance of biosensor and the addition of graphene enhanced the sensing ability to a peerless level. Amongst different graphene-based biosensing schemes, graphene field-effect transistor marked its unique presence owing to its ability of ultrasensitive and low-noise detection thereby facilitating instantaneous measurements even in the presence of small amounts of analytes. Recently, graphene field-effect transistor type biosensor is even successfully employed in rapid detection of SARS-CoV-2 and this triggers the interest of the scientific community in reviewing the current developments in graphene field-effect transistor. Subsequently, in this article, the recent progress in graphene field-effect transistor type biosensors for the detection of the virus is reviewed and challenges along with their strengths are discussed.

Keywords: COVID-19, Biosensor, Graphene, Field-effect transistor, Virus detection

QianZhang[a], YanxiaWu[b], QinfengXu[c], Fei Ma[a], Chun-yang Zhang[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, China, b. Department of Pathology and Pathological Diagnosis & Research Center, Affiliated Hospital of Guangdong Medical University, Zhanjiang, 524001, China, c. School of Food and Biological Engineering, National R&D Center for Goat Dairy Products

Processing Technology, Shaanxi University of Science and Technology, Xi'an, 710021, China) Recent advances in biosensors for in vitro detection and in vivo imaging of DNA methylation, Biosensors and Bioelectronics, (2021) 112712

DNA methylation is the predominant epigenetic modification that participates in many fundamental cellular processes through posttranscriptional regulation of gene expression. Aberrant DNA methylation is closely associated with a variety of human diseases including cancers. Therefore, accurate and sensitive detection of DNA methylation may greatly facilitate the epigenetic biological researches and disease diagnosis. In recent years, a series of novel biosensors have been developed for highly sensitive detection of DNA methylation, but an overview of recent advances in biosensors for in vitro detection and especially live-cell imaging of DNA methylation is absent. In this review, we summarize the emerging biosensors for in vitro and in vivo DNA methylation assays in the past five years (2015–2020). Based on the signal types, the biosensors for in vitro DNA methylation assay are classified into five categories including fluorescent, electrochemical, colorimetric, surface enhanced Raman spectroscopy, mass spectrometry, and surface plasmon resonance biosensors, while the biosensors for in vivo DNA methylation assay mainly rely on fluorescent imaging. We review the strategies, features and applications of these biosensors, and provide a new insight into the challenges and future directions in this area.

Keywords: DNA methylation, Epigenetics, Biosensor, In vitro detection, In vivo imaging

XueSun[abc], Qinggang Li[ab], Yu Wang[ab], Wenjuan Zhou[ab], Yanmei Guo[ab], Jiuzhou Chen[ab], Ping Zheng[ab], Jibin Sun[ab], Yanhe Ma[ab] (a. Tianjin Institute of Industrial Biotechnology, Key Laboratory of Systems Microbial Biotechnology, Chinese Academy of Sciences, Tianjin 300308, China, b. National Technology Innovation Center of Synthetic Biology, Tianjin 300308, China, c. University of Chinese Academy of Sciences, Beijing 100049, China) **Isoleucyl-tRNA synthetase mutant based whole-cell biosensor for high-throughput selection of isoleucine overproducers, Biosensors and Bioelectronics, (2021) 112783**

Whole-cell amino acid biosensors can sense the concentrations of certain amino acids and output easily detectable signals, which are important for construction of microbial producers. However, many reported biosensors have poor specificity because they also sense non-target amino acids. Besides, biosensors for many amino acids are still unavailable. In this study, we proposed a new strategy for constructing whole-cell biosensors based on aminoacyl-tRNA synthetases (aaRSs), which take the advantage of their universality and intrinsically specific binding ability to corresponding amino acids. Taking isoleucine biosensor as an example, we first mutated the isoleucyl-tRNA synthetase in Escherichia coli to dramatically decrease its affinity to isoleucine. The engineered cells specifically sensed isoleucine and output isoleucine dose-dependent cell growth as an easily detectable signal. To further expand the sensing range, an isoleucine exporter was overexpressed to enhance excretion of intracellular isoleucine. Since cells equipped with the optimized whole-cell biosensor showed accelerated growth when cells produced higher concentrations of isoleucine, the biosensor was successfully applied in high-throughput selection of isoleucine overproducers from random mutation libraries. This work demonstrates the feasibility of engineering aaRSs to construct a new kind of whole-cell biosensors for amino acids. Considering all twenty proteinogenic and many non-canonical amino acids have their specific aaRSs, this strategy should be useful for developing biosensors for various amino acids.

Keywords: Whole-cell biosensor, Aminoacyl-tRNA synthetase, Isoleucyl-tRNA synthetase, Isoleucine, Amino acid, Growth-coupled selection

Bioengineering

Da-Hyun Kim[a], Jungho Ahn[b], Hyun Kyoung Kang[a], Min-Soo Kim[a], Nam-Gyo Kim[a], Myung Geun Kook[a], Soon Won Choi[a], Noo Li Jeon[b], Heung-Myong Woo[c], Kyung-Sun Kang[a] (a. Adult Stem Cell Research Center and Research Institute for Veterinary Medicine, College of Veterinary Medicine, Seoul National University, Seoul, Republic of Korea, b. School of Mechanical Aerospace Engineering, Seoul National University, Seoul, Republic of Korea, c. College of Veterinary Medicine & Institute of Veterinary Science, Kangwon National University, Chuncheon, Gangwon, Republic of Korea) Development of highly functional bioengineered human liver with perfusable vasculature, Biomaterials, Volume 265 (2021) 120417

Liver tissue engineering offers a promising strategy for liver failure patients. Since transplantation rejection resulting in vessel thrombosis is regarded as a major hurdle, vascular reconstruction is one of indispensable requirements of whole organ engineering. Here we demonstrated a novel strategy for reconstruction of a vascularized bioengineered human liver (VBHL) using decellularized liver scaffolds in an efficient manner. First we achieved fully functional endothelial coverage of scaffolds by adopting the anti-CD31 aptamer as a potent coating agent for re-endothelialization. Through an ex vivo human blood perfusion that recapitulates the blood coagulation response in humans, we demonstrated significantly reduced platelet aggregation in anti-CD31 aptamer coated scaffolds. We then produced VBHL constructs using liver parenchymal cells and nonparenchymal cells, properly organized into liver-like structures with an aligned vasculature. Interestingly, VBHL constructs displayed prominently enhanced long-term liver-specific functions that are affected by vascular functionality. The VBHL constructs formed perfusable vessel networks in vivo as evidenced by the direct vascular connection between the VBHL constructs and the renal circulation. Furthermore, heterotopic transplantation of VBHL constructs supported liver functions in a rat model of liver fibrosis. Overall, we proposed a new strategy to generate transplantable bioengineered livers characterized by highly functional vascular reconstruction.

Keywords: Bioengineering, Liver tissue engineering, Re-endothelialization, Aptamer, Artificial organ

Xu Chen, Yiqiu Gao, Yunlong Wang, Guoqing Pan (Institute for Advanced Materials, School of Materials Science and Engineering, Jiangsu University, Zhenjiang, Jiangsu, 212013, PR China) Mussel-Inspired Peptide Mimicking: An Emerging Strategy for Surface Bioengineering of Medical Implants, Smart Materials in Medicine (2020) 10.005

With the massive use of medical implants (e.g., metals, polymers and ceramics) in orthopedic and cardiovascular surgery, surface biomodification of these exogenous biomaterials has caused growing concern, for the purpose of improving their functions and avoiding surgical failure. Mussel-inspired chemistry (i.e., dopamine self-polymerization) based on covalent and noncovalent catechol-mediated molecular adhesion exhibits versatility in surface

biomodification. However, the inevitable consumption of amino and thiol groups in the bioactive molecules still make this robust surface chemistry in a dilemma. Taking this biomimetic strategy one step further, synthetic peptides with multiple DOPA (3,4-Dihydroxy-L-phenylalanine) units were recently extensively studied. Since the catecholic DOPA unit is abundant in the main component of mussel foot protein, these peptides are able to adhere onto various substrates. In addition, these mussel-inspired peptides could be flexibly linked with bioactive or attachable molecules, which can bypass the consumption of active groups in the second-step biomodification of poly (dopamine) method. Owing to these superiorities, mussel adhesive peptides mimics with diversified bioactivity are widely used for surface modification of medical implants to regulate different cell responses. The purpose of this review is to provide a brief overview of the latest developments in the surface bioengineering of medical implants using these mussel adhesive peptides mimics as a medium. We anticipate that the stepwise discussions from peptide mimicking and synthesis to surface bioactivity adaptation in different implants may also encourage researchers to innovate current mussel-inspired peptides at molecular level and expand their applications in the field of biomaterial engineering.

Keywords: medical implants, mussel adhesive peptide, surface biomodification, catechol group, cell behavior regulation

Amir Seyfoori[1], Mahdieh Shokrollahi Barough[2], Meitham Amereh[1], Bardia Khun Jush[1], Julian J.Lum[34], Mohsen Akbari[156] (1. Laboratory for Innovations in Micro Engineering (LiME), Department of Mechanical Engineering, University of Victoria, VIC, Canada, 2. ATMP Department, Breast Cancer Research Center, Motamed Cancer Institute, ACECR, Tehran, Iran, 3. Trev and Joyce Deeley Research Centre, BC Cancer Agency, Victoria, BC V8R 6V5, Canada, 4. Department of Biochemistry and Microbiology, University of Victoria, Victoria, BC V8W 2Y2, Canada, 5. Center for Biomedical Research, University of Victoria, VIC, Canada, 6. Center for Advanced Materials and Related Technologies, University of Victoria, VIC, Canada) **Bioengineered tissue models for the development of dynamic immuno-associated tumor models and high-throughput immunotherapy cytotoxicity assays, Drug Discovery Today, (2020) 11.028**

Cancer immunotherapy is rapidly developing, with numerous therapies approved over the past decade and more therapies expected to gain approval in the future. However, immunotherapy of solid tumors has been less successful because immunosuppressive barriers limit immune cell trafficking and function against cancer cells. Interactions between suppressive immune cells, cytokines, and inhibitory factors are central to cancer immunotherapy approaches. In this review, we discuss recent advances in utilizing microfluidic platforms for understanding cancer-suppressive immune system interactions. Dendritic cell (DC)-mediated tumor models, infiltrated lymphocyte-mediated tumor models [e.g., natural killer (NK) cells, T cells, chimeric antigen receptor (CAR) T cells, and macrophages], monocyte-mediated tumor models, and immune checkpoint blockade (ICB) tumor models are among the various bioengineered immune cell–cancer cell interactions that we reviewed herein.

Keywords: Bioengineering

Agnes M Resto Irizarry[1], Sajedeh Nasr Esfahani[1], Jianping Fu[123] (1. Department of Mechanical Engineering, University of Michigan, Ann Arbor, MI 48109, USA, 2. Department of Biomedical Engineering, University of Michigan, Ann Arbor, MI 48109,

USA, 3. Department of Cell and Developmental Biology, University of Michigan Medical School, Ann Arbor, MI 48109, USA) Bioengineered pluripotent stem cell models: new approaches to explore early human embryo development, Current Opinion in Biotechnology, (2020) Pages 52-58

Human development is a complex process in which environmental signals and factors encoded by the genome interact to engender cell fate changes and self-organization that drive the progressive formation of the human body. Herein, we discuss engineered biomimetic platforms with controllable environments that are being used to develop human pluripotent stem cell (hPSC)-based embryo models (or embryoids) that recapitulate a wide range of early human embryonic developmental events. Coupled with genome editing tools, single-cell analysis, and computational models, they can be used to parse the spatiotemporal dynamics that lead to differentiation, patterning, and growth in early human development. Furthermore, we discuss ongoing efforts in human extraembryonic lineage derivation and what can be learned from mouse embryoid models that have used both embryonic and extraembryonic stem cells. Finally, we discuss promising bioengineering tools for the generation of more controllable systems and the need for validation of findings from hPSC-based embryoid models.

Keywords: Bioengineering

Lars Symmank[a], Stephanie Natho[b], Mathias Scholz[c], Uwe Schröder[a], Katharina Raupach[d], Christiane Schulz-Zunkel[c] (a. German Federal Institute of Hydrology (BFG), Am Mainzer Tor 1, 56068 Koblenz, Germany, b. University of Potsdam (UP), Institute of Environmental Science and Geography, Karl-Liebknecht-Str. 24-25, 14476 Potsdam-Golm, Germany, c. Helmholtz Centre for Environmental Research (UFZ), Department of Conservation Biology, Permoserstraße 15, 04318 Leipzig, Germany, d. Georg-August University Göttingen, Department of Agricultural Economics and Rural Development, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany) **The impact of bioengineering techniques for riverbank protection on ecosystem services of riparian zones, Ecological Engineering (2020) 106040**

Rivers and floodplains are hotspots of biodiversity and provide an exceptional number of ecological functions. However, they are negatively affected by human impact worldwide. The need for restoration is high, but its realization is often hampered by antagonistic human interests. Replacing artificial riverbank protection with bioengineering techniques can be a first and straightforward step to restore riparian ecosystems. However, bioengineering still plays a marginal role in river management. We aim to introduce new arguments for bioengineering along riverbanks by applying the ecosystem service approach. We focus on major regulating services usually provided by floodplains. Denitrification and phosphorous retention were estimated by applying proxy-based models. Carbon sequestration within vegetation was calculated using biomass equations. Our study clearly indicates an increase of ecosystem services by bioengineering measures compared to conventionally fixed riverbanks. The dismantling of riprap removes up to 30 times more nitrogen and 20 times more phosphorous from the river load. Additional slope lowering increases both values up to 50-fold. The carbon storage capacity is four times higher in reed beds and 30 times higher in willow-brush mattresses. Our results show that bioengineering techniques for riverbank protection can be a

feasible tool to support general efforts towards enhancing the self-purification of rivers and contribute to mitigating climate change, especially if conducted on a larger scale.

Keywords: Biotechnical streambank stabilization, Riverbank restoration, Self-purification, Carbon sequestration, Nature-based solution, Buffer zone

Aurélien Tidu[ab], Marie-Claire Schanne-Klein[c], Vincent M.Borderie[ab] (a. Institut de la Vision, Sorbonne Université, INSERM, CNRS, Centre Hospitalier, National d'Ophtalmologie des 15-20, 75571, Paris, France, b. Groupe de Recherche Clinique 32, Sorbonne Université, Paris, France, c. Laboratory for Optics and Biosciences, LOB, Ecole Polytechnique, CNRS, Inserm, Université Paris-Saclay, 91128, Palaiseau, France) **Development, structure, and bioengineering of the human corneal stroma: A review of collagen-based implants, Experimental Eye Research (2020) 108256**

Bio-engineering technologies are currently used to produce biomimetic artificial corneas that should present structural, chemical, optical, and biomechanical properties close to the native tissue. These properties are mainly supported by the corneal stroma which accounts for 90% of corneal thickness and is mainly made of collagen type I. The stromal collagen fibrils are arranged in lamellae that have a plywood-like organization. The fibril diameter is between 25 and 35 nm and the interfibrillar space about 57 nm. The number of lamellae in the central stroma is estimated to be 300. In the anterior part, their size is 10–40 μm. They appear to be larger in the posterior part of the stroma with a size of 60–120 μm. Their thicknesses also vary from 0.2 to 2.5 μm. During development, the acellular corneal stroma, which features a complex pattern of organization, serves as a scaffold for mesenchymal cells that invade and further produce the cellular stroma. Several pathways including Bmp4, Wnt/β-catenin, Notch, retinoic acid, and TGF-β, in addition to EFTFs including the mastering gene Pax-6, are involved in corneal development. Besides, retinoic acid and TGF- β seem to have a crucial role in the neural crest cell migration in the stroma. Several technologies can be used to produce artificial stroma. Taking advantage of the liquid-crystal properties of acid-soluble collagen, it is possible to produce transparent stroma-like matrices with native-like collagen I fibrils and plywood-like organization, where epithelial cells can adhere and proliferate. Other approaches include the use of recombinant collagen, cross-linkers, vitrification, plastically compressed collagen or magnetically aligned collagen, providing interesting optical and mechanical properties. These technologies can be classified according to collagen type and origin, presence of telopeptides and native-like fibrils, structure, and transparency. Collagen matrices feature transparency >80% for the appropriate 500-μm thickness. Non-collagenous matrices made of biopolymers including gelatin, silk, or fish scale have been developed which feature interesting properties but are less biomimetic. These bioengineered matrices still need to be colonized by stromal cells to fully reproduce the native stroma.

Keywords: Artificial cornea, Collagen, Keratocytes, Stromal structure, Cornea development

Maria K.Koch[ab], Anna Jaeschke[ab], Berline Murekatete[a], Akhilandeshwari Ravichandran[a], Mikhail Tsurkan[c], Carsten Werner[c], Patsy Soond[ef], Dietmar W.Hutmacher[abh], Larisa M.Haupt[agh], Laura J.Bray[ab] (a. Institute of Health and Biomedical Innovation, Queensland University of Technology, Australia, b. School of Mechanical, Medical and Process Engineering, Science and Engineering Faculty, Queensland University of Technology, 60 Musk Avenue, Kelvin Grove, QLD 4059, Australia, c. Leibniz Institute of Polymer

Research Dresden, Germany, d. South Western Sydney Clinical School, University of New South Wales, Australia, e. Department of Surgery, Bankstown Hospital, South Western Sydney Local Health District, Australia, f. Ingham Institute for Applied Medical Research, Australia, g. Genomics Research Centre, Institute of Health and Biomedical Innovation, Queensland University of Technology, Australia, h. School of Biomedical Sciences, Faculty of Health, Queensland University of Technology, Australia) **Stromal fibroblasts regulate microvascular-like network architecture in a bioengineered breast tumour angiogenesis model, Acta Biomaterialia (2020) Pages 256-269**

The plasticity of the tumour microenvironment is a key contributor to cancer development and progression. Here, we present a bioengineered breast tumour angiogenesis model comprised of mammary derived epithelial, endothelial and fibroblast cells, to dissect the mechanisms of cancer-associated fibroblasts (CAFs) on microvascular-like network formation and epithelial spheroid morphology. Primary patient-derived mammary endothelial cells, normal breast fibroblasts (NBF, patient matched) and CAFs were cultured within three-dimensional (3D) semi-synthetic hydrogels where CAFs promoted an increase in the density and morphology of the microvascular-like network. The mammary microenvironment also increased the number of MCF-10a epithelial spheroids when compared with a non-mammary microenvironment, and a malignant mammary microenvironment resulted in further morphological differences in the epithelial spheroids. The morphological changes observed following interactions between breast CAFs and endothelial cells, highlight the plasticity of the malignant stroma in tumour vascularisation. Our in vitro bioengineered breast cancer microenvironment provides a robust model to study cell-cell and cell-matrix interactions.

Statement of Significance

In recent years there has been an increase in the sophistication of 3D culture models, however less attention has been paid to the cell source utilised. In this study, we describe the influence of a normal and malignant stromal microenvironment on vessel-like behaviour in a 3D model. Using a semi-synthetic hydrogel, we studied the effects of mammary-derived cancer-associated fibroblasts and normal fibroblasts on human umbilical vein endothelial cells or human mammary microvascular endothelial cells. An increase in vessel-like network and epithelial cell density was seen in a mammary versus non-mammary microenvironment. This study highlights the importance of using tissue-specific endothelial cells in cancer research and demonstrates the microenvironmental impact of fibroblasts on endothelial and epithelial growth and morphology.

Keywords: Breast cancer, Cancer-associated fibroblasts Hydrogel, Tumour microenvironment, Angiogenesis

Cui Li[a], Oliver Kitzerow[b], Fujiao Nie[a], Jingxuan Dai[a], Xiaoyan Liu[a], Mark A.Carlson[cde,] George P.Casal[ec], Iraklis I.Pipinos[c], Xiaowei Li[a] (a. Mary & Dick Holland Regenerative Medicine Program and Department of Neurological Sciences, College of Medicine, University of Nebraska Medical Center, Omaha, NE, 68198, United States, b. Department of Genetics Cell Biology and Anatomy, College of Medicine, University of Nebraska Medical Center, Omaha, NE, 68198, United States, c. Department of Surgery, University of Nebraska Medical Center, Omaha, NE, 68198, United States, d. Department of Genetics, Cell Biology and Anatomy, University of Nebraska Medical Center, Omaha, NE, 68198, United States, e. Omaha VA Medical Center, Omaha, NE, 68105, United States)

Bioengineering strategies for the treatment of peripheral arterial disease, Bioactive Materials (2021) Pages 684-696

Peripheral arterial disease (PAD) is a progressive atherosclerotic disorder characterized by narrowing and occlusion of arteries supplying the lower extremities. Approximately 200 million people worldwide are affected by PAD. The current standard of operative care is open or endovascular revascularization in which blood flow restoration is the goal. However, many patients are not appropriate candidates for these treatments and are subject to continuous ischemia of their lower limbs. Current research in the therapy of PAD involves developing modalities that induce angiogenesis, but the results of simple cell transplantation or growth factor delivery have been found to be relatively poor mainly due to difficulties in stem cell retention and survival and rapid diffusion and enzymolysis of growth factors following injection of these agents in the affected tissues. Biomaterials, including hydrogels, have the capability to protect stem cells during injection and to support cell survival. Hydrogels can also provide a sustained release of growth factors at the injection site. This review will focus on biomaterial systems currently being investigated as carriers for cell and growth factor delivery, and will also discuss biomaterials as a potential stand-alone method for the treatment of PAD. Finally, the challenges of development and use of biomaterials systems for PAD treatment will be reviewed.

Keywords: Hydrogels, Growth factors, Cell transplantation, Peripheral arterial disease

Pollen Biotechnology

Dariusz Kadluczka[a], Małgorzata Czernicka[a], Elwira Sliwinsk[ab], Monika Bieniasz[c], Katarzyna Maćkowska[a], Anna Kapczyńsk[ad], Ewa Grzebelus[a] (a. Department of Plant Biology and Biotechnology, Faculty of Biotechnology and Horticulture, University of Agriculture in Krakow, al. 29 Listopada 54, 31-425 Krakow, Poland, b. Laboratory of Molecular Biology and Cytometry, Faculty of Agriculture and Biotechnology, UTP University of Science and Technology, al. Kaliskiego 7, 85-789 Bydgoszcz, Poland, c. Department of Horticulture, Faculty of Biotechnology and Horticulture, University of Agriculture in Krakow, al. 29 Listopada 54, 31-425 Krakow, Poland, d. Department of Ornamental Plants and Garden Art, Faculty of Biotechnology and Horticulture, University of Agriculture in Krakow, al. 29 Listopada 54, 31-425 Krakow, Poland) **Development and quality of pollen in Lachenalia cultivars with determination of genome size and chromosome number, Scientia Horticulturae (2021) 109842**

The genus Lachenalia J. Jacq. ex Js. Murray (Asparagaceae) comprises 136 species endemic to South Africa and Namibia. These bulbous geophytes are considered to have excellent horticultural potential due to their morphological and genetic diversity, and thus have been chosen for the initiation of a breeding program to develop new cultivars that suitable for commercial use. From breeding perspective, studies on pollen viability and morphology are of great importance, since pollen quality represents an essential factor that influences crossbreeding processes. Therefore, to comprehensively characterize the pollen of selected Lachenalia cultivars, we conducted a multi-level analysis in which we investigated the processes of microsporogenesis and pollen grain development, as well as evaluated pollen morphology and viability. We also performed somatic chromosome counts and flow cytometry, thereby providing, for the first time, valuable cytogenetic data on the chromosome numbers and nuclear DNA contents of these cultivars. Morphologically, all the pollen grains were classified as

medium-sized, subspheroidal in shape, and monosulcate with a single elongated aperture. Their exine ornamentation was categorized as reticulate with a heterobrochate reticulum. The pollen viability analysis revealed one of the cultivars to be nearly completely sterile, however, we were able to explain this phenomenon and found that this cultivar was affected by meiotic abnormalities associated with its triploid nature. Based on the obtained results, three of the studied cultivars may be considered as suitable pollinizers. From the perspective of applied research, the findings of our research offer important information for selecting appropriate donors for cross-pollination in the development of new Lachenalia cultivars.

Keywords: Flower bulbs, Male gametophyte, Nuclear DNA content, Ornamental plants, Pollen morphology, Pollen viability

Yue Yang[ab], Ming-chang Liu[b], He Li[b], Yan-ge Yang[b], Ning Su[b], Ya-jun Wu[b], Hong Wang[a] (a. Guangdong Provincial Key Laboratory of Food Quality and Safety, South China Agricultural University, Guangzhou 510642, China, b. Chinese Academy of Inspection and Quarantine, No. 11, Ronghua South Street, Yizhuang Economic Zone, Beijing 100176, China) **Proteomics analysis of the protective effect of canola (Brassica campestris L.) bee pollen flavonoids on the tert-butyl hydroperoxide-induced EA.hy926 cell injury model, Journal of Functional Foods (2020) 104223**

Pollen contains various antioxidants, including flavonoids, which are beneficial to cardiovascular health. However, the protective effect and mechanism of pollen flavonoids extract on the cardiovascular system are still unclear. Herein, the protective effects of crude flavonoids of pollen (CFP) from canola (Brassica campestris L.) on tert-butyl hydroperoxide (TBHP)-induced cell injury were assessed in the EA.hy926 cell line. Then, the potential mechanism by which canola CFP protects vascular endothelial cells was explored at the proteome level and was verified by determining relevant indicators. Canola CFP exerted antioxidant and anti-inflammatory effects on the EA.hy926 cell injury model. Proteomics analysis and mechanism verification assays demonstrated that pretreatment with canola CFP produced effects primarily through maintenance of normal redox, mitochondrial function and lipid metabolism in cells. Our results indicate that canola CFP has great potential for preventing TBHP-induced vascular endothelial cell dysfunction.

Keywords: Canola bee pollen flavonoids, vascular endothelial cell injury, Protective effect, Protection mechanism

Jana Ščevková[a], Zuzana Vašková[a], Regina Sepšiová[b], Jozef Dušička[a], Jozef Kováč[c] (a. Comenius University, Faculty of Natural Sciences, Department of Botany, Révová 39, 811 02, Bratislava, Slovakia, b. Comenius University, Faculty of Natural Sciences, Department of Genetics, Ilkovičova 6, 842 48, Bratislava, Slovakia, c. Comenius University, Faculty of Mathematics, Physics and Informatics, Department of Applied Mathematics and Statistics, Mlynská dolina, 842 48, Bratislava, Slovakia) **Relationship between Poaceae pollen and Phl p 5 allergen concentrations and the impact of weather variables and air pollutants on their levels in the atmosphere, Heliyon (2020) e04421**

The sensitization to grass pollen is a known problem in European countries. Phl p 5 is an important allergen recognized by the majority of grass sensitized individuals. In this study, we evaluated daily variation in airborne Poaceae pollen and Phl p 5 allergen concentrations to determine whether airborne pollen concentrations alone are sufficient to reflect the actual allergenic potential of the air. The relationships between the mentioned pollen and allergen concentrations and associated environmental variables were also examined. The airborne particles were collected during the Poaceae flowering season in Bratislava in 2019. Pollen sampling was performed using a Hirst-type sampler, while a cyclone sampler was used for the aeroallergen capturing. Allergenic molecules were quantified by ELISA assay. The associations between pollen and allergen concentrations showed that these two variables are positively correlated; however, the correlation was not significant. We observed the concurrent occurrence of airborne pollen and allergen peaks on the same day. Nevertheless, during some days of the pollen season, the allergen concentrations did not correspond to the airborne pollen values. Moreover, the days with low pollen concentration but high pollen potency and vice versa were observed. The effect of selected environmental variables on daily pollen and allergen concentrations was evaluated through Spearman's correlation analysis. Of all meteorological variables considered, air temperature, precipitation, and relative air humidity were significantly correlated with airborne pollen and/or allergen concentrations. The association with air temperature was positive, while the negative association was observed with precipitation and relative air humidity. Among the atmospheric pollutants, O3 and PM10 were significantly and positively associated with both pollen and allergen concentrations, whereas CO and PM2.5 were significantly and positively associated only with pollen concentration.

Keywords: Grass pollen, Aeroallergens, Meteorological parameters, Atmospheric pollutants, Bratislava, Central Europe, Atmospheric science, Environmental analysis, Environmental health, Environmental pollution, Microbiology, Environmental science

Saqer S.Alotaibi[a], Samy M.Sayed[b], Manal Alosaimi[a], Raghad Alharthi[a], Aseel Banjar[a], Nosaiba Abdulqader[a], Reem Alhamed[a] (a. Biotechnology Department, College of Science, Taif University, Taif, Saudi Arabia, b. Faculty of Agriculture, Cairo University, Giza 12613, Egypt) **Pollen molecular biology: Applications in the forensic palynology and future prospects: A review, Saudi Journal of Biological Science (2020) Pages 1185-1190**

Palynology, which is the study of pollen and spores in an archaeological or geological context, has become a well-established research tool leading to many significant scientific developments. The term palynomorph includes pollen of spermatophytes, spores of fungi, ferns, and bryophytes, as well as other organic-walled microfossils, such as dinoflagellates and acritarches. Advances in plant genomics have had a high impact on the field of forensic botany. Forensic palynology has also been used and applied more recently to criminal investigation in a meaningful way. However, the use of pollen DNA profiling in forensic investigations has yet to be applied. There were earlier uses of dust traces in some forensic analyses that considered pollen as a type of botanical dust debris. Pollen grains can be studied for comparative morphological data, clues to unexpected aspects relating to breeding systems, pollination biology and hybridization. This can provide a better understanding of the entire biology of the group under investigation. Forensic palynology refers to the use of pollen and other spores when it is used as evidence in legal cases to resolve criminal issues by proving or disproving relationships between people and crime scenes. This overview describes the various contributions and the

significance of palynology, its applications, and different recent approaches and how it could be further employed in solving criminal investigations.

Keywords: Palynology, Forensic, Forensic palynology, Pollen, Spores

B.C.Campbell[a], J.Al Koub[ab], V.Timbrell[a], M.J.Noor[c], K.Massel[d], E.K.Gilding[d], N.Angel[e], B.Kemish[e], P.Hugenholtz[e], I.D.Godwin[d], J.M.Davies[af] (a. Queensland University of Technology, Brisbane, Australia, b. Maquarie University, Sydney, Australia, c. Fatema Jinnah Women University, Rawalpindi, Pakistan d. The University of Queensland, Brisbane, Australia, e. Australian Centre for Ecogenomics, School of Chemistry and Molecular Biosciences, The University of Queensland, Brisbane, Australia, f. Metro North Hospital and Health Service, Brisbane, Australia) **Tracking seasonal changes in diversity of pollen allergen exposure: Targeted metabarcoding of a subtropical aerobiome, Science of The Total Environment (2020) 141189**

The importance of grass pollen to the global burden of allergic respiratory disease is well established but exposure to subtropical and temperate pollens is difficult to discern. Current monitoring of airborne pollen relies on light microscopy, limiting identification of taxa to family level. This informs seasonal fluctuations in pollen aerobiology but restricts analysis of aerobiological composition. We aimed to test the utility of DNA metabarcoding to identify specific taxa contributing to the aerobiome of environmental air samples, using routine pollen and spore monitoring equipment, as well as assess temporal variation of Poaceae pollen across an entire season. Airborne pollen concentrations were determined by light microscopy over two pollen seasons in the subtropical city of Brisbane (27°32′S, 153°00E), Australia. Thirty daily pollen samples were subjected to high throughput sequencing of the plastid rbcL amplicon. Amplicons corresponded to plants observed in the local biogeographical region with up to 3238 different operational taxonomic units (OTU) detected. The aerobiome sequencing data frequently identified pollen to genus levels with significant quantitative differences in aerobiome diversity between the months and seasons detected. Moreover, multiple peaks of Chloridoideae and Panicoideae pollen were evident over the collection period confirming these grasses as the dominant Poaceae pollen source across the season. Targeted high throughput sequencing of routinely collected airborne pollen samples appears to offer utility to track temporal changes in the aerobiome and shifts in pollen exposure. Precise identification of the composition and temporal distributions of airborne pollen is important for tracking biodiversity and for management of allergic respiratory disease.

Keywords: Aerobiome, Allergic rhinitis, Metabarcoding, Next generation sequencing, Pollen-monitoring, Subtropics

Ya-Jie Chen, Xiao-Xue Yang, Wen-Chao, Li Shu-Qing Zhao (Key Laboratory of Chemical Biology and Molecular Engineering of Ministry of Education, Institute of Biotechnology, Shanxi University, Taiyuan, 030006, China) **Plant Science (2020) 110645**

ROOT UV-B SENSITIVE4 (RUS4) encodes a Domain of Unknown Function647 (DUF647) protein, whose function is poorly understood, We have previously shown the artificial microRNA knockdown Arabidopsis RUS4 plants, referred to as amiR-RUS4, have severely

reduced male fertility with a defect in anther dehiscence. Here, we show that amiR-RUS4 plants are also defective in pollen maturation and germination. Promoter-reporter analysis shows that RUS4 is highly expressed in tapetal layer, developing microspores, mature and germinating pollen, strongly suggesting its role in the process of pollen maturation. As the translational RUS4-GFP fusion protein has been localized to the chloroplasts where the first step of jasmonic acid (JA) biosynthesis takes place, leading to the hypothesis that RUS4 may be involved in JA-mediated stamen development. We show that expression of several JA metabolic genes increased markedly in flower buds of the amiR-RUS4 plants compared to that of the wild-type. We further show that transcript abundance of a clade of the JA-responsive MYB transcript factor genes, especially MYB108, reduced significantly in stamens of amiR-RUS4 plants relative to the wild-type; these MYB transcript factors have been shown to be required for JA-mediated stamen and pollen maturation. Our data suggest that RUS4 may play a role in coordinating anther dehiscence and pollen maturation by affecting the expression of JA-related genes.

Keywords: Arabidopsis thaliana, Jasmonate, Pollen maturation, Pollen germination, RUS4

Zhou Shumin[ab], Zhang Luying[a], Lu Senlin[a], Peng Jiaxian[a], Li Yang[b], Rao Lanfang[a], Xie Tingting[a], Zhang Wei[b], Li Shuijun[c], Wang Weqian[d], Wang Qingyue[d] (a. School of Environmental and Chemical Engineering, Shanghai University, Shanghai 200444, China, b. Lab of Plant Cell Biology, Shanghai Key Laboratory of Bio-Energy Crops, School of Life Sciences, Shanghai University, Shanghai 200444, China, c. Shanghai Xuhui Center Hospital, Shanghai 200031, China, d. School of Science and Engineering, Saitama University, Saitama 338-8570, Japan) **Ambient particulate matter-associated autophagy alleviates pulmonary inflammation induced by Platanus pollen protein 3 (Pla3), Science of The Total Environment (2020) 143696**

Subpollen particles (SPPs) with diameter less than 1 mm released from allergenic pollen grains contain allergens could trigger asthma and lung inflammation after being inhaled. In the meaning time, ambient fine particles attached on the pollen grains could have further effects on the inflammation. However, the mechanisms underlying these phenomena have not been fully elucidated. In this study, the effects of autophagy triggered by PM2.5 and Platanus SPPs were evaluated by using the A549 cell lines and a pollen sensitized rat model. First, autophagy in A549 cells was analyzed after exposure to PM2.5 using acridine orange staining, real-time quantitative PCR (qRT-PCR), and western blot (WB) assays. The increased levels of ROS, superoxide dismutase, and malonaldehyde in the lung homogenates of rats exposed to SPPs indicated that inflammatory response was triggered in the lungs. Treatment with autophagy-inhibiting drugs showed that autophagy suppressed ROS formation and decreased the production of thymic stromal lymphopoietin (TSLP), a critical pathway altering the inflammatory response. Although the effect was indirect, autophagy appeared to negatively regulate TSLP levels, resulting in a compromised immune response. These results suggested that SPPs promote ROS generation and increase TSLP levels, triggering downstream inflammation reactions. However, ambient PM2.5 could aggravate autophagy, which in turn effectively suppressed ROS and TSLP levels, leading to the alleviation of the immune response and pulmonary inflammation.

Keywords: Autophagy, Aeroallergens, Pollen allergy, thymic stromal lymphopoietin

Min-Jung Yook[a], Hae-Rim Park[a], Chuan-Jie Zhang[ab], Soo-Hyun Lim[a], Soon-Chun Jeong[c], Young Soo Chung[d], Do-Soon Kim[a] (a. Department of Plant Science, Department of

Agriculture, Forestry and Bioresources, Research Institute of Agriculture and Life Sciences, College of Agriculture and Life Sciences, Seoul National University, Seoul, Republic of Korea, b. College of Animal Science and Technology, Yangzhou University, Jiangsu Province, People's Republic of China, c. Bio-Evaluation Center, Korea Research Institute of Bioscience and Biotechnology, Cheongju, Chungbuk, Republic of Korea, d. Department of Genetic Engineering, Dong-A University, Busan, Republic of Korea) **Environmental risk assessment of glufosinate-resistant soybean by pollen-mediated gene flow under field conditions in the region of the genetic origin, Science of The Total Environment (2020) 143073**

Pollen-mediated gene flow of genetically modified crops to their wild relatives can facilitate the spread of transgenes into the ecosystem and alter the fitness of the consequential progeny. A two-year field study was conducted to quantify the gene flow from glufosinate-ammonium resistant (GR) soybean (Glycine max) to its wild relative, wild soybean (G. soja), and assess the potential weed risk of hybrids resulting from the gene flow during their entire life cycle under field conditions in Korea, where wild soybean is the natural inhabitant. Pollen-mediated gene flow from GR soybeans to wild soybeans ranged from 0.292% (mixed planting) to 0.027% at 8 m distance. The log-logistic model described the gene flow rate with increasing distance from GR soybean to wild soybean; the estimated effective isolation distance for 0.01% gene flow between GR and wild soybeans was 37.7 m. The F1 and F2 hybrids exhibited the intermediate characteristics of their parental soybeans in their vegetative and reproductive stages. Canopy height and stem length of hybrids were close to those of wild soybean, which shows an indeterminate growth; the numbers of flowers, pods, and seeds per hybrid plant were close to those of wild soybean and significantly higher than those of GR soybean. Seed longevity of F2 hybrid plants was also intermediate but significantly greater than that of GR soybean due to high seed dormancy. Our results suggest that transgenes of the GR soybean might disperse into wild populations and persist in the agroecosystem of the genetic origin regions due to the pollen-mediated gene flow and the relatively high fitness of the hybrid progeny.

Keywords: Glufosinate resistance, Relative fitness, Seed longevity, Transgene flow, Weed risk

Biotechnology Policy Issue

X. Cuong Nguyen[ab], Thi Phuong Quynh Tran[c], T. Thanh Huyen Nguyen[ab], D. Duc La[d], V. Khanh Nguyen[e], T. Phuong Nguyen[f] X.H.Nguyen[g], S.W.Chang[h], R.Balasubramanih W. JinChung[h], D. Duc Nguyen[hi] (a. Center for Advanced Chemistry, Institute of Research and Development, Duy Tan University, Da Nang, 550000, Viet Nam, b. Faculty of Environmental Chemical Engineering, Duy Tan University, Da Nang, 550000, Viet Nam, c. Hoa Vang High School, Department of Education and Training, Da Nang, 550000, Viet Nam, d. Institute of Chemistry and Materials, Nghia Do, Cau Giay, Hanoi, Viet Nam, e. Department of Microbiology, Pusan National University, South Korea, f. Département de Chimie, Biochimie et Physique, Université du Québec à Trois-Rivières (UQTR), Trois-Rivières, QC, G8Z 4M3, Canada, g. Faculty of Environment – Natural Resources and Climate Change, Ho Chi Minh City University of Food Industry, Ho Chi Minh City, Viet Nam, h. Department of Environmental Energy Engineering, Kyonggi University, Suwon, South Korea, i. Faculty of Environmental and Food Engineering, Nguyen Tat Thanh

University, 300A Nguyen Tat Thanh, District 4, Ho Chi Minh City, 755414, Vietnam) Call for planning policy and biotechnology solutions for food waste management and valorization in Vietnam, Biotechnology Reports, Volume 28, December 2020, e00529

Food waste (FW) is more harmful than previously imagined. A large amount of Vietnam's FW ends up in landfills, only 20 % of which are sanitary. This causes significant environmental problems such as greenhouse gas emissions, high carbon footprint, leachate, and landfill-related conflicts. The FW from Vietnam's urban areas is 0.29 kg p−1 d−1, accounting for 31.7 % of total waste. 38.81 % of families discharge FW which, along with municipal waste, corresponds to 4,429.21 ton d−1 for the entire country. For FW collection, under transportation and treatment heads, 80,416.95 $ d−1 and 74,605.57 $ d−1 were spent, respectively. An analysis of Vietnam's national strategy for the integrated management of solid waste indicates that the amount of attention and concern currently given to FW issues is not adequate to address them. To resolve FW issues, Vietnam needs to be more proactive regarding solutions and efforts, in addition to implementing strict regulations. These include the setting of national goals under the priority of national strategy, strict regulations, stake holder engagement, FW recycling to animal feed, biorefinery, and awareness-raising campaigns.

Keywords: Food waste, Animal feed, Fertilizer, Biorefinery, Waste management.

Agricultural Biotechnology

Pedro F.N.Souza (Laboratory of Plant Defense Proteins, Department of Biochemistry and Molecular Biology, Federal University of Ceará, Fortaleza, Ceará CEP 60.440-554, Brazil) The forgotten 2S albumin proteins: Importance, structure, and biotechnological application in agriculture and human health, International Journal of Biological Macromolecules, (2020) Pages 4638-4649

2S albumin proteins are a group of important seed storage proteins (SSPs) essential to seeds at early and late developmental stages, by providing amino acids and other nutrients during germination and for seed defense. 2S albumins possess a well-conserved cysteine supporting the stability of temperature, pH, and proteolysis. The 3D structure rich in alpha-helices and positively charged is particularly suited for antibacterial and antifungal activity, which is presented by many 2S albumins. However, the hypervariable region present in 2S albumins induces allergenic reactions. Because of that, 2S albumins have never been recognized for their biotechnological potential. However, the development of servers used for the rational design of antimicrobial molecules has now brought a new application to 2S albumins, acting as a model to design antimicrobial molecules without the toxic or allergenic effects of 2S albumins. Therefore, this review is focused on discussing the importance of 2S albumins to seed development and defense and the biochemical, structural and functional properties of these proteins thought to play a role in their antimicrobial activity. Additionally, the application of 2S albumins to design synthetic antimicrobial peptides is discussed, potentially bringing new functions to these forgotten proteins.

Keywords: Seed storage proteins, Antimicrobial activity, Biotechnological potential

Bioenergy

Sam Cross[a], Andrew J.Welfle[bd], Patricia Thornley[cd], Sanna Syri[a], Mikael Mikaelsson[e] (a. Department of Mechanical Engineering, Aalto University, Espoo, Finland, b. Tyndall Centre for Climate Change Research, Department of Mechanical, Aerospace and Civil Engineering, University of Manchester, UK, c. Energy & Bioproducts Research Institute, School of Engineering & Applied Science, Aston University, Birmingham, B4 7ET, United Kingdom, d. UK Supergen Bioenergy Hub, United Kingdom, e. UK Foreign & Commonwealth Office, Science & Innovation Team, British Embassy Stockholm, Sweden) **Bioenergy development in the UK & Nordic countries: A comparison of effectiveness of support policies for sustainable development of the bioenergy sector, Biomass and Bioenergy (2021) 105887**

This paper uses both quantitative and qualitative analyses to evaluate the effectiveness of government policy and support mechanisms in the UK, Sweden, Denmark and Finland in promoting bioenergy – a key technology fundamental to each country's decarbonisation strategies. It is crucial that countries develop effective policies and support mechanisms to grow sustainable bioenergy sectors. This paper analyses the success of bioenergy policies within each country and evaluates the importance of wider independent variables that collectively characterise the background to energy sector, economic and environmental dynamics. Statistical correlation and regression analyses are applied to identify if the policy landscape has had an identifiable impact on actual bioenergy development. Furthermore, the outputs from a stakeholder workshop and expert interviews are analysed to identify drivers and barriers to bioenergy. The result is a comprehensive analysis of the successes and challenges in bioenergy development, and possible lessons that can be drawn for future promotion of the sector. The research finds that the UK and Nordic countries have had different yet equally successful approaches to promoting bio-power and bio-heat respectively. However, the influence of wider factors within different countries is found to have a potentially greater collective impact on bioenergy than any single policy mechanism. Thus there is credence in learning lessons from what does and does not work in different countries, but countries also need to develop their own brands of policy interventions that suit their country's unique challenges.

Keywords: Bioenergy, UK, Nordic, Policy, Support

Mirjam Röder[a], Alison Mohr[b], Yan Liu[c] (a. Supergen Bioenergy Hub, Energy & Bioproducts Research Institute, School of Engineering & Applied Science, Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom, b. School of Sociology and Social Policy, University of Nottingham, University Park, Nottingham, NG7 2RD, United Kingdom, c. Department of Biosystems and Agricultural Engineering, Michigan State University, East Lansing, USA) **Sustainable bioenergy solutions to enable development in low- and middle-income countries beyond technology and energy access, Biomass and Bioenergy, (2020) 105876**

Bioenergy is the main renewable energy source and the main primary energy source in low- and middle-income countries (LMIC). However, in many cases biomass use is unsustainable and inefficient, resulting in significant environmental and health risks. This short communication

synthesises the key findings from 15 research articles published in the Special Issue "Development of modern bioenergy approaches in low- and middle-income countries" published in the journal Biomass & Bioenergy and highlights the overarching research and deployment challenges of bioenergy in a LMIC context. The research presented in the Special Issue shows the relevance of demand-driven and participatory approaches and understanding the technical, environmental, economic and social implications of bioenergy and the synergies with other sectors to enable the full potential of sustainable bioenergy. The findings also show the contribution modern bioenergy systems can make to energy access and human and economic development, underpinning several of the Sustainable Development Goals. While there is large agreement that bioenergy can provide environmental, economic and social co-benefits, research not always capture the full breadth of sustainability and often focuses at the most obvious environmental and economic benefits such as climate change, energy access, related economic development and sustainable production and innovation. Including less visible co-benefits in the evaluation of bioenergy systems would strengthen the analysis of non-monetary values and would support institutional and commercial decision making beyond renewable energy and energy access, underpinning the overarching concept of the SDGS of "leaving no one behind".

Keywords: Bioenergy, Low- and middle-income countries, International development, Technology innovation, Sustainability

N.Gómez-Marín, A.V.Bridgwater (Energy and Bioproducts Research Institute (EBRI), Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom) Mapping bioenergy stakeholders: A systematic and scientometric review of capabilities and expertise in bioenergy research in the United Kingdom, Renewable and Sustainable Energy Reviews (2020) 110496

This work, led by the SUPERGEN Bioenergy Hub of United Kingdom (UK), examines the current status of the UK bioenergy research, identifies important research gaps and makes recommendations for exploitation of current capabilities and future research development. It was based on a survey-based research covering 71 bioenergy research stakeholders' responses and a taxonomy map with key bioenergy topics and subtopics carefully defined. This novel study adapts the concept of "business intelligence" to innovation, in order to transform data into actionable intelligence that informs about strategic decisions.

The map shows that the UK bioenergy research explores the whole bioenergy chain, and the areas with high probability of exploitation and improvement identified are: biomass pre-treatment; application of bioenergy products and standardisation, portfolio of commercialisation opportunities, and research into market opportunities. Working on them will help technology and bio-products to be market-ready.

To complement the outcomes of this map, a scientometric review was done through analysing the trend of the number of publication, publication impacts, and stakeholders' co-authorships. The study reveals that pyrolysis had the highest number of publications during 2017, in agreement with the major number of participants; and the highest publication growth was found in both pyrolysis and gasification. Conversely, combustion, which had the lowest number of stakeholders (by 30%), had the highest number of publications until 2015, indicating combustion research is more concentrated in specific stakeholders. Hydrolysis and fermentation showed high number of research stakeholders, but the lowest number of publications suggest that more effort in publication should be done.

Keywords: Bioenergy, Biomass, State of the art, Taxonomy map, Scientometric review, Research gaps, Research stakeholders, Knowledge management

Daniela Thrän[ab], Martin Bauschmann[a], Nicolaus Dahmen[c], Berit Erlach[d], Katharina Heinbach[e], Bernd Hirschl[ef], Jan Hildebran[dg], Irina Rau[g], Stefan Majer[a], Katja Oehmichen[a], Petra Schweizer-Ries[g], Christiane Hennig[a] (a. Deutsches Biomasseforschungszentrum Gemeinnützige GmbH—DBFZ, Torgauer Straße 116, 04347, Leipzig, Germany, b. Helmoltz-Centre for Environmental Research – UFZ, Permoserstraße 15, 04318, Leipzig, Germany, c. Karlsruhe Institute of Technology (KIT) - Hermann-von-Helmholtz-Platz 1, 76344, Eggenstein-Leopoldshafen, Germany, d. Acatech – National Academy of Science and Engineering, Pariser Platz 4a, 10117, Berlin, Germany, e. Institut für ökologische Wirtschaftsforschung (IÖW) GmbH, Gemeinnützig, Potsdamer Str. 105, 10785, Berlin, Germany, f. Brandenburgische Technische Universität Cottbus-Senftenberg, Universitätsplatz 1, 01968, Senftenberg, Germany, g. Institut für ZukunftsEnergie- und Stoffstromsysteme, Altenkesseler Str. 17, D66115, Saarbrücken, Germany)

To fulfil the ambitious greenhouse gas reduction targets in Germany requires a fundamental transformation of the energy system. Accordingly, today's bioenergy value chains are faced with substantial transformations to find their role in 2050's low carbon emission energy and supply systems. In this regard, not only economic, environmental, and social aspects need to be taken into consideration. The technology maturity, flexible energy generation and supply and the ability to combine the technologies with CO2 capture are relevant aspects for future bioenergy systems. To evaluate appropriate options for a future energy system an assessment framework with 29 criteria was developed in form of an assessment matrix, and applied for several bioenergy technology pathways.
The results show much larger challenges for the implementation and transformation of lignocelluse-based pathways than of biogas-based ones. Trade-offs of the assessment criteria are shown in a heat map. Results might support policy decision makers to develop and implement a long term bioenergy strategy and thus a successful transformation towards a sustainable energy system 2050.

Keywords: Bioenergy, Germany, Renewable energy systems, Bioenergy carbon capture and storage, integrated assessment, Climate policy

A.Anca-Couce[a], C.Hochenauer[ab], R.Scharler[ab] (a. Institute of Thermal Engineering, Graz University of Technology, Inffeldgasse 25b, 8010, Graz, Austria, b. BEST – Bioenergy and Sustainable Technologies GmbH, Inffeldgasse 21b, 8010, Graz, Austria) Bioenergy technologies, uses, market and future trends with Austria as a case study, Renewable and Sustainable Energy Reviews (2021) 110237

The current bioenergy uses and conversion technologies as well as future trends for the production of heat, power, fuels and chemicals from biomass are reviewed. The focus is placed in Austria, which is selected due to its high bioenergy utilization, providing 18.4% of the gross energy final consumption in 2017, and its strong industrial and scientific position in the field. The most common bioenergy application in Austria is bioheat with 170 PJ in 2017 mainly

obtained from woody biomass combustion, followed by biofuels with 21 PJ and bioelectricity with 17 PJ. Bioheat has a stable market, where Austrian manufacturers of boilers and stoves have a strong position exporting most of their production. Future developments in bioheat production should go in the line of further reducing emissions, increasing feedstock flexibility and coupling with other renewables. For bioelectricity and biofuels, the current framework does not promote the growth of the current main technologies, i.e. combined heat and power (CHP) based on biomass combustion or biogas and first generation biofuels. However, an increase in all bioenergy uses is required to achieve the Austrian plan to be climate neutral in 2040. The current initiatives and future possibilities to achieve this increase are presented and discussed, e.g. mandatory substitution of old oil boilers, production of biomethane and early commercialization of CHP with a high efficiency or demonstration of advanced biofuels production based on gasification.

Keywords: Bioenergy, Austria, Bioheat, Bioelectricity, Biofuel, Future trends

Wen Wang[a], Kritsadaporn Pornint[ab], Pruk Aggarangsi[d], Noppol Leksawasdi[bc], Lianhua Li[a], Xiaoyan Chen[a], Xinshu Zhuang[a], Zhenhong Yuan[ae], Wei Qi[a] (a. Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, CAS Key Laboratory of Renewable Energy, Guangdong Provincial Key Laboratory of New and Renewable Energy Research and Development, Guangzhou, 510640, PR China, b. Cluster of Agro Bio-Circular-Green Industry (Agro BCG) and Bioprocess Research Cluster (BRC), School of Agro-Industry, Faculty of Agro-Industry, Chiang Mai University, Chiang Mai, 50100, Thailand, c. Center of Excellence in Materials Science and Technology, Faculty of Science, Chiang Mai University, Chiang Mai, 50100, Thailand, d. Department of Mechanical Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai, 50100, Thailand, e. Collaborative Innovation Center of Biomass Energy, Zhengzhou, 450002, PR China) **Bioenergy development in Thailand based on the potential estimation from crop residues and livestock manures, Biomass and Bioenergy (2021) 105914**

Bioresource evaluation is prerequisite and important to reduce cost of feedstock collection and avoid battle for feedstock to promote the healthy development of bioenergy industry. This study estimated Thai bioresources from arable field crops, horticultural plants and livestock with product quantity or livestock number, residue-product ratio or manure productivity, and moisture content. Rice straw and husk, Para rubber residues and cattle manure separately have the top amount in arable field crop biomass, horticultural residues and livestock manures. The northeastern region has the most amounts of arable field crop biomass and livestock manures, and the southern region possesses the largest quantities of horticultural residues. The available energy potentials from residues of arable field crops and horticultural plants can reach to maximum of 4.91 × 105 TJ and 7.65 × 105 TJ, respectively, which can theoretically share 21.67% of current total primary energy supply. The available biogas potential from livestock manures is nearly ten times than its current generation. After analysis the status of technologies and government policies for Thai bioenergy industry, it indicates that the utilization of bioenergy in the form of electricity, heat and transportation fuels has promising prospect in Thailand. The provinces of Thailand which are more suitable for developing bioenergy industry are suggested. This work may guide the reasonable layout of bioenergy industry in Thailand via the presence of bioresouces distribution in every province.

Keywords: Arable field crops, Horticultural plants, Livestock, Biogas, Lignocellulose, Biofuels

Richa Kothari[ag], Ashutosh Vashishth[ab], Har Mohan Singh[c], Vinayak V.Pathak[d], V.V.Tyagi[c], B.C.Yadav[e], Veeramuthu Ashokkumar[f], D.P.Singh[g] (a. Department of Environmental Sciences, Central University of Jammu, Samba, (J&K), 181143, India, b. School of Business, Shri Mata Vaishno Devi University, Jammu, Katra, (J&K), 182320, India, c. School of Energy Management, Shri Mata Vaishno Devi University, Katra, (J&K), 182320, India, d. Department of Chemistry, Manav Rachna University, Faridabad, Haryana, India, e. Department of Physical Sciences, Babasaheb Bhimrao Ambedkar University, Lucknow 226025, U.P., India, f. Department of Chemical Technology, Chulaloangkorn University, Bangkok, Thailand, g. Department of Environmental Sciences, Babasaheb Bhimrao Ambedkar University, Lucknow 226025, U.P., India) **Assessment of Indian bioenergy policy for sustainable environment and its impact for rural India: Strategic implementation and challenges, Environmental Technology & Innovation (2020) 101078**

Indian energy scenario has been suffering from persistent problems of reliable supply of energy and environmental deterioration. Among various available renewable energy sources, India has abundance of bioenergy options that used since long time to meet the cooking and heating requirements. Bioenergy economy is totally dependent on market of supply and demands, interdependent to each other. However, traditional bioenergy applications were found as inefficient practice with harmful environment impacts. Modern bioenergy technologies have potential to fulfill the demand and supply gap of the country. Furthermore, they have high energy efficiency with low carbon emissions. Bioenergy technologies such as biogas, biodiesel, bio-ethanol and biomass gasification has potential for cooking, transport and power generation. Various bioenergy policies and programs have been introduced to accelerate the bioenergy in India in past years. However, country is unable to use adequate available potential of bioenergy options due to policy gaps. Implementation of bioenergy policy is allied with various challenges like technical, institutional, financial, environmental and social aspects. Indian government introduces the new bioenergy policy to accelerate the bioenergy based generation in India. Thus, this article attempts to explore and critically analyze the present bioenergy policies and possible options of recent Indian experiences for successful adoption of bioenergy. A survey based findings is also analyzed through logistic regression and linear regression to explain the pattern of awareness and willingness to pay for bioenergy technology with reference to biogas and improved cookstoves. We found that socio-economic variables are important parameters for the success of bioenergy policies in rural India.

Keywords: Bioenergy, Bioenergy policy, Biofuel, Biogas, Bio-waste

Samira Garcia-Freites[a], Mirjam Röder[ab], Patricia Thornley[ab] (a. Tyndall Centre for Climate Change Research, Department of Mechanical, Aerospace and Civil Engineering, University of Manchester, UK, b. Supergen Bioenergy Hub, Energy and Bioproducts Research Institute (EBRI), School of Engineering and Applied Science, Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom) **Environmental trade-offs associated with bioenergy from agri-residues in sub-tropical regions: A case study of the Colombian coffee sector, Biomass and Bioenergy (2020) 105581**

The coffee sector generates vast amounts of residues along its value chain. Crop residues, like coffee stems, are burned in the field, used for domestic cooking or coffee drying in processing plants having significant environmental and health implication to rural communities. This research investigated the environmental impacts of replacing current practices with modern bioenergy applications in the Colombian coffee sector. A biomass gasification system to produce decentralised energy from coffee stems was considered, and the environmental impacts of such bioenergy implementation were evaluated. A lifecycle assessment was conducted to quantify the environmental performance of this bioenergy system and compare it to current residues uses and energy needs that feature small-to large-scale coffee farms. The results show that deploying modern bioenergy could result in reductions in 48–86% greenhouse gas (GHG) emissions and up to 98% less particulate matter formation when current practices and fossil-based energy are replaced. However, negative impacts should be considered as substituting grid electricity, largely generated from hydro-electricity, could increase GHGs by 68% and fossil fuel consumption by 73%. The results also show the relevance of understanding the environmental performance of bioenergy systems compared to reference scenarios; this allowed to evaluate and identify environmental trade-offs from modern bioenergy implementations. To maximise benefits and minimise the limitations of these systems, it is important to conduct whole-system assessments that inform on the wider environmental impacts of using agri-residues for bioenergy generation in a region- and system-specific context.

Keywords: Bioenergy, Lifecycle assessment, Coffee stems, Gasification, Environmental trade-offs, Colombia

Nano Biotechnology

Nisha Singh[a], B.S.Dhany[ab], Madan L.Verma[c] (a. DBT-IOC Centre For Advanced Bioenergy Research, R&D Indian Oil Corporation, Faridabad 121002, Haryana, India, b. Department of Biotechnology, Udaya School of Engineering, Udaya Nagar, Kanyakumari, Tamil Nadu 629 204, India, c. Department of Biotechnology, School of Basic Sciences, Indian Institute of Information Technology Una, Himachal Pradesh, 177220, India) **Nano-immobilized biocatalysts and their potential biotechnological applications in bioenergy production, Materials Science for Energy Technologies (2020) Pages 808-824**

Developing highly efficient biocatalyst is a pertinent requirement for biofuels production, in particularly biodiesel/bioethanol. To circumvent the minimal efficiency of conventionally used biocatalysts, nanotechnology paves a way by indulging nanoparticles as carriers of biocatalysts. The nanobiocatalysts so formed are applied as a tool for utilizing wide set of biomass related molecules into biofuels. The disadvantages of conventional biocatalysts such as catalyst deactivation, mass transfer, poisoning, and long reaction time can be outstripped by novel nanobiocatalysts. Nanobiocatalyst increases the catalytic activity; and this higher activity is because of the increased surface to volume ratio and hence it can act as a deoxygenation catalyst too. In recent years, exploiting modern tools for nanoparticles synthesis and characterization yielded high quality optimized and conditioned nanocatalyst systems such as metal oxide nanoparticles, magnetic nanoparticles, and carbon nanotubes to increase the biofuel productivity. Nanomaterial immobilized lipases and cellulases are predictably innovative catalysts having remarkable properties. The present article is critically discussed various nanomaterial immobilized enzyme development and its influence over production of biofuel. Continuous

research and development and novel nanobiocatalyst engineering is essential for stabilization of biofuel producing companies.

Keywords: Nanomaterial, Nano-immobilized lipases, Nano-immobilized cellulase, Immobilization, Nanobiocatalysts, Biofuel, Nanoparticle synthesis

Biomimicry

Samantha Hayes[a], Cheryl Desha[a], Dayna Baumeister[b] (a. School of Engineering and Built Environment, Cities Research Institute, Griffith University, 170 Kessels Road, Nathan, Brisbane QLD 4111, Australia, b. The Biomimicry Center, Arizona State University, PO Box 873505, Tempe AZ 85287-3505) **Learning from nature – Biomimicry innovation to support infrastructure sustainability and resilience, Technological Forecasting and Social Change (2020) 120287**

Regenerative development calls for built environment design, construction and operation approaches that do not degrade social and ecological systems but actively regenerate them, with net positive performance outcomes. Within infrastructure, existing industry approaches focus on improving sustainability and resilience through progressive reductions in negative impact. To shift beyond damage reduction towards regenerative performance, it will be necessary to harness new and innovative technologies, design and engineering approaches as they emerge. The field of biomimicry looks to biology and ecology to identify natural models that can inspire design and engineering solutions. Despite increasing biomimicry research, enquiry into infrastructure opportunities for biomimicry has been limited, and the potential for biomimicry to support regenerative performance in infrastructure has not been explored. This paper uses a systematic literature review to identify applications of biomimicry in built environment, with a focus on the potential for infrastructure applications. The paper identifies a need for further investigation into 'system-level' biomimicry opportunities; for clearer articulation of sustainability and resilience benefits; and for greater alignment with broader industry and global trends. The paper is relevant for practitioners, academics and government agencies looking to leverage emerging technologies and innovation to achieve project and organisational sustainability, resilience and regenerative performance objectives.

Keywords: Infrastructure, Innovation, Biomimicry, Regenerative, Sustainability, Resilience.

Enric Brillas[a], Albert Serrà[b], Sergi Garcia-Segura[c] (a. Laboratori d'Electroquímica dels Materials i del Medi Ambient, Departament de Química Física, Facultat de Química, Universitat de Barcelona, Martí i Franquès 1-11, 08028 Barcelona, Spain, b. Empa, Swiss Federal Laboratories for Materials Science and Technology, Laboratory for Mechanics of Materials and Nanostructures, Feuerwerkerstrasse 39, CH-3602, Thun, Switzerland, c. Nanosystems Engineering Research Center for Nanotechnology-Enabled Water Treatment. School of Sustainable Engineering and the Built Environment, Arizona State University, Tempe, Arizona 85287, United States) **Biomimicry designs for photoelectrochemical systems: strategies to improve light delivery efficiency, Current Opinion in Electrochemistry, (2020) 100660**

In the last years, photoelectrocatalysis has been developed to offer green and sustainable application to wastewater remediation, water disinfection, H2 production and CO2 reduction. The advances of these systems with new semiconductor photoelectrocatalysts that are photoexcitated with visible light giving photogenerated charge carriers efficiently separated in a photoelectrochemical cell are explained. These studies do not consider the light transport as fundamental aspect of light-matter interaction, although the harvesting of photons at the semiconductor surface limits the quantum yield by the existing semiconductor architectures. This opinion review envisages biomimicry as an alternative natural guide for synthesizing more efficient photoelectrodes. Micro- and nanostructure shapes from nature are identified to prepare new bio-inspired photoelectrodes for photoelectrochemical reactors with the light transport as indispensable element. The implementation of strategies of phototroph organisms to maximize light adsorption and the enhancement of photoelectrocatalytic surface area are analyzed as key factors for such bio-based photoelectrodes.

Keywords: Electrochemical water treatment, water splitting, CO_2 reduction, bio-based structures, bio-inspired materials, photocatalysis, semiconductors

Daicong Da, Xiaoping Qian (Department of Mechanical Engineering, University of Wisconsin–Madison, Madison, WI 53706-1572, USA) **Fracture resistance design through biomimicry and topology optimization, Extreme Mechanics Letters (2020) 100890**

Most biological composites including bones, teeth and nacres have superior fracture resistance properties than that of their constituents. Their complex mixing of stiff and soft constituents enables energy dissipation ahead of the crack tip and contributes to enhance the fracture performance. In this study, phase-field based modeling is used to understand the fracture resistance of bio-inspired designs. Phase-field based topology optimization is then proposed to further improve the fracture resistance of these composite structures. The fracture process from damage to multiple crack propagation and ultimately to failure is fully studied. Numerical experiments show that significant enhancement of the fracture toughness, failure strain and overall strength can be achieved over the homogeneous constitutive stiff material.

Keywords: Fracture resistance, Nacre-like composites, Structural optimization, Phase field modeling, Crack propagation, Soft materials

Name of Journals

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2. Aerobiologia
3. Annual Review-Plant Pathology
4. Annual Review- Ecology and Systematics
5. Annual Review-Biochemistry
6. Annual Review-Biomedical Engineering
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