EIACP PROGRAM CENTER
RESOURCE PARTNER
On
ENVIRONMENTAL BIOTECHNOLOGY

Abstract Vol. XXXXI

Sponsored by

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

Department of Environmental Science
University of Kalyani
Nadia, West Bengal
December 2022

Published by:
Prof. Prof. Kausik Mondal
Co-ordinator
EIACP-PC RESOURCE PARTNER
on Environmental Biotechnology
Department of Environmental Science
University of Kalyani,
Kalyani –741235, Nadia,
West Bengal, INDIA
Email: desku-env@nic.in
Website: http://www.deskuenvis.nic.in

EIACP-PC RESOURCE PARTNER

on

ENVIRONMENTAL BIOTECHBNOLOGY

- *Co-Ordinator (In-charge):* *Prof. Kausik Mondal*
- *Dy. Co-Ordinator:* *Dr. Subhankar Kumar Sarkar*

ENVIS's Staff

1.	**Dr (Mrs.) Anusaya Mallick**	**:**	***Programme Officer***
2.	**Shri Sourav Banerjee**	**:**	***Information Officer***
3.	**Tanmay Acharjee**	**:**	***IT Officer***
4.	**Subham Dutta**	**:**	***Data Entry Operator***

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 Forest & Climate Change, Govt. of India. 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. To buildup more awareness to safe the environment as well as for the betterment of livelihood for each and every classess of people in India, now the centre is revump as Environmental Information Awareness, Capacity building and livelihood programme (EIACP) Programme center – Resource Partner

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

This is the 41th publication of Abstract Volume of this EIACP 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 2022. In this issue, various topics like Bioenergy, Bioengineering, Bio-degradation, Bio-remediation, Bio-transformation etc. have been covered. We are grateful to the various libraries and their staff for their cooperation extended to us during the collection of the articles.

Abstract Format

The format of the abstract is as follows:

Abstract: The abstracts are arranged in different subheads.

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

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

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

GENERAL INFORMATION

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

Abstract are broadly classified and arranged under the following 16 heads:

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

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

1. Ingest and degrade organic substances as their food and energy source,

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

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

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

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

Biofertilizer: To reduce the impact of excess chemical fertilizers in the field of agriculture the biofertilizer is being considered as a potential tool; biologically fixed nitrogen

is such a source which can supply an adequate amount of Nitrogen to plants and other nutrients to some extent. Many free living and symbiotic bacteria, which fix atmospheric Nitrogen are used as biofertiliser material as a substitute for Nitrogen fertilizer. In general two types of biofertiliser are used

1. Bacterial Biofertilizer
2. Algal Biofertilizer

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

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

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

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

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

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

Bioengineering: It is a developing speciality featuring a multidisciplinary approach to the solution of problems in medicine and biology, based on the application of advances in science, engineering and technology. It generally engineers the biological processes through biotechnological or genetic engineering interventions. It may also be a broad-based engineering discipline that involve product design, sustainability and analysis of biological systems.

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

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

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

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

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

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

Biomimicry: Biomimicry is an applied science that derives inspiration for solutions to human problems through the study of natural designs, systems and processes. Biomimicry on the other hand, which is not a science, is a more subtle way which we can benefit from nature. It is the modern, often high tech, equivalent of the historical practices of emulating nature. . The science of biomimicry is a newly developing field but the application of biomimicry has been around since the beginning of man. The biomimetic technologies (flight controls, bio-robotics, ventilation systems, etc.) and potential technologies (fin geometry, nacre materials, etc.) improve performance. The use of biomimicry as an approach to sustainable engineering, specifically the environmental components.

ABBREVIATIONS USED IN ADDRESSES AND CITED JOURNALS

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

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

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

Bioaccumulation

Yan Yang[ad], SiningLi[b], Zhuoqun Wang[ad], YuanyuanRen[a], Yingchun Mu[a], Xin Zhang[c], Paul J.Van den Brink[be],HuiwuSun[a], Yi Songa Bo Cheng[a] (a. Chinese Academy of Fishery Sciences, No.150, Qingta West Road, Fengtai District, Beijing, 100141, China, b. Aquatic Ecology and Water Quality Management Group, Wageningen University, P.O. Box 47, 6700 AA, Wageningen, the Netherlands, c. Beijing Fisheries Research Institute, No. 18, Jiaomen Road, Fengtai District, Beijing, 100068, China, d. Shanghai Ocean University, 999 Hucheng Ring Road, Nanhui New Town, Pudong New Area, Shanghai, 201306, China, e. Wageningen Environmental Research, P.O. Box 47, 6700, AA, Wageningen, the Netherlands)**Acute toxicity, bioaccumulation and elimination of prometryn in tilapia (Oreochromis niloticus). Chemosphere, Volume 300 (2022): 134565**

Tilapia juvenile (Oreochromis niloticus) (mean weight 50.00 ± 10.00 g) were aqueous exposed to different concentrations of the herbicide prometryn to investigate its acute toxicity, bioaccumulation and uptake and elimination rates. First, a 96-h acute toxicity test was carried out. The resulting 96 h LC50 was 5.49 mg/L, and the 96 h LC10 was 5.02 mg/L. Then, fish were exposed to 0.55 mg/L (1/10 96 h LC50) and 0.055 mg/L (1/100 96 h LC50) of prometryn solution for 28 days, followed by 14 days of elimination in clean groundwater. The result shows that in both water and tissues, prometryn concentrations fluctuated during the exposure period, indicating that steady state was not reached. The bioaccumulation of prometryn was the highest in liver, followed by gill, muscle and blood. The accumulated concentration levels in various tissues were always higher in the high concentration compared to the low concentration. The highest accumulated concentration of prometryn in various tissues in the 0.055 mg/L treatment were for muscle: 0.136 ± 0.0616 mg/kg (1 d), liver: 3.74 ± 2.95 mg/kg (7 d), gill: 0.971 ± 1.45 mg/kg (1 d) and blood: 0.0716 ± 0.0669 mg/kg (22 d). In the 0.55 mg/L treatment, the highest levels were for muscle: 1.27 ± 0.284 mg/kg (1 d), liver: 16.9 ± 12.7 mg/kg (7 d), gill: 8.11 ± 3.02 mg/kg (1 d) and blood: 0.751 ± 0.0775 mg/kg (22 d). The highest bioconcentration factor (BCF) of 93.1 was observed in the liver when exposed to the low concentration. Besides, for other tissues, the highest BCF were for muscle: 5.76, gill: 32.3 and blood: 2.91, all observed in the 0.55 mg/L treatment. Most of the accumulated prometryn was removed from all tissues within 24 h after the organisms were transferred to clean water. However, management of using prometryn in China aquaculture should be improved to prevent possible ecotoxicological effects and ensure food safety.

Keywords: Bioaccumulation

Imad Krikech[abcd], Ali Ranjbar Jafarabadi[e], Martine Leermakers[c], GaëlLe Penne[cb], Tiziana Cappello[d], Mohammed Ezziyyani[a]. (a. Department of Life Sciences, Polydisciplinary Faculty of Larache, Abdelmalek Essaadi University, 745 BP, 92004 Larache, Morocco, b Laboratoire de Biotechnologie et de Chimie Marines, Université de Bretagne Sud, EA 3884–IUEM, BP 92116, 56321 CS, Lorient, Brittany, France, c. Analytical, Environmental and Geochemistry (AMGC), Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium, d. Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Viale F. Stagno d'Alcontres 31, 98166 Messina, Italy,e. Department of Environmental Sciences, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, Noor, Mazandaran, Iran). Insights into

bioaccumulation and bioconcentration of potentially toxic elements in marine sponges from the Northwestern Mediterranean coast of Morocco. Marine Pollution Bulletin, Volume 180 (2022): 113770

The present research aimed to investigate the concentrations and patterns of six potentially toxic elements (PTEs) in three common sponge species collected along the Moroccan Mediterranean coast, as well as their levels in ambient seawater and sediments. Distinct inter-species variability in PTEs bioaccumulation was observed among the three species, suggesting that sponges have distinct selectivity for assimilating PTEs from the surrounding environment. C. crambe had a higher enrichment capacity for Cu, As, Cr and Ni, while P. ficiformis and C. reniformis exhibited the highest concentration of Cd and Pb, respectively. Interestingly, a similar spatial distribution patterns of PTEs was observed in the three media, with high values occurring in Tangier and Al-Hoceima locations. Overall, our results confirm that sponges reliably reflect the bioavailability of PTEs in their immediate environment, especially C. crambe, whose PTE tissue contents were highly and positively correlated with the contents of all PTEs in the sediments.

Keywords: Filter-feeders, Bioindicators, Trace metal elements, Sediments, Coastal waters, Source apportionment

Iestyn Lloyd Penry-Williams[abc], Ioanna Kalantzi[ab], Eleni Tzempelikou[d], Manolis Tsapakis[a]. (a. Hellenic Centre for Marine Research, Institute of Oceanography, Heraklion 71300, Crete, Greece, b. Biology Department, University of Crete, Heraklion 71409, Crete, Greece, c. Department of Life Sciences, University of Bristol, BS8 1TQ Bristol, UK, d. Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos 19013, Attica, Greece). **Intensive marine finfish aquaculture impacts community structure and metal bioaccumulation in meso-zooplankton. Marine Pollution Bulletin, Volume 182(2022): 114015**

Commercial aquaculture has a profound impact on coastal marine environments. Here, we investigate the spatial impact of intensive commercial finfish aquaculture on local meso-zooplankton communities and the bioaccumulation of aquaculturally-derived metals (and other elements) within zooplankton samples in the Vourlias Bay, Greece. The results indicate alterations to zooplankton community composition correlate with increased eutrophic compound concentrations in the water column in closer proximity to aquaculture stations (100–300 m from fish cages). During the summer sampling, higher concentrations of accumulated metals within zooplankton samples were found at reference stations furthest from fish cages (>1000 m). During the winter sampling, however, spatial differences in accumulated metal concentrations were limited. We suggest metals are rapidly accumulated at lower trophic levels near aquaculture stations and are then dispersed to greater distances while ascending the trophic chain. This research provides good evidence for future investigations into zooplankton as an environmental impact bioindicator for aquaculture.

Keywords: Zooplankton ecology, Aquaculture, Bioaccumulation, Trace metals, Elements, Mediterranean Sea

Pooja Sharma[a], Deblina Dutta[a], Aswathy Udayan[a], Ashok Kumar Nadda[b], Su Shiung Lam[c], Sunil Kumar[a]. (a. CSIR-National Environmental Engineering Research Institute (CSIR-NEERI), Nehru Marg, Nagpur, 440 020, India, b. Department of Biotechnology and Bioinformatics, Jaypee University of Information Technology, Waknaghat, Solan, Himachal Pradesh, 173 234, India, c. Higher Institution Centre of Excellence (HICoE), Institute of Tropical Aquaculture and Fisheries (AKUATROP), Universiti Malaysia Terengganu, 21030, Kuala Nerus, Terengganu, Malaysia). **Role of microbes in**

bioaccumulation of heavy metals in municipal solid waste: Impacts on plant and human being. Environmental Pollution, Volume 305 (2022): 119248

The presence of heavy metals in municipal solid waste (MSW) is considered as prevalent global pollutants that cause serious risks to the environment and living organisms. Due to industrial and anthropogenic activities, the accumulation of heavy metals in the environmental matrices is increasing alarmingly. MSW causes several adverse environmental impacts, including greenhouse gas (GHG) emissions, river plastic accumulation, and other environmental pollution. Indigenous microorganisms (Pseudomonas, Flavobacterium, Bacillus, Nitrosomonas, etc.) with the help of new pathways and metabolic channels can offer the potential approaches for the treatment of pollutants. Microorganisms, that exhibit the ability of bioaccumulation and sequestration of metal ions in their intracellular spaces, can be utilized further for the cellular processes like enzyme signaling, catalysis, stabilizing charges on biomolecules, etc. Microbiological techniques for the treatment and remediation of heavy metals provide a new prospects for MSW management. This review provides the key insights on profiling of heavy metals in MSW, tolerance of microorganisms, and application of indigenous microorganisms in bioremediation. The literatures revealed that indigenous microbes can be exploited as potential agents for bioremediation.

Keywords: Bioaccumulation

Yinghuan Qin[ab], Yuqiang Tao[a]. (a. College of Oceanography, Hohai University, Nanjing, China, 210024, b, Terrestrial Ecology Section, Department of Biology, University of Copenhagen, DK-2100 Copenhagen, Denmark). **Pollution status of heavy metals and metalloids in Chinese lakes: Distribution, bioaccumulation and risk assessment. Ecotoxicology and Environmental Safety, Volume 248 (2022): 114293**

Due to intensive human activities, most of Chinese lakes are suffering from the pollution of heavy metals and metalloids. Previous studies on heavy metals and metalloids in Chinese lakes were limited to a few lakes and mainly focused on sediments, to date the knowledge on heavy metals and metalloids in multiple media of Chinese lakes from a national perspective is scarce. We collected the data of nine heavy metals and metalloids including Copper (Cu), Cadmium (Cd), Lead (Pb), Mercury (Hg), Arsenic (As), Chromium (Cr), Nickel (Ni), Zinc (Zn), and Manganese (Mn) in water, surface sediments, and fish of 87 Chinese lakes sampled in the period from 2009 to 2019 from the literature, summarized the distribution of heavy metals and metalloids, evaluated their pollution, and apportioned their sources from a national perspective. Concentration of individual heavy metal and metalloid in water, surface sediments, and fish in Chinese lakes was in the ranges of 0.0080–282 μg/L, 0.020–33858 μg/g, and 0.00030–207 μg/g, respectively. 5.6 % and 33.3 % of lake water were polluted by Cd and As. 88.2 %, 78.6 %, and 66 % of lake sediments were polluted by Cd, Hg, and As. 35.3 %, 11.3 %, 52.4 %, and 12.8 % of Cd, Pb, As, and Cr concentrations in lake fish exceeded the food limits. Concentrations of heavy metals and metalloids in fish viscera were higher than those in other organs. Higher partition coefficient and bioaccumulation factors were found for Pb and Cd, Hg and Zn, respectively. Concentrations of heavy metals and metalloids in both water and sediments of lakes in eastern China were higher than those in western China. Concentrations of heavy metals and metalloids in both lake water and sediments of urban lakes were higher than those of rural lakes. Lakes with extremely high ecological risk of heavy metals and metalloids were mainly located in central China and eastern China. Pollution of heavy metals and metalloids in Chinese lakes was closely

correlated with regional economic development. Heavy metals and metalloids in Chinese lakes were mainly derived from industrial, domestic, and mixed discharges. Cd and Hg were selected as the heavy metals for priority control in Chinese lakes.

Keywords: Heavy metal, Chinese lake, Bioaccumulation, Risk assessment, Pollution source

Wei Sun[a], Sen Yan[a], Zhiyuan Meng[b], Sinuo Tian[a], Ming Jia[a], Shiran Huang[a], Yu Wang[a], Zhiqiang Zhou[a], Jinling Diao[a], Wentao Zhu[a.] (a. Innovation Center of Pesticide Research, Department of Applied Chemistry, College of Science, China Agricultural University, Beijing 100193, China, b. School of Horticulture and Plant Protection, Yangzhou University, Yangzhou, Jiangsu 225009, China). Combined ingestion of polystyrene microplastics and epoxiconazole increases health risk to mice: Based on their synergistic bioaccumulation in vivo. Environment International Volume 166(2022): 107391

Microplastic and pesticide are two common environmental pollutants whose adverse effects have been widely reported, but it is unclear whether they cause combined toxicity in mammals. In this study, polystyrene microplastics (5 μm, 0.012 or 0.120 mg/kg) or/and epoxiconazole (0.080 mg/kg) were administered orally to mice for 6 weeks, their toxicity to liver and kidney was assessed from changes in histopathology, tissue function, oxidative defense system and metabolic profile. In addition, mechanism of combined toxicity was explored in terms of bioaccumulation levels, intestinal barrier, gut microbiota. Results showed that combined ingestion of polystyrene (0.120 mg/kg) and epoxiconazole caused more severe tissue damage, dysfunction, oxidative stress, and metabolic disorders compared to single exposure sources. Interestingly, occurrence of combined toxicity was associated with their increased accumulation in tissues. In-depth exploration found that epoxiconazole caused intestinal barrier damage by targeting the gut microbiota, leading to massive invasion and accumulation of polystyrene, which in turn interfered with the metabolic clearance of epoxiconazole in liver. In all, findings highlighted that polystyrene and epoxiconazole could cause combined toxicity in mice through the synergistic effect of their bioaccumulation in vivo, which provided new reference for understanding the health risks of microplastics and pesticides and sheds light on the potential risk to humans of their combined ingestion.

Keywords: Polystyrene microplastics, Epoxiconazole, Combined toxicity, Metabolomics, Intestinal barrier, Gut microbiota

Jiangong Jiang, Bingying He, Yimu Wei, Jingna Cui, Qiang Zhang, Xueke Liu, Donghui Liu, Peng Wang, Zhiqiang Zhou. (Beijing Advanced Innovation Centre for Food Nutrition and Human Health, Department of Applied Chemistry, College of Science, China Agricultural University, Beijing 100193, PR China). The toxic effects of combined exposure of chlorpyrifos and p, p'-DDE to zebrafish (Danio rerio) and tissue bioaccumulation. Aquatic Toxicology, Volume 248 (2022): 106194

Pesticides are widely used and frequently detected in the environment. The evaluation on the toxic effects of the co-exposure of two or more pesticides or related metabolites could reflect the real situation of the exposing risks. In this study, zebrafish was used as a model to investigate the potential toxic interactions of chlorpyrifos and 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene (p,p'-DDE) on the survival rate, oxidative stress response and neurotoxicity, as well as their bioaccumulation and distribution in tissues. Co-exposure of chlorpyrifos and p,p'-DDE resulted in significant additive acute toxic effects on adult zebrafish with model deviation ratio (MDR) = 1.64. Both 7-day short-term at 1% LC50 and 35-day long-term at 0.5% LC50 co-exposure of chlorpyrifos with p,p'-DDE (50 and 100 μg/L) significantly reduced the survival rate of zebrafish colony to 75 and 82.5%. Co-exposure of chlorpyrifos and p,p'-DDE contributed to

increased activity of antioxidant enzyme CAT, SOD and GST and excessive MDA generation, and decreased activity of CarE, CYP450 and AChE, compared with either single exposure of them. In co-exposure, the bioaccumulation of chlorpyrifos and p,p'-DDE was significantly different from the single exposure group. Overall, this study unraveled the potential toxic interaction of chlorpyrifos and p,p'-DDE on zebrafish and provided reference for environmental risk assessment of pesticide mixture.

Keywords: Bioaccumulation

Xuming Xu[ab], Baozhu Pan[c], Fengyue Shu[d], Xiufen Chen[e],Nan Xu[e], Jinren Ni[abf]. (a. Department of Environmental Engineering, Peking University, The Key Laboratory of Water and Sediment Sciences, Ministry of Education, Beijing, 100871, China, b. State Environmental Protection Key Laboratory of All Material Fluxes in River Ecosystems, Beijing, 100871, China, c. State Key Laboratory of Eco-hydraulics in Northwest Arid Region of China, Xi'an University of Technology, Xi'an, 710048, China, d. College of Life Sciences, Qufu Normal University, Qufu, 273165, China, e. Shenzhen Key Laboratory for Heavy Metal Pollution Control and Reutilization, School of Environment and Energy, Peking University Shenzhen Graduate School, Shenzhen, 518055, China, f. State Key Laboratory of Plateau Ecology and Agriculture, Qinghai University, Xining, 810016, China). Bioaccumulation of 35 metal(loid)s in organs of a freshwater mussel (Hyriopsis cumingii) and environmental implications in Poyang Lake, China. Chemosphere, Volume 307, Part 4 (2022): 136150

Benthic bioaccumulation of hazardous materials has been a great challenge to the health of lake ecosystems. As representative benthic macroinvertebrates, freshwater mussels and their accumulation characteristics have been regarded as effective indicators for assessing potential risks induced by sedimentary metal(loid)s in lakes. Here we profile organ-specific accumulation of 35 metal(loid)s in a freshwater mussel (Hyriopsis cumingii) and their correlations to metal speciation in sediments of Poyang Lake, the largest lake of China. Significant organ-specific characteristics of metal accumulation were found in gills, though higher thallium (Tl) and selenium (Se) were found in the hepatopancreas, and greater arsenic (As) mostly accumulated in gonads. Pearson correlation analysis revealed that the bioaccumulation of silver (Ag), cobalt (Co), and rare earth elements (ΣREE) in gills and As in gonads were closely associated with those in bioavailable fraction of sediments. Based on the biochemical analysis in the major organs, gills exhibited the highest enzymatic activity compared with hepatopancreas and gonads. Sedimentary metals, particularly for available Ag, Co, and ΣREE, play key roles in causing lipid peroxidation in gills and significantly promote the activities of superoxide dismutase (SOD)/glutathione reductase (GR), while many metals (e.g., cadmium, manganese, Se) inhibit the glutathione (GSH) content in gonads and hepatopancreas. Our study indicates a high physiological sensitivity of mussels to these target metals, which highlights the significance of organ-specific accumulation of metal(loid)s in understanding the potential ecological risks of sedimentary metal(loid)s in lake ecosystems.

Keywords: Bioaccumulation

N.Ajermoun[a], S.Aghris[a], F.Ettadili[a]O.Tahiri Alaoui[b], F Laghrib[ac], A.Farahi[a], S.Lahrich[a], M.Bakasse[d], S.Saqrane[a], M.A.El Mhammedi[a]. (a. Sultan Moulay Slimane University of Beni Mellal, Laboratory of Materials Science, Mathematics and Environment, Polydisciplinary Faculty, 25 000 Khouribga, Morocco, b. Moulay Ismail University,

Laboratory of Physical Chemistry, Materials and Environment, Sciences and Technologies Faculty, Errachidia, Morocco, c. Sidi Mohamed Ben Abdellah University, Engineering Laboratory of Organometallic, Molecular Materials, and Environment, Faculty of sciences, Fez, Morocco, d. Chouaib Doukkali University, Faculty of Sciences, Laboratory of Organic Bioorganic Chemistry and Environment, El Jadida, Morocco). Phytotoxic effect of the insecticide imidacloprid in Phaseolus vulgaris L. plant and evaluation of its bioaccumulation and translocation by electrochemical methods. Environmental Research, Volume 214, Part 1 (2022): 113794

The objective of this work is to study the toxicological effect of the imidacloprid (IMD) on common bean plants (Phaseolus vulgaris L) when used at high doses and its quantification by electrochemical method. Common bean plants were exposed to increasing concentrations of IMD and the different plant tissues were subjected to various analyses. The IMD detection in different tissues of the bean plant was performed after extraction on the metallic silver electrode using square wave voltammetry. The analytical and calibration parameters (Slope, correlation coefficient, linear range, detection limit and relative standard deviation) were calculated for the different plant tissues. The effect of different doses (5.0 × 10−3 to 5.0 × 10−2 mol L−1) of IMD was evaluated on germination, seedling (vigour, growth) and photosynthetic pigments in the bean plant.

The results indicate that germination rate and seed vigour index reduced significantly ($p \leq 0.05$) only in the applied concentrations above the recommended dose. A similar effect of IMD was observed on seedling development in term of roots length, plant length, number of leaves and number of nods. Concerning pigments content, chlorophyll a, b and total chlorophyll maximally decreased by 95.26%, 80.44% and 82.15% respectively at high applied dose. The bioaccumulation and translocation behaviour of IMD in bean plant was investigated, revealing that the IMD can be bioaccumulated in roots and can easily be translocated into stems and leaves.

Keywords: Bioaccumulation

Zhenzhen Yua[b], Enfeng Liu[a], Qi Lin[c], Qinghui Zhang[a], Hezhong Yuan[d], Enlou Zhang[c], Ji Shen[e]. (a. College of Geography and Environment, Shandong Normal University, Ji'nan 250358, PR China, b. Key Laboratory of Land Surface Pattern and Simulation, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, PR China, c. State Key Laboratory of Lake Science and Environment, Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing 210008, PR China, d. School of Environmental Science and Engineering, Nanjing University of Information Science & Technology, Nanjing 210044, PR China, e. School of Geographic and Oceanographic Sciences, Nanjing University, Nanjing 210023, PR China). Integrating indices based on different chemical extractions and bioaccumulation in Bellamya aeruginosa to assess metal pollution and ecological risk in sediment. Ecotoxicology and Environmental Safety, Volume 242 (2022): 113853

Various indices based on metal chemical data are used to evaluate pollution and ecological risk, but the consistency of the assessment results is usually unsatisfactory, and it is unclear if the ecological risk from sediment metals is accurately represented in in situ zoobenthos. Herein, the pollution and ecological risk associated with As, Cd, Cr, Cu, Ni, Pb and Zn in the sediments of two adjacent lakes (Datun (DT) and Changqiao (CQ)) were comprehensively evaluated by integrating metal concentrations, chemical forms and bioaccumulation in Bellamya aeruginosa (B. aeruginosa). The metal concentrations and chemical compositions varied widely in the

sediments. Over 50% of the Cd, Pb and Zn in the sediments was present in bioavailable forms, followed by 28% of Cu and less than 25% of As, Cr and Ni. According to the enrichment factor (EF) and concentration enrichment ratio (CER) assessments, Cr and Ni were natural in origin, while the other metals were at minor to extremely high pollution levels, with average EFs of 1.5–77.6 and CERs of 1.1–113.4. The pollution levels for Cd, Cu and Pb from the EF and CER assessments were similar, while those for As and Zn were higher according to CER than EF ($p = 0.05$), likely due to the baseline underestimation associated with the potential diagenetic remobilization of bioavailable metals. The ecological risk index (Er), sediment quality guidelines (SQGs) and risk assessment code (RAC) showed a high eco-risk for Cd, while no similar risk was found for the other metals. By integrating risk indices with the chemical forms and pollution levels of metals, we deduced high eco-risks for As and Pb and moderate eco-risks for Cu and Zn in DT Lake and moderate eco-risks for As, Pb and Zn in CQ Lake. The other metals in the sediments of the two lakes presented low eco-risks. No significant positive correlations ($p = 0.05$) between metal accumulation in B. aeruginosa and the indices of pollution and eco-risk were observed except for the case of As, implying that measuring the metal concentrations in B. aeruginosa would not accurately characterize the metal pollution and ecological risk of sediments.

Keywords: Total concentration, Chemical form, Metal pollution, Ecological risk, Bellamya aeruginosa, Bioaccumulation

Noelia Urseler[a], Romina Bachetti[a], Fernanda Biolé[a], Verónica Morgante[b], Carolina Morgante[a]. (a. Instituto Académico Pedagógico de Ciencias Básicas y Aplicadas (IAPCByA), Universidad Nacional de Villa María, Instituto Multidisciplinario de Investigación y Transferencia Agro-alimentaria y Biotecnológica, IMITAB-CONICET, Av. Arturo Jauretche 1555 (CP 5900), Villa María, Córdoba, Argentina, b. Centro de Investigación en Recursos Naturales y Sustentabilidad (CIRENYS), Universidad Bernardo O'Higgins, Avenida Viel 1497, Santiago de Chile, Chile). Atrazine pollution in groundwater and raw bovine milk: Water quality, bioaccumulation and human risk assessment. Science of The Total Environment, Volume 852 (2022): 158498

Atrazine herbicide can bioaccumulate over time and thus affect humans for generations to come. However, scarce studies have evaluated its bioaccumulation potential in bovine milk, a nutritional staple for children and the elderly both domestically and internationally. This study aimed to determine its concentration in groundwater and bovine milk, as well as the risks it is likely to pose for human health. Eighteen dairy farms in the Pampean plain of Argentina were analyzed. A strong correlation was found between the chemical composition and the geomorphological characteristics of the plain. In addition, increased salinity was observed in the groundwater at greater distances from the aquifer's recharge area. Atrazine was quantified in 50 % of the groundwater samples (at values ranging from 0.07 to 1.40 μg/L), and in 89 % of the bovine milk samples (from 2.51 to 20.97 μg/L). Moreover, atrazine levels in 44.4 % of the groundwater samples and 11.1 % of the bovine milk samples ($n = 18$) exceeded the limits internationally established as safe for human consumption. The hazard quotient (HQ) values of the compound were negligible for children and adults, both in groundwater (child = 9.7E-4, adult = 4.5E-4) and in milk (child = 1.0E-2, adult = 1.6E-3). The estimated cancer risk (CR) values need further evaluation (child = 7.8E-6, adult = 3.6E-6 in groundwater; child = 6.6E-5, adult = 1.3E-5 in milk). In both types of samples, the HQ and CR of residual atrazine were higher for children than for adults. Nevertheless, bioaccumulation factors suggest that dairy cows have a

moderate capacity to incorporate atrazine from abiotic matrices. This is the first report on residual atrazine in bovine milk in Argentina. The results presented here indicate that the status of atrazine contamination in the area should continue to be monitored in order to assess its long-term impact on public health.

Keywords: Atrazine, Groundwater, Bovine milk, Bioaccumulation factor, Hydrogeological features, Health risk assessment

Mariana V.Capparelli[a], Mario A.Gómez-Ponce[a], Merle M.Borges-Ramírez[b], Jaime Rendón-von Osten[c], Omar Celis-Hernández[ad], Antony E.Briceño-Vera[a], Enrique Ávila[a], Gabriel M.Moulatlet[e]. (a. Estación El Carmen, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Carretera Carmen-Puerto Real km 9.5, C. P 24157 Ciudad del Carmen, Campeche, Mexico, b. El Colegio de la Frontera Sur (ECOSUR), Avenida Rancho, Polígono 2-A, Ciudad Industrial Lerma, CP 24500 Campeche, Campeche, Mexico, c. Instituto de Ecología, Pesquería y Oceanografía del Golfo de México (EPOMEX), Campus VI, Av. Héroe de Nacozari 480, Universidad Autónoma de Campeche, 24070 Campeche, Mexico, d. Dirección de Cátedras CONACYT, Av. Insurgentes Sur 1582, Alcaldía Benito Juárez, 03940 Ciudad de México, Mexico, e. Red de Biología Evolutiva, Instituto de Ecología, A.C., Xalapa, Veracruz, Mexico). **Ecological traits influence the bioaccumulation of microplastics in commercially important estuarine crabs from the southeastern Gulf of Mexico. Marine Pollution Bulletin, Volume 183 (2022): 114088**

We assessed microplastics (MPs) contamination in water, sediments, and tissues (gills, digestive tract, and muscle) of two intertidal crab species with different ecological traits and commercial importance (Menippe mercenaria and Callinectes sapidus), from a coastal lagoon in the southeastern Gulf of Mexico. There were significant differences between MP abundances in the abiotic matrices and between crab species. The burrower, sedentary and carnivorous M. mercenaria bioaccumulates 50 % more MPs than the free-swimming, omnivorous C. sapidus. However, no differences were observed between species' tissues. Fragments were the predominant shape in the tissues of both species, with the exception in the digestive tract of M. mercenaria. We identified polyethylene, and polyethylene terephthalate in water samples and Silopren® in sediment. In both crab species, Silopren and polyethylene predominated. Differences in ecological traits resulted in different bioaccumulation patterns in intertidal crabs.

Keywords: Menippe mercenaria, Callinectes sapidus, Laguna de Términos, Polymeric identification, Human consumption

Bioremediation

Madeline Stanleya, Vince Palaceb, Richard Grosshansc, David B.Levina. (a. Department of Biosystems Engineering, University of Manitoba, E2-376 EITC, Winnipeg, MB, R3T 5V6, Canada, b. International Institute for Sustainable Development Experimental Lakes Area, 325-111 Lombard Ave, Winnipeg, MB, R3B 0T4, Canada, c. International Institute for Sustainable Development, 325-111 Lombard Ave, Winnipeg, MB, R3B 0T4, Canada). **Floating treatment wetlands for the bioremediation of oil spills: A review. Journal of Environmental Management, Volume 317 (2022): 115416**

Conventional oil spill recovery may cause significant damage to shoreline habitats during the removal of oiled material and from human and equipment interaction. In addition, these methods

are costly and can leave a significant amount of residual oil in the environment. Biological remediation strategies may be a less invasive option for recovering oil from sensitive regions, with potential to increase recovery. Floating treatment wetlands are a growing area of interest for biodegradation of oil facilitated by plant-bacterial partnerships. Plants are able to stimulate microbial colonization in the rhizosphere, creating greater opportunity for contaminant interaction and degradation. A literature review analysis revealed thirteen articles researching this topic, and found that floating treatment wetlands have high potential to degrade oil contaminants. In some instances, plants and inoculated bacteria exhibited the highest degradation potential, however, plants alone had higher degradation potential than bacteria alone. Research is needed to explore how floating treatment wetlands perform in field-based trials and under variable environmental conditions.

Keywords: Floating treatment wetland, Bioremediation, Phytoremediation, Biodegradation, Crude oil, Hydrocarbons

Anna M.O'Brien[ab], Zhu Hao Yu[c], Clara Pencer[a], Megan E.Frederickson[a], Gregory H.LeFevre[d], Elodie Passeport[ce]. (a. Department of Ecology and Evolutionary Biology, University of Toronto, 25 Willcocks St, Toronto, ON, M5S 3B2, Canada, b. Department of Molecular, Cellular, and Biomedical Sciences, University of New Hampshire, 46 College Rd, Durham, NH, 03824, USA, c. Department of Chemical Engineering and Applied Chemistry, University of Toronto, 200 College Street, Toronto, ON, M5S 3E5, Canada, d. Department of Civil & Environmental Engineering and IIHR-Hydroscience & Engineering, University of Iowa, 4105 Seamans Center, Iowa City, IA, 52242, USA, e. Department of Civil and Mineral Engineering, University of Toronto, 35 St George St, Toronto, ON, M5S 1A4, Canada). **Harnessing plant-microbiome interactions for bioremediation across a freshwater urbanization gradient. Water Research, Volume 223 (2022): 118926**

Urbanization impacts land, air, and water, creating environmental gradients between cities and rural areas. Urban stormwater delivers myriad co-occurring, understudied, and mostly unregulated contaminants to aquatic ecosystems, causing a pollution gradient. Recipient ecosystems host interacting species that can affect each others' growth and responses to these contaminants. For example, plants and their microbiomes often reciprocally increase growth and contaminant tolerance. Here, we identified ecological variables affecting contaminant fate across an urban-rural gradient using 50 sources of the aquatic plant Lemna minor (duckweed) and associated microbes, and two co-occurring winter contaminants of temperate cities, benzotriazole and salt. We conducted experiments totalling 2,500 independent host-microbe-contaminant microcosms. Benzotriazole and salt negatively affected duckweed growth, but not microbial growth, and duckweeds maintained faster growth with their local, rather than disrupted, microbiota. Benzotriazole transformation products of plant, microbial, and phototransformation pathways were linked to duckweed and microbial growth, and were affected by salt co-contamination, microbiome disruption, and source sites of duckweeds and microbes. Duckweeds from urban sites grew faster and enhanced phytotransformation, but supported less total transformation of benzotriazole. Increasing microbial community diversity correlated with greater removal of benzotriazole, but taxonomic groups may explain shifts across transformation pathways: the genus Aeromonas was linked to increasing phototransformation. Because benzotriazole toxicity could depend on amount and type of in situ transformation, this variation across duckweeds and microbes could be harnessed for better management of urban

stormwater. Broadly, our results demonstrate that plant-microbiome interactions harbour manipulable variation for bioremediation applications.

Keywords: Bioredemption

Kumar Vishven Naveen, Kandasamy Saravanakumar, Xin Zhang, Anbazhagan Sathiyaseelan, Myeong-Hyeon Wang. (Department of Bio-Health Convergence, Kangwon National University, Chuncheon 200-701, Republic of Korea). Impact of environmental phthalate on human health and their bioremediation strategies using fungal cell factory- A review. Environmental Research, Volume 214, Part 1 (2022): 113781

Phthalates are utilized as plasticizers in plastic products to enhance their durability, transparency, and elasticity. However, phthalates are not covalently bonded to the polymer matrix of the phthalate-containing products and can be gradually released into the environment through biogeochemical processes. Hence, phthalates are now pervasive in our environment, including our food. Reports suggested that phthalates exposure to the mammalian systems is linked to various health consequences. It has become vital to develop highly efficient strategies to reduce phthalates from the environment. In this context, the utilization of fungi for phthalate bioremediation (mycoremediation) is advantageous due to their highly effective enzyme secretory system. Extracellular and intracellular enzymes of fungi are believed to break down the phthalates by ester hydrolysis to produce phthalic acid and alcohol, and subsequent digestion of the benzene rings of phthalic acid and their metabolites. The present review scrutinizes and highlights the knowledge gap in phthalate prevalence, exposure to mammals, and associated human health challenges. Furthermore, discusses the role of fungi and their secretory enzymes in the biodegradation of phthalates and gives a perspective to better describe and tackle this continuous threat.

Keywords: Bioredemption

Charles Chinyere Dike[ad], Ibrahim Gbolahan Hakeem[bd], Alka Rani[ad], Aravind Surapaneni[cd], Leadin Khudur[ad], Kalpit Shah[bd], Andrew S.Ball[ad]. (a. School of Science, RMIT University, Bundoora, Victoria 3083, Australia, b. School of Engineering, RMIT University, Melbourne, Victoria 3000, Australia, c. South East Water, 101 Wells Street, Frankston, Victoria 3199, Australia, d. ARC Training Centre for the Transformation of Australia's Biosolids Resource, RMIT University, Bundoora, Victoria 3083, Australia). The co-application of biochar with bioremediation for the removal of petroleum hydrocarbons from contaminated soil. Science of The Total Environment, Volume 849 (2022): 157753

Soil pollution from petroleum hydrocarbon is a global environmental problem that could contribute to the non-actualisation of the United Nations Sustainable Development Goals. Several techniques have been used to remediate petroleum hydrocarbon-contaminated soils; however, there are technical and economical limitations to existing methods. As such, the development of new approaches and the improvement of existing techniques are imperative. Biochar, a low-cost carbonaceous product of the thermal decomposition of waste biomass has gained relevance in soil remediation. Biochar has been applied to remediate hydrocarbon-contaminated soils, with positive and negative results reported. Consequently, attempts have been made to improve the performance of biochar in the hydrocarbon-based remediation process through the co-application of biochar with other bioremediation techniques as well as modifying biochar properties before use. Despite the progress made in this domain, there is a lack of a detailed single review consolidating the critical findings, new developments, and challenges in biochar-based remediation of petroleum hydrocarbon-contaminated soil. This review assessed the potential of biochar co-application with other well-known bioremediation techniques such as

bioaugmentation, phytoremediation, and biostimulation. Additionally, the benefits of modification in enhancing biochar suitability for bioremediation were examined. It was concluded that biochar co-application generally resulted in higher hydrocarbon removal than sole biochar treatment, with up to a 4-fold higher removal observed in some cases. However, most of the biochar co-applied treatments did not result in hydrocarbon removal that was greater than the additive effects of individual treatment. Overall, compared to their complementary treatments, biochar co-application with bioaugmentation was more beneficial in hydrocarbon removal than biochar co-application with either phytoremediation or biostimulation. Future studies should integrate the ecotoxicological and cost implications of biochar co-application for a viable remediation process. Lastly, improving the synergistic interactions of co-treatment on hydrocarbon removal is critical to capturing the full potential of biochar-based remediation.

Keywords: Bioaugmentation, Biochar co-application, Biomass, Biostimulation, Phytoremediation, Remediation

Eduardo Beltrán-Flores[a], Martí Pla-Ferriol[b], Maira Martínez-Alonso[b], Núria Gaju[b], Paqui Blánquez[a], Montserrat Sarrà[a]. (a. Departament d′Enginyeria Química Biològica i Ambiental, Escola d′Enginyeria, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain, b. Departament de Genètica i Microbiologia, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain). Fungal bioremediation of agricultural wastewater in a long-term treatment: biomass stabilization by immobilization strategy. Journal of Hazardous Materials, Volume 439 (2022): 129614

Fungal bioremediation emerges as an effective technology for pesticide treatment, but its successful implementation depends on overcoming the problem of microbial contamination. In this regard, fungal immobilization on wood seems to be a promising strategy, but there are two main drawbacks: the predominant removal of pesticides by sorption and fungal detachment. In this study, agricultural wastewater with pesticides was treated by Trametes versicolor immobilized on wood chips in a rotary drum bioreactor (RDB) for 225 days, achieving fungal consolidation and high pesticide biodegradation through two main improvements: the use of a more favorable substrate and the modification of operating conditions. Fungal community dynamic was assessed by denaturing gradient gel electrophoresis (DGGE) analysis and subsequent prominent band sequencing, showing a quite stable community in the RDB, mainly attributed to the presence of T. versicolor. Pesticide removals were up to 54 % diuron and 48 % bentazon throughout the treatment. Afterwards, pesticide-contaminated wood chips were treated by T. versicolor in a solid biopile-like system. Hence, these results demonstrate that the microbial contamination constraint has definitely been overcome, and fungal bioremediation technology is ready to be implemented on a larger scale.

Keywords: Pesticides, Wood chips, Continuous treatment, Trametes versicolor, Rotating drum bioreactor

Shafiul Haque[a], Neha Srivastava[c], Dan Bahadur Pal[d], Mustfa F.Alkhanani[e], Atiah H.Almalki[fg], Mohammed Y.Areeshi[ab], Ravi Naiduh Vij[ai], Kumar Gupta[ij]. (a. Research and Scientific Studies Unit, College of Nursing and Allied Health Sciences, Jazan University, Jazan-45142, Saudi Arabia,b. Medical Laboratory Technology Department, College of Applied Medical Sciences, Jazan University, Jazan 45142, Saudi Arabia, c. Department of Chemical Engineering & Technology, IIT (BHU), Varanasi 221005, India, d. Department of Chemical Engineering, Birla Institute of Technology, Mesra, Ranchi 835215, Jharkhand,

India, e. Emergency Service Department, College of Applied Sciences, AlMaarefa University, Riyadh 11597, Saudi Arabia, f. Department of Pharmaceutical Chemistry, College of Pharmacy, Taif University, P.O. Box 11099, Taif 21944, Saudi Arabia, g. Addiction and Neuroscience Research Unit, College of Pharmacy, Taif University, Al-Hawiah, Taif 21944, Saudi Arabia, h. Global Centre for Environmental Remediation (GCER), University of Newcastle, Callaghan, NSW 2308, Australia, i. Biorefining and Advanced Materials Research Center, SRUC, Kings Buildings, West Mains Road, Edinburgh EH9 3JG, UK, j. Center for Safe and Improved Food, SRUC, Kings Buildings, West Mains Road, Edinburgh EH9 3JG, UK). Functional microbiome strategies for the bioremediation of petroleum-hydrocarbon and heavy metal contaminated soils: A review. Science of The Total Environment, Volume 833 (2022): 155222

Petroleum hydrocarbons and heavy metals are the two major soil contaminants that are released into the environment in the forms of industrial effluents. These contaminants exert serious impacts on human health and the sustainability of the environment. In this context, remediation of these pollutants via a biological approach can be effective, low-cost, and eco-friendly approach. The implementation of microorganisms and metagenomics are regarded as the advanced solution for remediating such pollutants. Further, microbiomes can overcome this issue via adopting specific structural, functional and metabolic pathways involved in the microbial community to degrade these pollutants. Genomic sequencing and library can effectively channelize the degradation of these pollutants via microbiomes. Nevertheless, more advanced technology and reliable strategies are required to develop. The present review provides insights into the role of microbiomes to effectively remediate/degrade petroleum hydrocarbons and heavy metals in contaminated soil. The possible degradation mechanisms of these pollutants have also been discussed in detail along with their existing limitations. Finally, prospects of the bioremediation strategies using microbiomes are discussed.

Keywords: Petroleum hydrocarbons, Heavy metals contaminants, Bioremediation, Biodegradation, Plants, Microbes

Hongling Yu, Lingru Ruan, Limei Huang, Xiuli Liang, Fengcai Ye, Changhua Shang. (Key Laboratory of Ecology of Rare and Endangered Species and Environmental Protection (Guangxi Normal University), Ministry of Education, China, Guangxi Key Laboratory of Landscape Resources Conservation and Sustainable Utilization in Lijiang River Basin (Guangxi Normal University), Guilin 541006, China). A comparative analysis of antioxidant system and bioremediation of chromium in Pseudomonas sp. Cr13 and its transgenic strain F1251. Environmental Technology & Innovation, Volume 28(2022): 102935

The present study describes the Cr(VI) bioaccumulation potential of Pseudomonas sp. Cr13 and its transgenic strain F1251. Compared with strain Cr13, transgenic strain F1251 with the antisense CadR gene encoding Cd(II)/Pb(II)-responsive transcriptional regulator (GenBank Accession no., OP564917) showed the higher removal efficiency of Cr(VI), the enhanced activities of antioxidative enzymes such as SOD (superoxide dismutase), GR (glutathione reductase), CAT (catalase), APX (ascorbate peroxidase), POD (peroxidase), the increased exopolysaccharide content and the decreased malondialdehyde content. The transgenic strain F1251 could more efficiently bioaccumulate Cr(VI) compared with strain Cr13, which provided a better solution for the removal of metal pollutant Cr(VI).

Keywords: Antioxidant system, Bioremediation of chromium, Pseudomonas sp. cr13, Transgenic strain F1251, CadR gene, Removal efficiency

Sofia Nobili[a], Carolina Elisabet Masin[ab], Cristina Susana Zalazar[a], Maia Raquel Lescano[a](a. Instituto de Desarrollo Tecnológico para la Industria Química. (INTEC, UNL – CONICET), Argentina, b. Facultad de Ciencias de la Salud, Universidad Católica de Santa Fe (UCSF), Argentina). Bioremediation of hydrocarbon contaminated soil using local organic materials and earthworms. Environmental Pollution, Volume 314 (2022): 120169

Bioremediation technologies have demonstrated significant success on biological quality recovery of hydrocarbon contaminated soils, employing techniques among which composting and vermiremediation stand out. The aim of this study was to evaluate the efficiency of these processes to remediate diesel-contaminated soil, employing local organic materials and earthworms. During the initial composting stage (75 days), the substrate was made up using contaminated soil, lombricompost, rice hulls and wheat stubbles (60:20:15:5% w/w). Diesel concentration in the contaminated substrate was about 5 g kg−1, equivalent to a Total Petroleum Hidrocarbons (TPH) experimental concentration of 3425 ± 50 mg kg−1. During the later vermiremediation stage (60 days), the earthworm species Eisenia fetida and Amynthas morrisi were evaluated for their hydrocarbon degradation capacity. Physicochemical and biological assays were measured at different times of each stage and ecotoxicity assays were performed at the end of the experiments. TPH concentration reduced 10.91% after composting and from 45.2 to 60.81% in the different treatments after vermiremediation. Compared with TPH degradation in the treatment without earthworms (16.05%), results indicate that earthworms, along with indigenous microorganisms, accelerate the remediation process. Vermiremediation treatments did not present phytotoxicity and reflected high substrate maturity values (>80% Germination Index) although toxic effects were observed due to E. fetida and A morrisi exposure to diesel. Vermiremediation was an efficient technology for the recovery of substrate biological quality after diesel contamination in a short period. The addition of organic materials and suitable food sources aided earthworm subsistence, promoted the decontamination process and improved the substrate quality for future productive applications.

Keywords: Bioredemption

Vikram P.Rathod[a], Hetvi H.Parekh[b], Palak D.Rajpura[b], Manish V.Shah[a], Shalini R.Singh[a], Rakeshkumar R.Panchal[b], Vijay J.Upadhye[c]. (a. Department of Applied Mechanics, L.D. College of Engineering, Ahmedabad, 380015, India, b. Department of Microbiology and Biotechnology, University School of Sciences, Gujarat University, Ahmedabad, 380015, India, c. Parul Institute of Applied Science & Centre of Research for Development, Parul University, Vadodara, 391760, India). Effect of bioremediation technique on engineering properties of crude oil-contaminated soil. Biocatalysis and Agricultural Biotechnology, Volume 43 (2022): 102393

Crude oil plays an important role in maintaining national energy security and economic development, with the expansion of population, expanding income, and rapid urbanization. However, in industrial regions, crude oil leaks and penetration into the soil can alter soil engineering features and trigger environmental disasters. Also, restoring contaminated sites to their original condition and reusing contaminated material in construction fields after treatment necessitates remediation procedures that are both environmentally benign and geotechnically sound. Bioremediation is an effective, low cost & no harmful side effect technique will be used in this research study. In this study, two different types of soils from different locations such as

poorly graded sand and highly plastic clayey soil are artificially contaminated with crude oil at 4%, 8% and 12% with the dried weight of soil. As the purpose of bioremediation, Acinetobacter calcoaceticus (MTCC-2409) bacterial strain used as a reference of oil-degrading bacteria and the other strains are identified from the natural soils by biological study, which have the capability to degrade crude oil. In the present study, for better understand to change in geotechnical properties, Atterberg limits, compaction, unconfined compressive strength and permeability test were conducted and from the results comparison is to be done for these strains. Also, gravimetric analysis were used as determination of total petroleum hydrocarbon. Biofilms developed in the presence of crude oil acquire more biomass and have larger thickness than biofilms formed in the presence of glucose as the sole carbon source, according to microscopic research. Generally, the application of bio-treated soil as utilized in the construction of liners, road construction, manufacturing portland cement, and erosion control projects.

Keywords: Bioredemption

Biotransformation

Hannah Rolston, Michael Hyman & Lewis Semprini. (Oregon State University, Corvallis, OR, USA). Single-well push–pull tests evaluating isobutane as a primary substrate for promoting in situ cometabolic biotransformation reactions. Biodegradation volume 33 (2022): 349–371

A series of single-well push–pull tests (SWPPTs) were performed to investigate the efficacy of isobutane (2-methylpropane) as a primary substrate for in situ stimulation of microorganisms able to cometabolically transform common groundwater contaminants, such as chlorinated aliphatic hydrocarbons and 1,4-dioxane (1,4-D). In biostimulation tests, the disappearance of isobutane relative to a nonreactive bromide tracer indicated an isobutane-utilizing microbial community rapidly developed in the aquifer around the test well. SWPPTs were performed as natural drift tests with first-order rates of isobutane consumption ranging from 0.4 to 1.4 day^{-1}. Because groundwater contaminants were not present at the demonstration site, isobutene (2-methylpropene) was used as a nontoxic surrogate to demonstrate cometabolic activity in the subsurface after biostimulation. The transformation of isobutene to isobutene epoxide (2-methyl-1,2-epoxypropane) illustrates the epoxidation process previously shown for common groundwater contaminants after cometabolic transformation by alkane-utilizing bacteria. The rate and extent of isobutene consumption and the formation and transformation of isobutene epoxide were greater in the presence of isobutane, with no evidence of primary substrate inhibition. Modeled concentrations of isobutane-utilizing biomass in microcosms constructed with groundwater collected before and after each SWPPT offered additional evidence that the isobutane-utilizing microbial community was stimulated in the aquifer. Experiments in groundwater microcosms also demonstrated that the isobutane-utilizing bacteria stimulated in the subsurface could cometabolically transform a mixture of co-substrates including isobutene, 1,1-dichloroethene, *cis*-1,2-dichloroethene, and 1,4-D with the same co-substrate preferences as the bacterium *Rhodococcus rhodochrous* ATCC strain 21198 after growth on isobutane. This study demonstrated the effectiveness of isobutane as primary substrate for stimulating in situ cometabolic activity and the use of isobutene as surrogate to investigate in situ cometabolic reactions catalyzed by isobutane-stimulated bacteria.

Keywords: Cometabolism; Push–pull tests; Isobutane; Isobutene; 1,1-Dichloroethene; 1,4-Dioxane

Madeleine Lépine, Jonathan Verreault. (Centre de recherche en toxicologie de l'environnement (TOXEN), Département des sciences biologiques, Université du Québec à Montréal, C.P. 8888, Succursale Centre-ville, Montreal, QC, H3C 3P8, Canada). Biotransformation of Dec-604 and potential effect on thyroid deiodinase activity in highly flame retardant-exposed gulls. Environmental Research, Volume 215, Part 1(2022): 114268

Several halogenated flame retardants (HFRs) have been identified as thyroid disruptors in birds including the polybrominated diphenyl ether (PBDE) mixtures, which have been replaced with other HFRs such as Dechlorane-604 (Dec-604). Dec-604 Component B (Dec-604 CB), a putative debrominated product of Dec-604, has been frequently reported in urban-adapted ring-billed gulls (Larus delawarensis) breeding in the Montreal area (QC, Canada). The metabolic pathways of Dec-604 are yet to be characterized, although the occurrence of Dec-604 CB in gulls may suggest that enzyme-mediated dehalogenation may occur, potentially involving the thyroid deiodinases. The objective of this study was to investigate the effect of Dec-604 on type 1 deiodinase (DIO1) in the presence of thyroxine (T4) in an in vitro DIO1 assay using liver microsomes of ring-billed gulls that are highly exposed to HFRs in the Montreal area, and to determine whether DIO1 is involved in the in vitro debromination of Dec-604. We tested the in vitro activity of DIO1 in gull liver microsomes in the presence of five concentrations of Dec-604 ranging from 0.86 to 86.21 nM. HFR concentrations (Σ40HFR) were also determined in liver samples of gulls. Results showed that total DIO1 activity in gull liver microsomes was increased by three of the five concentrations of Dec-604. No relationship between liver Σ40HFR concentrations and DIO1 activity was observed, except for T2 formation rates that significantly decreased with increasing liver HFR concentrations. Moreover, greater Dec-604 CB to Dec-604 concentration ratios in activated gull microsomes (with the DIO1 cofactor dithiothreitol) were found at the intermediate Dec-604 concentration compared to controls. These results suggested that liver microsome DIO1 activity may be perturbed in ring-billed gulls exposed to Dec-604, and be involved at least in part, in the debromination of Dec-604 leading to the formation of Dec-604 CB.

Keywords: Biotransformation

Shih-ChenYang, Wan-Wen Ting, I-Son Ng. (Department of Chemical Engineering, National Cheng Kung University, Tainan 701, Taiwan). Effective whole cell biotransformation of arginine to a four-carbon diamine putrescine using engineered Escherichia coli. Biochemical Engineering Journal, Volume 185 (2022): 108502

The rising awareness of environmental protection has triggered bio-based materials to replace the traditional petrochemical plastics. Putrescine as 1,4-diaminobutane is an important monomer of polyamide (PA) and uses in the sustainable chemical industry. Herein, a time-effective whole cell bioconversion of L-arginine to putrescine was developed, which has applied the key enzymes (i.e., SpeA and SpeB) from the arginine decarboxylase (ADC) pathway. The synergetic collaboration of both enzymes was examined from the different combination of plasmids among 4 Escherichia coli chassis. The optimal reaction condition was at pH 9 with 1 mM pyridoxal-5′-phosphate (PLP) and 10 mM magnesium, thus 90% conversion was obtained using an all-in-one plasmid with equal protein of SpeA and SpeB in BL21(DE3). The enzymatic kinetics demonstrated the higher kcat of SpeA (1212 s−1) than that of SpeB (418 s−1), while severe

inhibition of putrescine on SpeA (KI = 8.61 mM), thus it was disadvantage using the surface display of enzyme. To prevent the feedback-inhibition by product, a 2-step enzymatic reaction with cold treatment was conducted. Finally, the putrescine was achieved 17.1 g/L with the productivity of 8.56 g/L/h under 86% conversion of 50 g/L L-arginine-HCl, which is an effective approach to obtain high putrescine titer.

Keywords: Biotransformation

Alexey V.Kuzikov[ab], Tatiana A.Filippova[ab], Rami A.Masamrekh[ab], Victoria V.Shumyantseva[ab]. (a. Pirogov Russian National Research Medical University, 1, Ostrovityanova Street, Moscow 117997, Russia, b. Institute of Biomedical Chemistry, 10, Pogodinskaya Street, Moscow 119121, Russia). Biotransformation of phenytoin in the electrochemically-driven CYP2C19 system. Biophysical Chemistry, Volume 291 (2022): 106894

The possibility of the detection of atypical kinetic profiles of drug biotransformation using electrochemical systems based on immobilized cytochromes P450 with phenytoin hydroxylation by cytochrome P450 2C19 (CYP2C19) as an example was evaluated for the first time. For this purpose, we developed an electrochemical system, where one of the electrodes was modified by didodecyldimethylammonium bromide (DDAB) and was used as an electron donor for reduction of heme iron ion of the immobilized CYP2C19 and initiation of the catalytic reaction, while the second electrode was not modified and served for an electrochemical quantitation of 4-hydroxyphenytoin, which is a metabolite of antiepileptic drug phenytoin, by its oxidation peak. It was revealed that the dependence of the rate of 4-hydroxyphenytoin formation on phenytoin concentration is described by the equation for two enzymes or two binding sites indicating the existing of high- and low-affinity forms of the enzyme. The atypical kinetics and the kinetic parameters of CYP2C19-mediated phenytoin hydroxylation in the electrochemical system correlate to the same characteristics obtained by other authors in an alternative enzymatic system. Our results demonstrate the possibility of electrochemical systems based on cytochromes P450 to be applied for the detection of atypical kinetic profiles of drug metabolism.

Keywords: CYP2C19, Electrochemistry, Kinetic profiles, Phenytoin, 4-Hydroxyphenitoin

Xiangyin Chen, Jiaming Yu, Lixin Zhang. (State Key Laboratory of Bioreactor Engineering, School of Biotechnology, East China University of Science and Technology, 130 Meilong Road, Shanghai, 200237, China). Enhancing methanol biotransformation for overproducing fatty acid derivatives. Synthetic and Systems Biotechnology, Volume 7, Issue 4 (2022): 1187-1188

Excess amount of CO_2 in the atmosphere is one of the major causes of the greenhouse effect and global warming. CO_2, a promising feedstock for bio-refinery, its efficient utilization is challenging due to its stable structure and low energy state. However, small energetic compounds like methanol become a bridge and bond of efficient CO_2 transformation. Therefore, methanol biotransformation via microbial cell factories will pave the way for sustainable production of value-added chemicals.

Methanol metabolism is a complex and tightly regulated process, which generates toxic intermediate formaldehyde to hinder cell growth. Although artificial methanol metabolism could be achieved in model microbes such as Escherichia coli, the limited cell growth is far behind bio-productions. Alternatively, harnessing native methylotrophs could help methanol biotransformation toward high-level productions of high-value chemicals. Recently, Yongjin

Zhou et al. reported the engineering of methylotrophic yeasts for efficient production of fatty acid derivatives from sole methanol.

First, Ogataea polymorpha is engineered to produce free fatty acids (FFA) by blocking β-oxidation via deleting fatty acyl-CoA synthase gene FAA1. However, this faa1Δ strain failed to survive in methanol medium though it generated 983 mg/L of FFA from 20 g/L glucose. Rational metabolic rewiring to enhance the supply of cofactor and precursors, as well as methanol metabolism, failed in restoring the growth of faa1Δ strain from methanol. Then adaptive laboratory evolution (ALE) successfully obtained mutants with efficient cell growth and FFA production from sole methanol. Genome sequencing identified the mutation of two key genes, LPL1 (putative lipase) and IZH3 (membrane protein related to zinc metabolism), which were essential for restoring cell growth of faa1Δ strain in methanol and significantly increased the tolerance of wild-type strain against 50 g/L of methanol. Lipidomics revealed the deficiency in phospholipids hemostasis of faa1Δ strain, and the decreased levels of phosphatidylcholine (PC) and phosphatidyl-ethanolamine (PE) damaged peroxisomes. The leaked formaldehyde led to cell death via necrosis. Finally, the transcriptome-guided metabolic rewiring achieved a high level of FFA accumulation (up to 15.9 g/L) from sole methanol.

In the other study, Zhou et al. has reported engineering Pichia pastoris for high-level production of fatty acids and fatty alcohols from sole methanol. Interestingly, disruption of fatty acyl-CoA synthase (faa1Δ, faa2Δ) did not result in cell growth deficiency, despite a slight growth inhibition with increased levels of formaldehyde and reactive oxygen species. This observation suggested that P. pastoris was more robust than O. polymorpha in the overproduction of FFA from methanol. Further enhancing the supply of precursor acetyl-CoA and cofactor NADPH (overexpressing gene MmACL, ScIDP2, BbXFPK, CkPTA), and fine-tuning methanol metabolism (overexpressing gene DAS2) enabled up to 23.4 g/L of FFA in fed-batch fermentations. Finally, a metabolic transforming strategy was developed to enable 2.0 g/L fatty alcohol from sole methanol, which avoids labor-intensive and time-consuming genetic manipulation.

The different behaviors between O. polymorpha and P. pastoris on bio-productions of FFA from sole methanol, suggest there was a big difference in methanol metabolism among various methylotrophic yeasts. Systematical mining of genome sequences may help to identify other key genes in regulating methanol metabolism, requiring to construct a better model to describe methanol toxicity during bio-productions. The high-level production of fatty acid derivatives from sole methanol showed the strong potential of methanol biotransformation to value-added products for industrial applications.

Keywords: Biotransformation

Xin Wen[a], Yuhang Ning[a], Huibin Lin[b], Yilin Ren[c], Can Li[d], Yujie Liu[a], Chengjia Zhang[a], Jianqun Lin[a], Jianqiang Lin[a]. (a. State Key Laboratory of Microbial Technology, Shandong University (Qingdao), Qingdao city 266237, Shandong province, China, b. Shandong Academy of Chinese Medicine, Jinan city 250014, Shandong province, China, c. Qingdao Longding Biotech Limited Company, Qingdao city 266108, Shandong province, China, d. School of Biological Engineering, Qilu University of Technology, Jinan city 250353, Shandong province, China). **d-Allulose (d-psicose) biotransformation from d-glucose, separation by simulated moving bed chromatography (SMBC) and purification by crystallization. Process Biochemistry, Volume 119(2022): 29-38**

d-Allulose (or d-Psicose), a C-3 epimer of d-fructose, is a low-calorie rare sugar with excellent physiological functions. The recombinant Escherichia coli expressing d-allulose 3-epimerase for d-allulose conversion from d-fructose was constructed. Under the optimal conditions, 139.3 g/L d-allulose was produced from 500 g/L of d-fructose. In order to decrease the cost for mass production, one-pot reaction method by using immobilized glucose isomerase and recombinant E. coli expressing d-allulose 3-epimerase to produce d-allulose from d-glucose was developed. The immobilized glucose isomerase (200 g/L) and the recombinant E. coli cells (OD600 2) were mixed and used to transform d-glucose into d-allulose, and 228.5 g/L d-glucose, 216.3 g/L d-fructose and 90.7 g/L d-allulose were obtained from 550 g/L d-glucose after 3 h reaction. After that, d-allulose was separated from the reaction mixture by using simulated moving bed chromatography (SMBC) with the purity of 99.6%. Finally, crystallization was made to obtain the d-allulose crystals with 99.8% purity. The combination of enzyme and catalytic cells in biotransformation greatly expand the flexibility and capability of the catalytic reactions. This method developed in this study can be easily scaled up for mass production of highly purified d-allulose.

Keywords: D-Allulose (or D-Psicose), Biotransformation, Simulated moving bed chromatography (SMBC), Crystallization

Florencia Carmona-Viglianco[a], Daniel Zaragoza-Puchol[b], Gabriela E.Feresin[b], Fabricio R.Bisogno[c], Marcela Kurina-Sanz[a], Alejandro A.Orden[a]. (a. INTEQUI-CONICET, Facultad de Química, Bioquímica y Farmacia, Universidad Nacional de San Luis, Almirante Brown 1455, San Luis D5700ANW, Argentina, b. Instituto de Biotecnología, CONICET, Facultad de Ingeniería, Universidad Nacional de San Juan, Av. Libertador General San Martín 1109 (O), San Juan CP 5400, Argentina, c. Dpto. de Química Orgánica, Facultad de Ciencias Químicas, Universidad Nacional de Córdoba, Ciudad Universitaria, INFIQC-CONICET-UNC, Córdoba X5000HUA, Argentina). Fungal biotransformations of anticholinesterase norbelladine derivatives to obtain new products and mimic mammalian metabolism. Phytochemistry Letters, Volume 51(2022): 5-11

Norbelladine is the natural precursor of all alkaloids of the Amaryllidaceae family. These compounds have been reported to exert interesting biological activities. Particularly, galantamine is currently used in the palliative treatment of Alzheimer's disease for its cholinergic effect. The biotransformation of two norbelladine analogues exhibiting anticholinesterase activity was studied using 11 fungi belonging to Aspergillus, Rhizopus, Cunninghamella and Fusarium genera. The substrates were refractory to biotransformation by all fungi screened, except by A. clavatus. Based on GC-MS analyses, we demonstrated that its enzymes were able to catalyse the oxidative cleavage of the C-N bond of the secondary amine of 4'-O-methylnorbelladine. On the other hand, the hindered phenolic hydroxy group at the 3' position of the brominated derivative was regioselectively methylated. The latter compound was chemically synthesised for better characterisation and the biological assays showed that this metabolite exerted a lower inhibition of BChE and lost the anti-AChE activity. The metabolic pathways involved here were useful to mimic phase I and II xenobiotic metabolism in mammals and thus predict the products that could be formed. A new source of biocatalytic tools to obtain new protoalkaloid derivatives was also discovered.

Keywords: Amaryllidaceae, Cholinesterase inhibition, Phase I and II metabolism, Fungal bioconversion, Aspergillus clavatus

Xiao Li[a], Qi An[a], Sha-sha Qu[a], Jing-Nan Ren[a], Gang Fan[a], Lu-Lu Zhang[b], Si-Yi Pan[a]. (a. Key Laboratory of Environment Correlative Dietology, Ministry of Education, College of

Food Science and Technology, Huazhong Agricultural University, Wuhan 430070, China, b. College of Food Science and Technology, Henan University of Technology, Zhengzhou 450001, PR China). Differential proteomic analysis of citrus flavor (+)-valencene biotransformation to (+)-nootkatone by Yarrowia lipolytica. International Journal of Biological Macromolecules, Volume 220 (2022): 1031-1048

Natural products (+)-nootkatone is an important sesquiterpene compound and is widely used in pharmaceutical, cosmetic, agricultural and food industries. The aim of this study was to analyze the differentially expressed proteins (DEPs) during citrus aroma compound (+)-valencene biotransformation to (+)-nootkatone by Yarrowia lipolyticaby with high-throughput LC-MS/MS. A total of 778 proteins were differentially expressed, 385 DEPs were significantly up-regulated and 393 DEPs were markedly down-regulated. It was found that the enzymes transformed (+)-valencene to (+)-nootkatone were mainly existed in yeast intracellular and precipitated under the condition of 30–40 % ammonium sulfate. Most DEPs involved in amino acid and fatty acid metabolism were down-regulated during (+)-valencene biotransformation. The DEPs related to the carbohydrate metabolism, energy metabolism and most of transporter proteins were significantly up-regulated. Furthermore, the key enzymes involved in (+)-valencene transformation might be related to cytochrome P450s (gene2215 and gene2911) and dehydrogenases (gene6493). This is the first time that proteomics was used to investigate the metabolism mechanism of Yarrowia lipolytica during (+)-valencene biotransformation. The proteomic analysis of Yarrowia lipolytica provided a foundation for the molecular regulatory mechanism in the biotransformation to (+)-nootkatone from (+)-valencene.

Keywords: (+)-nootkatone, Yarrowia lipolytica, Proteomics

Biomarker

Todd Leckie[a], Daniel Fitzpatrick[b], Alan J.Richardson[b], Alex Hunter[c], Sonia Bains[d], Rachael Grimaldi[e], Rob Galloway[f], Lui G.Forni[g], Luke E.Hodgsona[h]. (a. Anaesthetics and Critical Care Department, Worthing Hospital, University Hospitals Sussex NHS Trust, Worthing, UK, b. School of Sport and Health Sciences, University of Brighton, Brighton, UK, c. Anaesthetics Department, Royal Devon and Exeter NHS Trust, Exeter, UK, d. Institute of Sport, Exercise and Health, University College London Hospital, London, UK, e. Anaesthetics Department, Great Ormond Street Hospital for Children, London, UK, f. Emergency Medicine Department, Royal Sussex County Hospital, University Hospitals Sussex NHS Trust, Brighton, UK, g. Critical Care Department, Royal Surrey County Hospital NHS Trust, Guildford, UK, h. Brighton and Sussex Medical School, Brighton, UK). Marathon running and cell-cycle arrest biomarkers of acute kidney injury. Journal of Science and Medicine in Sport, (2022): in press.

Endurance exercise is known to cause a rise in serum creatinine. It is not known to what extent this rise reflects renal stress and a potential acute kidney injury (AKI). Increases in Insulin Like Growth Factor Binding Protein 7 (IGFBP7) and Tissue Inhibitor of Metalloprotinases-2 (TIMP-2), urinary biomarkers of cell cycle arrest and renal stress, are associated with the development of AKI in clinical populations.

Repeated measures study.

Runners were recruited at the 2019 Brighton Marathon (UK) and provided urine and blood samples at baseline, immediately post-race and 24 h post-race. Serum creatinine, urinary creatinine and urinary IGFBP7 and TIMP-2 were analysed from the samples.

Seventy nine participants (23 females, 56 males), aged 43 ± 10 yrs. (mean ± SD), finish time 243 ± 40mins were included for analysis. Serum creatinine increased over the race by 40 ± 26% ($p < 0.001$), TIMP-2 increased by 555 ± 697% ($p < 0.001$) and IGFBP7 increased by 1094 ± 1491% ($p < 0.001$) over the race. A subset of twenty-two participants supplied samples 24 h post-race, reporting values similar to baseline for all variables.

This study is the first to report large rises in IGFBP7 and TIMP-2 following marathon running. This suggests that rises in creatinine are not fully explained by changes in production and clearance and marathon running induces a state of kidney stress and potential injury.

Keywords: Acute kidney injury, Biomarker, Endurance, Running, IGFBP7TIMP-2

D.Wen. (Key Laboratory of Clinical Precision Medication, GDPU - Guangdong Pharmaceutical University, Guangzhou, China). 77P Hypermethylation of genes HIST1H4F, Septin9 and RASSF1 as the potential biomarker for nasopharyngeal carcinoma screening. Annals of Oncology, Volume 33, Supplement 7(2022): S576

Nasopharyngeal carcinoma (NPC) is one of the most common malignant tumors in Southeast Asia, especially in southern China. There were about 129,000 new NPC cases and 34,000 deaths worldwide in 2018 according to Global Cancer Obsercatory. Even though NPC is sensitive to radiotherapy and has a 5-year survival rate of about 70%, the prognosis is poor in advanced stage. Therefore, it is important to screen NPC in the early stage. Epstein–Barr virus (EBV) infection plays important roles in the development of NPC, and EBV immunological assay is employed as a standard diagnostics of NPC, however, it is an invasive method. DNA methylation may lead to tumor initiation and progression by dysregulation of specific genes, should be a potential biomaker for NPC screening in early stage in a non-invasive format by collecting sample using the nose swab.

48 paraffin embedded NPC and 36 chronic nasopharyngitis (CN) speciments were collected from the First Affiliated Hospital of Guangdong Pharmaceutical University, China, and EBV serum antigen were assayed for all these patients. The quantitative methylation-sensitive PCR (qMS-PCR) assays were employed to analyse the methylation of HIST1H4F, Septin9 and RASSF1, after bisulfite modification of DNA which was extracted from the paraffin embedded samples using QIAamp DNA FFPE Tissue Kit. The individual and combination methylation gene results were compared with the antibody titer of EBV serum antigen on the basis of pathology.

EBV serum antigen was positive in 59% of patients with NPC. The percent of patients with hypermethylation of the genes HIST1H4F, Septin9 and RASSF1 in NPC group was 69%, 67% and 60% respectively, which were higher than patients with CN with the positive rate under 30%. Interestingly, The positive rate leapt to 90.5% (19/21) when combination of these three hypermethylated genes in patients, which was more than using EBV serum antigen with the positive rate about 63% (P=0.02).

The combination of the hypermethylation of the genes HIST1H4F, Septin9 and RASSF1 may provide a potential biomarker for nasopharyngeal carcinoma screening in early stage.

Keywords: Biomarker

Biofertilizer

Xuemin Wei, Xuanjiao Bai, Pei Cao, Gang Wang, Jianping Han, Zheng Zhang. (Institute of Medicinal Plant Development, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing 100193, China). Bacillus and microalgae biofertilizers improved quality and biomass of Salvia miltiorrhiza by altering microbial communities. Chinese Herbal Medicines (2022): Available online

Biofertilizers are reliable alternatives to chemical fertilizers due to various advantages. However, the effect of biofertilizers on Salvia miltiorrhiza yield and quality and the possible mechanisms remain little known. Here, an experiment was conducted in S. miltiorrhiza field treated with two kinds of biofertilizers including Bacillus and microalgae.

A field experiment was conducted on S. miltiorrhiza of one year old. The biofertilizers were applied at six treatments: (i) control check, CK; (ii) microalgae, VZ; (iii) Bacillus, TTB; (iv) microalgae + Bacillus (1:1), VTA; (v) microalgae + Bacillus (0.5:1), VTB; (vi) microalgae + Bacillus (1:0.5), VTC. Here, high-throughput sequencing, ICP-MS and UPLC were employed to systematically characterize changes of microbial diversity and structure composition, heavy metals content and bioactive compounds, respectively.

Compared to CK, root biomass increased by 29.31 %−60.39 % ($P < 0.001$). Meanwhile, bioactive compounds were higher than CK after the application of the biofertilizers, peculiarly in TTB and VTB. However, the content of Pb contents in roots significantly reduced by 46.03 % and 37.58 % respectively in VTC and TTB ($P < 0.05$). VTA application notably increased the available nitrogen content by 53.03 % ($P < 0.05$), indicating the improvement of soil fertility. Significantly, bacterial and fungal Chao I diversity indices showed an increasing trend with biofertilizer application ($P < 0.05$), and biofertilizer amendment enriched the rhizosphere soil with beneficial microorganisms that have abilities on promoting plant growth (Achromobacter and Penicillium), adsorbing heavy metal (Achromobacter and Beauveria), controlling plant pathogen (Plectosphaerella, Lechevalieria, Sorangium, Phlebiopsis and Beauveria) and promoting the accumulation of metabolites (Beauveria and Phoma).

Bacillus and microalgae biofertilizers improved the quality and biomass of S. miltiorrhiza by altering microbial communities in soil.

Keywords: biofertilizer, plant growth, quality, rhizosphere microorganisms, Salvia miltiorrhiza (Bge.)

Barkha Sharma[a], Shalini Tiwari[a], Kailash Chand Kumawat[b], Massimiliano Cardinale[c]. ([a]Department of Microbiology, G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India, b. Department of Industrial Microbiology, Jacob Institute of Biotechnology and Bioengineering, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh 211007, India, c. Department of Biological and Environmental Sciences and Technologies - DiSTeBA, University of Salento, SP6 Lecce-Monteroni, I-73100 Lecce, Italy). Nano-biofertilizers as bio-emerging strategies for sustainable agriculture development: Potentiality and their limitations. Science of The Total Environment (2022): doi: 10.1016/j.scitotenv.2022.160476.

Nanotechnology is a burgeoning revolutionary technology in the 21st century. Climate emergencies caused by natural or anthropogenic activities have tragically consequential repercussions on agricultural output worldwide. Modern cropping systems profoundly rely on synthetic fertilizers to deliver necessary nutrients, yet their prolonged and persistent administration is hazardous to the environment, soil fertility, and nutritional dynamics of the rhizospheric microbiome. By addressing the drawback of physico-chemically synthesized nano-dimensioned fertilizer, this review emphasizes on integrating nanoparticles and biofertilizers conjointly as nano-biofertilizers (NBF) which can safeguard global food security, in light of the population surge. Inoculation with nanoparticles and biofertilizers strengthens plant growth and stress tolerance. However, combined together (NBF), they have emerged as a more economically and environmentally sustainable, highly versatile, and long-lasting agriculture tool. Microbe-based green synthesis using the encapsulation of inorganic nanoparticles of Si, Zn, Cu, Fe, Ni, Ti, and Ag as well as organic materials, including chitosan, cellulose, and starch, to formulate NBFs can eliminate the constraints of conventional fertilizer contamination. The application of NBFs is in its infancy in agriculture, yet it has promising potential for transforming traditional farming techniques into smart agriculture, compared to any of the existing strategies. From this perspective, this review is an attempt to provide a comprehensive understanding of the formulations, fabrication, and characterization of NBFs while unraveling the underlying mechanisms of plant-NBF interactions along with their contribution to climate change-induced biotic and abiotic stress tolerance. We substantially summarize the latest advancements of field applications of NBFs for precision farming. Moreover, we critically revised their applications in agro-ecosystems according to the current literature, while also discussing the bottlenecks and future trends for developing potent NBFs.

Keywords: Abiotic and biotic stresses, Climatic changing condition, Nano-biofertilizer, Nutrient use efficiency, Sustainable agriculture

Jun Li[abc], Lila Otero-Gonzalez[a], Piet N.L.Lens[d], Ivet Ferrer[b], Gijs Du Laing[a]. ([a]·Laboratory of Analytical Chemistry and Applied Ecochemistry, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000, Ghent, Belgium, b. GEMMA-Group of Environmental Engineering and Microbiology, Department of Civil and Environmental Engineering, Universitat Politècnica de Catalunya·BarcelonaTech, Jordi Girona 1-3, Building D1, 08034, Barcelona, Spain, c. Key Laboratory of Reservoir Aquatic Environment, Chongqing Institute of Green and Intelligent Technology, Chinese Academy of Sciences, Chongqing, 400714, China, d. UNESCO-IHE Institute for Water Education, 2601, DA, Delft, Netherlands). Assessment of selenium and zinc enriched sludge and duckweed as slow-release micronutrient biofertilizers for Phaseolus vulgaris growth. Journal of Environmental Management, Volume 324(2022): 116397

Selenium (Se) and zinc (Zn) are essential micronutrients that are often lacking in the diet of humans and animals. Application of mineral Se and Zn fertilizers into soils may lead to a waste of Se and Zn due to the fast leaching and low utilization by plants. Slow-release Se and Zn biofertilizer may therefore be beneficial. This study aims to assess the potential of SeZn-enriched duckweed and sludge produced from wastewater as slow-release Se and Zn biofertilizers. Pot experiments with green beans (Phaseolus vulgaris) and sampling of Rhizon soil pore water were conducted to evaluate the bioavailability of Se and Zn in sandy and loamy soils mixed with SeZn-enriched duckweed and sludge. Both the Se and Zn concentrations in the soil pore water increased upon amending the two biomaterials. The concentration of Se released from SeZn-enriched duckweed rapidly decreased in the first 21 days and slowly declined afterwards, while it remained stable during the entire experiment upon application of SeZn-

enriched sludge. The Zn content in the soil pore water gradually increased over time. The application of SeZn-enriched duckweed and sludge significantly increased the Se concentrations in plant tissues, in particular in the form of organic Se-methionine in seeds, without a negative impact on plant growth when an appropriate dose was applied (1 mg Se/kg soil). While, it did not increase Zn concentrations in plant seeds. The results indicate that the SeZn-enriched duckweed and sludge could be only used as organic Se biofertilizers for Se-deficient soils. Particularly, the SeZn-enriched sludge dominated with elemental nano-Se was an effective Se source and slow-release Se biofertilizer. These results could offer a theoretical reference to choose an alternative to chemical Se fertilizers for biofortification, avoiding the problem of Se losses by leaching from mineral Se fertilizers while recovering resources from wastewater. This could contribute to the driver for a future circular economy.

Keywords: Selenium, Zinc Biofertilizer, Bioavailability, Biofortification, Resource recovery

Ahmed Alengebawy[a], Badr A.Mohamed[b], Keda Jin[a], Tingting Liu[a], Nirmal Ghimire[c], Mohamed Samer[b], Ping Aia[d]. (a. College of Engineering, Huazhong Agricultural University, Wuhan 430070, China, b. Department of Agricultural Engineering, Faculty of Agriculture, Cairo University, Giza 12613, Egypt, c. Department of Mechanical Engineering, Green Hydrogen Lab, Kathmandu University, Dhulikhel 45200, Nepal, d. Technology & Equipment Center for Carbon Neutrality, Huazhong Agricultural University, Wuhan 430070, China). A comparative life cycle assessment of biofertilizer production towards sustainable utilization of anaerobic digestate. Sustainable Production and Consumption, Volume 33 (2022): 875-889

Direct application of anaerobic digestate to agricultural soil has major environmental threats. Therefore, this study evaluates and compares four scenarios of digestate utilization as the first life cycle assessment (LCA) study conducted on these four scenarios. The four scenarios included (i) biofertilizer pellets (BFPs), (ii) biocompost (BC), (iii) liquid biofertilizer (LBF), and (iv) powder biofertilizer (PBF). The results showed that the LBF scenario was the best treatment choice, achieving environmental benefits in five of the ten impact categories examined; the highest was the marine aquatic ecotoxicity category (−141,304.03 kg 1,4-DB-eq./tonne digestate). Contrarily, the scenario with the least environmental benefits was the BC scenario in which it contributed to emissions in five categories; the most notable was the contribution to the global warming category with 25.68 kg CO2-eq./tonne digestate. However, all the studied scenarios achieved environmental gains compared to the chemical fertilizers, and the top three emission reduction categories were marine aquatic ecotoxicity, global warming, and human toxicity. This study provides a valuable reference and inventory data for digestate treatment options.

Keywords: Life cycle assessment, Anaerobic digestate, Digestate utilization, Biofertilizer, Environmental impact assessment

Rajendra Bam, Sharoj Raj Mishra, Subodh Khanal, Prakash Ghimire, Suman Bhattarai. (Institute of Agriculture and Animal Science, Tribhuwan University, Nepal). Effect of biofertilizers and nutrient sources on the performance of mungbean at Rupandehi, Nepal, Journal of Agriculture and Food Research, Volume 10 (2022): 100404

Nutrient management has been a major constraint in mungbean cultivation, resulting in huge economic losses to farmers. A field experiment was conducted at Paklihawa, Rupandehi, Nepal

to evaluate the effects of different biofertilizers and nutrient sources on yield, performance, and economics of mungbean in 2020. The experiment was laid out in a split-plot design comprising of three treatments of biofertilizers in the main plot i.e., Control, Rhizobium, and Azotobacter, and six treatments of organic and inorganic fertilizers in sub-plots i.e., Control, Farm Yard Manure (FYM) @5000 kg/ha, Poultry Manure (PM) @3000 kg/ha, Recommended dose of chemical fertilizer (RDF) @20:40:20 kg/ha, and Poultry manure in combination with the recommended dose of chemical fertilizer. The experiment results revealed that in the case of biofertilizer application, the highest grain yield was obtained by Rhizobium inoculation (1019.32 kg/ha) and with Azotobacter inoculation (962.57 kg/ha) as compared to control (756.35 kg/ha). In the case of fertilizer application, integrated application of poultry manure and recommended dose of fertilizers resulted in a higher yield (1045 kg/ha), which is statistically similar to the combination of farmyard manure and recommended dose of fertilizers (991.08 kg/ha), followed by the solo use of fertilizer and control. The treatment with the recommended dose of fertilizers alone resulted in higher economics, while interaction with Rhizobium resulted in a benefit-cost ratio of 3.96. Moreover, organic manure treatment in control plots contributed to a low benefit-cost ratio (3) compared to other combinations of treatments (>3). The authors suggested the use of biofertilizers in combination with other fertilizers for better crop yields and high economic returns. However, further research is required to conclude the effects of different nutrient sources on successful mungbean cultivation.

Keywords: B: C ratio, Fertilizers, Management, Mungbean, Nepal

César Danilo Valle Expósito, Janice Álvarez López, Junqing Liu, Ningna Bao, Jing Liang, Jianfeng Zhang. (College of Life Science, Key Laboratory of Straw Comprehensive Utilization and Black Soil Conservation, The Ministry of Education, Jilin Agricultural University, Changchun, 130118, China). Development of a cold-active microbial compound biofertilizer on the improvement for rice (oryza sativa L.) tolerance at low-temperature. Rhizosphere, Volume 24(2022): 100586

The use of plant growth-promoting bacteria has been used to improve low-temperature stress in agriculture. However, the use of cold compound biofertilizers is not widely used to reduce the application of chemical fertilizers. In this study, a compound biofertilizer was developed to improve the tolerance of rice (Oryza sativa L.) to low-temperature stress, containing six cold-tolerant bacteria that were isolated from wild rice rhizosphere, with following capabilities: solubilization of phosphate and potassium, fixation of nitrogen, production of indoleacetic acid, ammonium, hydrogen cyanide, and siderophores. The results indicated that seed inoculation significantly increased germination (25%) and promoted root (84.34%) and shoot (54.61%) growth compared to the control. In seedlings, the inoculation significantly increased ($P < 0.05$) the shoots length (69.11%), roots (110.12%), and plant biomass; in addition, a significant accumulation of chlorophyll (83.74%), proline (285.98%), soluble sugar (471%) and soluble protein (112.5%) was detected compared to the non-inoculated control. It also considerably improved protection against oxidative stress by lowering malondialdehyde content (127.93%) lower than control, increasing antioxidant enzymes, and higher accumulation of nitrogen, phosphorus, and potassium in plants compared to control. The biofertilizer application composed of phosphate solubilizing, potassium solubilizing, and nitrogen-fixing bacteria proved an effective alternative to improve cold stress in rice. Its effect was significantly better than the commercial products used in the study. Its use can be extended as an alternative to reduce chemical fertilization and contribute to the development of sustainable agriculture.

Keywords: Biofertilizer

Pouria Ataei[a], Hamid Karimi[b], Christian A.Klöckner[c], Seyed Reza Es'haghi[d], Raha Zarei[e]. (a. Department of Agricultural Extension & Education, College of Agriculture, Tarbiat Modares University (TMU), Tehran, Iran, b. Department of Agricultural Extension and Education, Faculty of Agriculture, University of Zabol, Zabol, Iran, c. Department of Psychology, Faculty of Social and Educational Sciences, Norwegian University of Science and Technology, Norway1, d. Department of Agricultural Extension and Education, College of Agriculture and Natural Resources, University of Tehran, P.O. Box 14155-6135, Tehran, Iran, e. Department of Agricultural Extension and Education, School of Agriculture, Shiraz University, Shiraz, Iran). The promotion of biofertilizer application on farms: Farmers' intentional processes. Environmental Technology & Innovation, Volume 28 (2022): 102722

The present research investigated factors that contribute to the farmer's behavioral intention to use biofertilizers based on a comprehensive model of environmental behavior (CADM). This study was a retrospective design, quantitative, non-experimental, causal-relational, descriptive-correlational, and applied study. This research contributed the new behavioral theory to recognize farmers' intention and it can be useful for policy makers in agriculture sector. From the total population of farmers in the Fars province, Iran, to whom biofertilizers had been introduced (N=2200), a sample of 327 farmers was selected by a stratified random sampling technique. The study was conducted by applying a questionnaire measuring the model variables in a face-to-face interview situation. The results of the model analyses show that the model receives a satisfactory model fit. Intentions to use biofertilizers are strongly determined by normative processes, situational influence, and attitudes. Habits are strongly related to personal norms and objective constraints, whereas the relation to subjective constraints is weaker. It can conclude that all four components proposed in the CADM have a significant direct or indirect relation to farmers' intentions to use biofertilizers and should be addressed when promoting further use.

Keywords: Biofertilizers, Comprehensive action determination model, Farmers' behavioral intention, Sustainable agriculture, Sustainable development

Palash Ghorai, Dipankar Ghosh. (Microbial Engineering and Algal Biotechnology Laboratory, Department of Biotechnology, 81 Nilgunj Road, Agarpara, JIS University, Kolkata, West Bengal 700109, India). Ameliorating the performance of NPK biofertilizers to attain sustainable agriculture with special emphasis on bioengineering. Bioresource Technology Reports, Volume 19 (2022): 101117

Food security is the world's most pressing challenge as populations grow. Globally, green revolution practices increase the use of chemically manufactured fertilizers, which have an influence on soil dynamics and disturb typical soil biodiversity. Thus, a paradigm shift is required to improve the eco-friendly potential of microbial biofertilizers in soil. Hence, this concise review explicates recent updates to address bioengineering ways to relieve nitrogen fixation, phosphorus, and potassium solubilization in a diverse range of oleaginous microbes in order to improve soil fertility and plant productivity. The nature of the multiple routes disclosed for plant growth promoting microbes' activities, as well as the capacity to genetically change a strain for a specific plant growth-promoting activity. As a result, there is an opportunity to conduct a more thorough study and produce sustainable potential formulations of NPK biofertilizer in the near future to increase accessibility and sustainable organic farming.

Keywords: Biofertilizer, Plant nutrients accessibility, Bioengineering, GMOsSustainable agriculture

Tian-Yu Du, Hai-Yun He, Qian Zhang, Lu Lu, Wen-Jing Mao, Mei-Zhi Zhai. (College of Forestry, Northwest A&F University, Yangling, Shaanxi 712100, China). Positive effects of organic fertilizers and biofertilizers on soil microbial community composition and walnut yield. Applied Soil Ecology, Volume 175(2022): 104457

Different fertilization regimes differentially impact the physicochemical properties, diversity, and ecosystem functioning of soil microbial communities. However, there is little research on the relationship between soil quality, microbial diversity, and crop production under different long-term fertilization regimes, especially on woody plants. Therefore, in this study, we investigated changes in the soil microbial communities of walnut orchards after nine years of continuous fertilization (no fertilizer, only chemical fertilizer, chemical + organic fertilizer, chemical + biofertilizer, and chemical + organic + biofertilizer), and analyzed the link between fertility improvement and yield increase from a microbial perspective. The results showed that the soil quality index was strongly correlated with organic fertilizers and biofertilizers addition, and exhibited a significant relationship with walnut yield. Furthermore, the addition of organic fertilizers or biofertilizers promoted the enrichment of microorganisms beneficial to soil fertility, crop growth (Bacillus spp.) and soil bioremediation (Solicoccozyma spp.) and decreased the amounts of Fusarium spp. in the walnut orchard soil. Moreover, structural equation modeling indicated strong and positive relationships between walnut yield and the diversity of the keystone microbial communities. Overall, the results confirm the feasibility of using multiple fertilizer blends to improve soil fertility and reveal the fundamental role of fungal diversity in maintaining economic forest tree production.

Keywords: Fertility, Soil quality index, Biodiversity, Crop growth, Ecosystem function

Biocomposting

S.Dinesh Kumar[a], Amol Balu Mande[a], M.Premalatha[a], T.Sivasankar[b]. (a. Department of Energy and Environment, National Institute of Technology Tiruchirappalli, India, b. Department of Chemical Engineering, National Institute of Technology Tiruchirappalli, India). Experimental studies on the impact of porous bed-induced solar evaporation (PBISE) and thermal degradation of the solid content of the distillery effluent using cocopeat- A sustainable approach. Journal of Cleaner Production, Volume 377 (2022): 134250

The distillery industries are a highly water-intensive unit that discharges a higher volume of effluent while producing alcohol. Various treatment methods were adopted for the treatment of the effluent to bring down the effluent to the discharge standards. The available treatment methods are highly energy intensive, besides producing a sludge at the end of the treatment process, which needs further treatment or a disposal technique. The objective of the present work is to arrive at a sustainable method of evaporating the distillery effluent using a solar still in presence of cocopeat as bed material for evaporation and to study the feasibility of the thermal decomposition of the sludge obtained from the still. This study compares the drying rate of distillery effluent in presence of cocopeat as a bed material with that of the distillery effluent without bed material at isothermal conditions (60–100 °C). Experiments are conducted in an open atmosphere using solar still to study the effect of bed material on the rate of evaporation of the effluent. Further, the distillate produced in the solar stills containing tap water(S1), distillery

effluent(S2), and effluent with cocopeat as bed material (S3) were compared. The sludge obtained from the stills (S2 & S3) was checked for the feasibility of thermal decomposition. The constant rate drying period got extended up to a critical moisture content (CMC) of 35% in the presence of cocopeat, compared to that of 62% in the case of effluent alone at 100 °C. This emphasizes the use of cocopeat as bed material in solar still could enhance the evaporation rate of effluent. The distillate yield in S1, S2, and S3 were 4.49 L/m2/day, 4.94 L/m2/day, and 5.41 L/m2/day respectively. The S3 shows a higher production of distillate yield by 10% than S2, proving that the extended constant rate period enhanced the distillate production. The sludge obtained from S2 and S3 was thermally decomposed by a Thermogravimetric analyzer. The residual weight in the case of thermal decomposition of effluent solids (S2) was 25% whereas in the case of a mixture of cocopeat and effluent solids (S3) was reduced to 5%. The synergistic behavior of the thermal decomposition between the cocopeat and the effluent solids was observed from the thermogravimetric analysis of the sludge. Hence, the solid waste obtained from the still is also effectively managed by co-combustion.

Keywords: Biocomposting

Mahmoud N.Menshawy, Ahmed M.Abdel-Hamid, Samy K.Mohamed, Mo'men H.El-Katatny. (Department of Botany and Microbiology, Faculty of Science, Minia University, El-Minia 61519, Egypt). Isolation and molecular identification of cellulose/hemicellulose degrading bacteria from agricultural compost and determination of their hydrolytic potential. South African Journal of Botany, Volume 149 (2022): 617-621

Nine cellulolytic bacteria were isolated from agricultural residues compost on selective culture medium amended with cellulose (filter paper) as the sole carbon source. Five of the nine isolates (CX2, CX4, CX5, CX7 and CX9) were able to degrade both cellulose (CMC) and xylan in congo red agar plates. The five isolates were able to depolymerize the agricultural wastes, rice straw and sugarcane bagasse. CMC-ase and xylanase production by the five isolates were determined on rice straw and sugarcane bagasse. CX2 and CX9 exhibited the highest CMC-ase and xylanase production on both rice straw and sugarcane bagasse. Among the isolated strains, CX9 produced the highest CMC-ase activity (71 pKat ml−1) on rice straw, whereas CX9 produced the highest xylanase activity (7.83 nKat ml−1) on sugarcane bagasse. In general, higher CMC-ase and xylanase production was obtained on rice straw compared with sugarcane bagasse. According to the sequences of the 16 s rRNA genes, the five isolates were identified as: Paracoccus kondratievae strain GB (CX2 and CX4), Paracoccus communis (CX5), Bacillus australimaris (CX7) and Bacillus pumilus (CX9). The sequences of the 16S rRNA genes of five isolates were submitted to the gene bank.

Keywords: Lignocellulytic bacteria, Cellulase, Xylanase 16S rRNA gene sequencing

Liza Melia Terry[a], Adrian Chun Minh Loy[b], Jiuan Jing Chew[a], Bing Shen How[a], Viknesh Andiappan[a], Jaka Sunarso[a]. (a. Biomass-Waste-to-Wealth Special Interest Group, Research Centre for Sustainable Technologies, Faculty of Engineering, Computing and Science, Swinburne University of Technology, Jalan Simpang Tiga, 93350 Kuching, Sarawak, Malaysia, b. Department of Chemical Engineering, Monash University, Melbourne, Victoria 3800, Australia). Chemical engineering and the sustainable oil palm biomass industry—Recent advances and perspectives for the future. Chemical Engineering Research and Design, Volume 188(2022): 729-735

Chemical engineers play an important and irreplaceable role in addressing all, if not most, of the grand challenges mankind faces. Chemical engineering knowledge has been crucial in advancing the current industrial sectors. This perspective paper attempts to outline the contributions of chemical engineering knowledge to the oil palm biomass industry, a green industry that converts waste into value-added products (e.g. energy, fuel, and chemicals). Several examples are presented to show how the three core chemical engineering knowledge subjects (i.e. (i) reaction engineering, (ii) multi-component/multi-phase separation, and (iii) process systems engineering (PSE)) have been applied in the industry. Apart from that, specific perspectives on the industry's future outlook are also given in this work. Generally, the illustrated potential areas in all three aspects (i.e. micro-scale, meso-scale, and macro-scale) have been discussed with several illustrative examples. This perspective paper aims to capture the state-of-the-art applications of chemical engineering knowledge in the oil palm biomass industry. It serves as a short note to recognise the importance of the chemical engineering domain and offer insights for future and current chemical engineers in advancing the oil palm biomass industry.

Keywords: Green economy, Multi-component separation, Oil palm biomass, Process systems engineering, Reaction engineering, Waste-to-Wealth

Alif Chebbi[abd], Andrea Franzetti[b], Francesca Formicol[ab], Tekilt Gebregiorgs Ambaye[a], Franco Hernan Gomez[a], Beatrice Murena[b], Emanuela De Marco[c], Tiziana Beltrani[c], Silvia Sbaffoni[c], Mentore Vaccari[a]. (a. Dep. of Civil, Environmental, Architectural Engineering, and Mathematics, University of Brescia, Via Branze 43, 25123, Brescia, Italy, b. Dept. of Earth and Environmental Sciences -DISAT, University of Milano-Bicocca, Piazza Della Scienza 1, 20126, Milano, Italy, c. Sustainability Department, Resource Valorisation Lab, Casaccia Research Center, ENEA, Via Anguillarese 301, 00123, Rome, Italy, d. Department of Science, Roma Tre University, Rome, 00146, Italy). **Insights into rhamnolipid-based soil remediation technologies by safe microorganisms: A critical review. Journal of Cleaner Production, Volume 367 (2022): 133088**

Petroleum-contaminated soil is a global problem that must be faced with novel and green technologies in the near future. Considering the toxicity of fossil-based surfactants, microbial surface-active compounds (SACs) have shown various advantages, including high remobilization of hydrocarbons, low toxicity, biodegradability, sustainability, and others. Their main criticisms are the downstream costs (i.e., extraction, purification), the pathogenic character of some biosurfactant producers, the low yield obtained, and heterogeneity (i.e., the number and abundance of congeners). The use of surfactants at low concentrations is of great interest for efficient and controllable bioremoval of pollutants from porous soil media without harming the autochthonous microbial communities and pollutants' degraders. In the absence of valid benchmarking studies among numerous biosurfactants' classes, novel rhamnolipids (RLs) by non-Pseudomonas aeruginosa producers also deserve in-depth investigations in the future. Herein, the main RL producers with a nonpathogenic character, with lower yields and safe capacities, were highlighted, which would be very advantageous for applying the circular economy across soil remediation sites, even at a large-scale. This review emphasizes the main current knowledge regarding the use of these glycolipids within the emerging soil remediation technologies, including soil washing, bioremediation, phytoremediators, bio-electrochemical systems, nanoparticle technologies, and others. The main prospects that should be addressed towards tackling RL costs by including safe producers and their broths moving towards replacing chemical surfactants, at least partly, were discussed. This review enhances the understanding of the novel RL-soil treatments and provides critical information to accelerate the transition to a circular economy within biosurfactant-based soil remediation technologies.

Keywords: Biocomposting

Pengfei Chen[a], Renjie Yang[b], Yuhou Pei[b], Yang Yang[b], Jiong Cheng[b], Daoping He[c], Qing Huang[d], Heng Zhong[bef], Fangming Jin[bdef]. (a. China-UK Low-carbon College, Shanghai Jiao Tong University, Shanghai 200240, PR China, b. School of Environmental Science and Engineering, State Key Lab of Metal Matrix Composites, Shanghai Jiao Tong University, Shanghai 200240, PR China, c. Earth-Life Science Institute (ELSI), Tokyo Institute of Technology, 2-12-IE-1 Ookayama, Meguro-ku, Tokyo 152-8550, Japan, d. College of Ecology and Environment, Hainan University, Haikou 570228, PR China, e. Center of Hydrogen Science, Shanghai Jiao Tong University, Shanghai 200240, PR China, f. Shanghai Institute of Pollution Control and Ecological Security, Shanghai 200092, PR China). Hydrothermal synthesis of similar mineral-sourced humic acid from food waste and the role of protein. Science of The Total Environment, Volume 828(2022): 154440

Food waste is a challenging biomass resource due to its high moisture content, low calorific value, and complex composition. Natural humification of animal and plant residues is highly related to microorganism activity, but natural hydrothermal conditions are also speculated to play a significant role. In this work, a novel method for the conversion of food waste into artificial humic acid (HAa) under hydrothermal conditions is proposed. The results revealed that an optimum HAa yield of 43.5% from food waste was successfully obtained at 215 °C for only 1 h. Detailed analyses, including elemental analysis (EA), X-ray photoelectron spectroscopy (XPS), nuclear magnetic resonance (NMR), and Fourier transform infrared (FT-IR) spectroscopy, showed that the produced HAa had similar structures and compositions with natural HA extracted from minerals. Moreover, the proteins contained in the food waste significantly promoted HA formation through the reaction of saccharides with amino acids, in which Maillard-like reactions were the key steps. These results not only provide experimental evidence for verifying the role of hydrothermal reactions in transforming food waste into humic acid but also provide insight into effective resource utilization of food waste.

Keywords: Food waste, Artificial humic acid, Hydrothermal humification, Protein

Barkha Sharma[a], Shalini Tiwari[a], Kailash Chand Kumawat[b], Massimiliano Cardinale[c]. ([a]Department of Microbiology, G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India, b. Department of Industrial Microbiology, Jacob Institute of Biotechnology and Bioengineering, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh 211007, India, c. Department of Biological and Environmental Sciences and Technologies - DiSTeBA, University of Salento, SP6 Lecce-Monteroni, I-73100 Lecce, Italy). Nano-biofertilizers as bio-emerging strategies for sustainable agriculture development: Potentiality and their limitations. Science of The Total Environment, Available online (2022): 160476

Nanotechnology is a burgeoning revolutionary technology in the 21st century. Climate emergencies caused by natural or anthropogenic activities have tragically consequential repercussions on agricultural output worldwide. Modern cropping systems profoundly rely on synthetic fertilizers to deliver necessary nutrients, yet their prolonged and persistent administration is hazardous to the environment, soil fertility, and nutritional dynamics of the rhizospheric microbiome. By addressing the drawback of physico-chemically synthesized nano-dimensioned fertilizer, this review emphasizes on integrating nanoparticles and biofertilizers conjointly as nano-biofertilizers (NBF) which can safeguard global food security, in light of the

population surge. Inoculation with nanoparticles and biofertilizers strengthens plant growth and stress tolerance. However, combined together (NBF), they have emerged as a more economically and environmentally sustainable, highly versatile, and long-lasting agriculture tool. Microbe-based green synthesis using the encapsulation of inorganic nanoparticles of Si, Zn, Cu, Fe, Ni, Ti, and Ag as well as organic materials, including chitosan, cellulose, and starch, to formulate NBFs can eliminate the constraints of conventional fertilizer contamination. The application of NBFs is in its infancy in agriculture, yet it has promising potential for transforming traditional farming techniques into smart agriculture, compared to any of the existing strategies. From this perspective, this review is an attempt to provide a comprehensive understanding of the formulations, fabrication, and characterization of NBFs while unraveling the underlying mechanisms of plant-NBF interactions along with their contribution to climate change-induced biotic and abiotic stress tolerance. We substantially summarize the latest advancements of field applications of NBFs for precision farming. Moreover, we critically revised their applications in agro-ecosystems according to the current literature, while also discussing the bottlenecks and future trends for developing potent NBFs.

Keywords: Abiotic and biotic stresses, Climatic changing condition, Nano-biofertilizer, Nutrient use efficiency, Sustainable agriculture

Rajendra Bam, Sharoj Raj Mishra, Subodh Khanal, Prakash Ghimire, Suman Bhattarai(Institute of Agriculture and Animal Science, Tribhuwan University, Nepal). Effect of biofertilizers and nutrient sources on the performance of mungbean at Rupandehi, Nepal. Journal of Agriculture and Food Research, Volume 10(2022): 100404

Nutrient management has been a major constraint in mungbean cultivation, resulting in huge economic losses to farmers. A field experiment was conducted at Paklihawa, Rupandehi, Nepal to evaluate the effects of different biofertilizers and nutrient sources on yield, performance, and economics of mungbean in 2020. The experiment was laid out in a split-plot design comprising of three treatments of biofertilizers in the main plot i.e., Control, Rhizobium, and Azotobacter, and six treatments of organic and inorganic fertilizers in sub-plots i.e., Control, Farm Yard Manure (FYM) @5000 kg/ha, Poultry Manure (PM) @3000 kg/ha, Recommended dose of chemical fertilizer (RDF) @20:40:20 kg/ha, and Poultry manure in combination with the recommended dose of chemical fertilizer. The experiment results revealed that in the case of biofertilizer application, the highest grain yield was obtained by Rhizobium inoculation (1019.32 kg/ha) and with Azotobacter inoculation (962.57 kg/ha) as compared to control (756.35 kg/ha). In the case of fertilizer application, integrated application of poultry manure and recommended dose of fertilizers resulted in a higher yield (1045 kg/ha), which is statistically similar to the combination of farmyard manure and recommended dose of fertilizers (991.08 kg/ha), followed by the solo use of fertilizer and control. The treatment with the recommended dose of fertilizers alone resulted in higher economics, while interaction with Rhizobium resulted in a benefit-cost ratio of 3.96. Moreover, organic manure treatment in control plots contributed to a low benefit-cost ratio (3) compared to other combinations of treatments (>3). The authors suggested the use of biofertilizers in combination with other fertilizers for better crop yields and high economic returns. However, further research is required to conclude the effects of different nutrient sources on successful mungbean cultivation.

Keywords: B: C ratio, Fertilizers, Management, Mungbean, Nepal

Biopesticides

Giulia Giunti[a], Giovanni Benelli[b], Vincenzo Palmeri[c], Francesca Laudani[c], Michele Ricupero[d], Renato Ricciardi[b], Filippo Maggi[e], Andrea Lucchi[b], Raul Narciso C.Guedes[f], Nicolas Desneux[g], Orlando Campolo[c]. (a. Department of Pharmacy, University of Salerno, via Giovanni Paolo II 132, 84084 Fisciano (SA), Italy, b. Department of Agriculture, Food and Environment, University of Pisa, via del Borghetto 80, 56124 Pisa, Italy, c. Department of Agriculture, University "Mediterranea" of Reggio Calabria, Loc. Feo Di Vito, 89122 Reggio Calabria, Italy, d. Department of Agriculture Food and Environment, University of Catania, via S. Sofia 100, 95123 Catania, Italy, e. Chemistry Interdisciplinary Project (ChIP), School of Pharmacy, University of Camerino, Via Madonna delle Carceri 9/B, 62032 Camerino, Italy, f. Departamento de Entomologia, Universidade Federal de Viçosa, Viçosa, MG 36570-900, Brazil, g. Université Côte d'Azur, INRAE, CNRS, UMR ISA, 06000 Nice, France). Non-target effects of essential oil-based biopesticides for crop protection: Impact on natural enemies, pollinators, and soil invertebrates. Biological Control Volume 176 (2022): 105071

The control of arthropod pests of agricultural importance is increasingly difficult due to the quick development of resistance in the targeted pest populations coupled to their massive non-target lethal and sublethal effects. This fostered the progressive banning of active ingredients at international and national levels, making pest management challenging. Reliable and environmentally sustainable pest control tools are required. Botanicals, with special reference to plant essential oils (EOs), can represent a broad source of active ingredients to develop effective insecticides and acaricides for agricultural purposes. In this context, our review analyzed the literature currently available about the lethal and sublethal activity of EOs on non-target terrestrial invertebrates in agricultural settings, including biological control agents (predators and parasitoids), pollinators and soil non-target species. Even if EO-based insecticides and acaricides are generally considered safer from a non-target point of view, a number of detrimental effects have been noted on biological control agents, including negative effects on respiration rate, reduced predatory ability and reduced parasitization rates, among others. Examples of sublethal effects experienced by pollinators exposed to EO-based pesticides are the reduction in the movement speed and distance travelled, while the toxicity of EO-based products on soil invertebrates is limited. Of note, the modes of action leading to EO toxicity on non-target species are scarcely studied. Further research on long-term non-target effects of EO-based pesticides in the field is still needed.

Keywords: Biocontrol, Integrated Pest Management, Lethal effects, Sublethal effects, Parasitic wasp, Honey bee, Bumblebee, Stingless bee, Earthworm

Kris S.Kim, Gilbert C.Walker. (Department of Chemistry, University of Toronto, 80 St. George Street, Toronto, Ontario M5S 3H6, Canada). Efficacy of neem extract against sea lice (Lepeophtheirus salmonis) infestations: A potential biopesticide for Atlantic salmon (Salmo salar). Aquaculture, Volume 560 (2022): 738453

Controlling sea lice (epeophtheirus salmonis) infestations has been a constant challenge encountered in the aquaculture industry. Currently, pesticides such as emamectin benzoate are widely employed due to their large safety margin and efficacy against all stages of sea lice. Unfortunately, the widespread use of emamectin benzoate has also led to resistance among sea

lice. In this study, we present the findings of a tank trial that demonstrate the efficacy of neem extract as a potential alternative biopesticide for controlling sea lice infestations. In particular, the accumulation and depletion of an active ingredient, azadirachtin A, in Atlantic salmon (S. salar) was monitored closely by HPLC/MS/MS. Azadirachtin A levels as low as 0.01 mg azadirachtin A/kg tissue (0.01 ppm) in tissue of salmon resulted in decrease in the attachment of sea lice (>75% efficacy) relative to control tanks.

Keywords: Biopesticide

Anupa Adhikari[a], Arjun Kumar Shrestha[a], Sudipta Timsina[a], Anup Adhikari[b]. (a.Department of Agriculture, Agriculture and Forestry University, Chitwan, 44209, Nepal, b. Central Department of Chemistry, Tribhuvan University, Kathmandu, 44600, Nepal). Efficacy of biopesticides in management of potato tuber moth, Phthorimaea operculella (Zeller), in potato under storage. Journal of Agriculture and Food Research, Volume 10 (2022): 100411

Pest infestation causes heavy loss to farmers; both in fields and in stores. This study evaluated the efficacy of biopesticides in management of potato tuber moths (PTM) under storage condition. The potato cultivars Khumal Seto-1, Janak Dev and MS-42.3 and biopesticides Bacillus thuringiensis, Acorus calamus, Azadirachta indica, Artemisia vulgaris were used at the rate of 5 g l−1, 2 g kg−1, 4 g kg−1 and 20 g kg−1 of potato tubers respectively; also, a control was set to compare the treatment effects. Tubers were coated with solution for Bacillus thuringiensis while for the remaining biopesticidial powder was dusted on tubers. The cv. Janak Dev had the lowest infestation points per tuber (8.13), emergence of PTM adults (19.77%), physiological loss in weight (26.03%), decay loss (17.89%) and tuber damage score (2.74). The biopesticide Acorus calamus had the least infestation points per tuber (2.56), infested eyes per tuber (0.17), emergence of PTM adults (1%), tuber damage index (2.24), physiological loss in weight (12.11%), decay loss (4%) and tuber damage score (1.36). Acorus calamus had reduced larval mining by 88% and eventually had reduced decay loss by 93% as compared to control. The parameters relating to damage indicated that the cv. Janak Dev was least susceptible among the tested cultivars and Acorus calamus provided the best protection against damage caused by potato tuber moth.

Keywords: Solanum tuberosum, Bacillus thuringiensis, Acorus calamus, Potato tuber moth, Damage

Song Gun Choe, Hang Ryol Maeng, Song Jin Pak, Song Nam U. (Department of Life Science, University of Science, Pyongyang, Democratic People's Republic of Korea). Production of Bacillus thuringiensis biopesticide using penicillin fermentation waste matter and application in agriculture. Journal of Natural Pesticide Research, Volume 2 (2022): 100012

Bacillus thuringiensis (Bt) has been widely used in pest control, but the large scale production of this biopesticide is expensive because of the high cost of the medium and production method. In this study, we attempted to use inexpensive penicillin fermentation waste matter for the growth of Bacillus thuringiensis. The penicillin fermentation waste samples were used under conditions: without pre-treatment, with Na2CO3 treatment, with acetic acid treatment and with drying treatment. The penicillin fermentation waste matter with Na2CO3 treatment gave the highest cell counts. A maximum spore count (24.5 ×108cfu/ml) was obtained by cultivating B. thuringiensis 2387 in medium containing 5% penicillin fermentation waste matter. Insecticidal potency of Bacillus thuringiensis biopesticide(Bt insecticidal concentrate) was about 8 000IU/mg Bt

insecticidal concentrate showed 77–90% insecticidal efficacy against Pieris rapae, Plutella xylostella and Heliothis virescens in the field trial.

Keywords: Bacillus thuringiensis, Biopesticide, Penicillin fermentation waste matter, Lepidopteran pest

Federico Cappa, David Baracchi, Rita Cervo. (Department of Biology, University of Florence, Via Madonna del Piano, 6, 50019 Sesto Fiorentino, Italy). Biopesticides and insect pollinators: Detrimental effects, outdated guidelines, and future directions. Science of The Total Environment, Volume 837 (2022): 155714

As synthetic pesticides play a major role in pollinator decline worldwide, biopesticides have been gaining increased attention to develop more sustainable methods for pest management in agriculture. These biocontrol agents are usually considered as safe for non-target species, such as pollinators. Unfortunately, when it comes to non-target insects, only the acute or chronic effects on survival following exposure to biopesticides are tested. Although international boards have highlighted the need to include also behavioral and morphophysiological traits when assessing risks of plant protection products on pollinators, no substantial concerns have been raised about the risks associated with sublethal exposure to these substances. Here, we provide a comprehensive review of the studies investigating the potential adverse effects of biopesticides on different taxa of pollinators (bees, butterflies, moths, beetles, flies, and wasps). We highlight the fragmentary knowledge on this topic and the lack of a systematic investigation of these negative effects of biopesticides on insect pollinators. We show that all the major classes of biopesticides, besides their direct toxicity, can also cause a plethora of more subtle detrimental effects in both solitary and social species of pollinators. Although research in this field is growing, the current risk assesment approach does not suffice to properly assess all the potential side-effects that these agents of control may have on pollinating insects. Given the urgent need for a sustainable agriculture and wildlife protection, it appears compelling that these so far neglected detrimental effects should be thoroughly assessed before allegedly safe biopesticides can be used in the field and, in this view, we provide a perspective for future directions.

Keywords: Biological control, Plant production products, Pollinators decline, Risk-assessment protocols, Toxicity, Sublethal effects

Fan PAN12*, Li-jie GAO2*, Kai-hui ZHU1, Gui-lin DU3, Meng-meng ZHU4, Li ZHAO5, Yu-lin GAO1, Xiong-bing TU1, Ze-hua ZHANG1. (1. State Key Laboratory for Biology of Plant Diseases and Insect Pests, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100193, P.R.China, 2. College of Animal Science and Technology, Hebei Agricultural University, Baoding 071001, P.R.China, 3. National Animal and Husbandry Service, Beijing 100125, P.R.China, 4. Institute of Plant Protection, Ningxia Academy of Agricultural and Forestry Sciences, Ningxia 750002, P.R.China, 5. College of Agriculture, Xinjiang Agricultural University, Wulumuqi 830052, P.R.China). Regional selection of insecticides and fungal biopesticides to control aphids and thrips and improve forage quality of alfalfa crops. Journal of Integrative Agriculture, (2022): Available online

Efficacies of biological and conventional chemical insecticides against two major insect pests of alfalfa (aphids and thrips) were compared in three sites across China's alfalfa belt. In addition,

the duration of the residues of chemical insecticides in alfalfa and their influence on the quality of alfalfa hay were examined. Efficacy varied with the different biological and chemical insecticides. Chemical insecticides were significantly more effective than biopesticides in a short time. The efficacy period of biopesticides was significantly higher than that of chemical insecticides, and the corrected mortality rate of aphids in all regions was above 50% 14 days after application. The analysis of pesticide residues showed that the residual dose of all the pesticides was within the allowed range after the safe period. The acid detergent fiber, neutral detergent fiber content in alfalfa hay were higher and the protein content was lower in chemical insecticide treatments than that in biopesticides treatments in Hebei. The relative feeding value of alfalfa hay treated with Metarhizium anisopliae IPP330189 was the highest among the treatments. Compared with chemical insecticides, the yield of alfalfa hay was higher in biopesticides treatments. Biopesticides show a stronger control effect on insect populations and also a better improvement in the quality of alfalfa hay than chemical insecticides. This study provides basis for exploring and developing a comprehensive control regime for alfalfa insect pests in different alfalfa-growing regions in China, reducing chemical insecticide usage and improving forage quality.

Keywords: insect pest control, pollution free control, pesticide residueaphidsthrips

Xiao-Xue Zheng[a], Jingwen Guo[b], Fu Jia[c], Shiyuan Zhang[b]. (a. Newhuadu Business School, Minjiang University, No.200 Xiyuangong Road, Shangjie Town, Minhou County, Fuzhou City, Fujian, 350108, China, b. School of Economics and Management, Chongqing Jiaotong University, No. 66 Xuefu Avenue, Nan'an District, Chongqing, China, c. Supply Chain Management, The York Management School, University of York, Heslington, York, YO10 5DD, UK). Cooperative game theory approach to develop an incentive mechanism for biopesticide adoption through farmer producer organizations. Journal of Environmental Management, Volume 319(2022): 115696

Biopesticides have been recognized as viable alternatives to chemical pesticides in controlling agricultural pests for plants and reducing harmful chemical residues. However, small and marginal farmers are facing challenges while adopting biopesticides, namely, high cost and complicated application techniques, resulting in a low level of farmer acceptance. Accordingly, Farmer Producer Organizations (FPOs), voluntarily formed by farmers, develop mutual technical assistance among their members to solve the technical problems of biopesticide adoption. This study assumes that as a new form of farmer cooperative, FPOs have the potential to promote biopesticide adoption through the implementation of collective pesticide adoption (CPA). Along this line, this paper uses a cooperative game-based hybrid method to develop an incentive mechanism of biopesticide adoption for FPOs to implement CPAs. First, we construct a CPA decision model for mixed pesticides (i.e., biopesticides and chemical pesticides) based on multichoice goal programming (MCGP) to compromise the conflicting objectives regarding cost efficiency and chemical residue reduction, thereby obtaining the optimal total cost of pesticide adoption. Second, recognizing the optimal total adoption cost as a baseline, we devise a cooperative game-based cost allocation scheme to maintain farmers' voluntary participation in FPOs. This study demonstrates that the CPA implemented based on our proposed models can at least match if not surpass the economic and environmental performance of farmers' independent pesticide adoption (IPA). We further demonstrate that the proposed cooperative game solution is more suitable for the FPO's cost allocation issue than the eminent solutions, such as the Shapley value.

Keywords: Farmer producer organization (FPO), Biopesticide, Collective pesticide adoption (CPA), Cooperative game, Cost allocation

Sophie Manson[a], Marco Campera[ab], Katherine Hedgerb, Nabil Ahmadb, Esther Adindab, Vincent Nijmana, Budiadi Budiadic, Muhammad Ali Imronc, Ganis Lukmandaruc, K.A.I.Nekarisab. (a. Nocturnal Primate Research Group, School of Social Sciences, Oxford Brookes University, Oxford, OX3 0BP, UK, b. Little Fireface Project, Cipaganti, West Java, 40131, Indonesia, c. Faculty of Forestry, Universitas Gadjah Mada, Yogyakarta, 55281, Indonesia). **The effectiveness of a biopesticide in the reduction of coffee berry borers in coffee plants. Crop Protection, Volume 161 (2022): 106075**

Context

Crop pest outbreaks are expected to become more frequent and unpredictable due to climate change, posing risks to ecosystem health and farmers' livelihoods. At the same time, there is growing evidence that chemical pesticides can persist in the landscape and contribute to land degradation. The use of natural pesticides in place of chemical pesticides is hoped to manage pest outbreaks while also restoring pollinator populations and improving the quality of arable land. During the 1970s, many countries committed to promoting and legislating Integrated Pest Management (IPM) strategies (encouraging natural and holistic approaches to pest management), often including using natural pesticides, known as biopesticides.

Objective

We assessed the effectiveness of a biopesticide on coffee berry borer (CBB; Hypothenemus hampei) presence in 57 small-holder coffee home gardens in West Java, Indonesia across three years.

Methods

Prior to the application of the biopesticide, we randomly chose ten coffee plants from each field and recorded the proportion of healthy berries per plant (berries without pest infestation) as a control. In April 2020, we distributed the biopesticide in each of the 57 coffee home gardens and repeated the above experiment. The biopesticide was redistributed in October 2020 and April 2021. We repeated the experiment for the last time in April 2021.

Results and conclusions

We found that CBB presence significantly decreased, with an inverse relationship between distance to natural forest and CBB presence and a positive relationship between shade cover and CBB presence. We also interviewed farmers in April 2021 to investigate their perception of the effectiveness of the biopesticide and 87% of farmers thought it was more effective than conventional pesticides.

Significance

We contribute to the growing literature on the effectiveness of natural pesticides through assessing farmers' perceptions of these methods and providing empirical evidence for their effectiveness in remedying CBB infestation. We hope that this study will empower farmers to make conscious land-use choices and provide government authorities with evidence to support increased accessibility to biopesticides.

Keywords: Biopesticide, Coffee, Ecosystem services, Integrated pest management, Natural pest control

Giovana Matos Franco[a], Yan Chen[b], Vinson P.Doyle[c], Stephen A.Rehner[d], Rodrigo Diaz[a]. (a. Department of Entomology, Louisiana State University, Baton Rouge, United States, b. Hammond Research Station, Louisiana State University Agricultural Center, Hammond, United States, c. Department of Plant Pathology and Crop Physiology, Louisiana State University, Baton Rouge, United States, d. USDA Mycology and Nematology Genetic Diversity and Biology Laboratory, Beltsville, United States). Mortality of the crapemyrtle bark scale (Hemiptera: Eriococcidae) by commercial biopesticides under greenhouse and field conditions. Biological Control, Volume 175 (2022): 105061

The crapemyrtle bark scale (CMBS), Acanthococcus lagerstroemiae, is an important pest of crapemyrtles, Lagerstroemia spp. Biopesticides are frequently used to control soft-bodied insects; however, there is no information on their efficacy against CMBS. The objectives of this study were to test the use of selected biopesticides against CMBS under different seasons, evaluate their pathogenicity to CMBS, and determine optimum temperature for spore germination. Commercial formulations of the fungal biopesticides Isaria fumosorosea PFR97, Beauveria bassiana ANT-03, and the bacterial biopesticides Burkholderia rinojensis A396 and Chromobacterium subtsugae PRAA4-1 T were tested in greenhouse settings and did not have significant treatment effect on immature mortality. Biopesticides containing I. fumosorosea PFR97, B. bassiana ANT-03, and B. bassiana GHA were applied to mature crapemyrtles grown in the landscape and naturally infested with CMBS, and the scale survivorship was determined in two trials at different seasons. When treatments were applied in winter, scale survivorship was significantly lower in the B. bassiana ANT-03 treatment compared to the control. When treatments were applied in spring, no treatment effect was observed. During another trial conducted in autumn using container-grown crapemyrtles, B. bassiana GHA treatment reduced scales survivorship when compared to the control. Pathogen re-isolation assays confirmed that scales collected in the spring trial were had all pathogens delivered; in addition, B. bassiana ANT-03 was the most recovered pathogen. In a temperature-dependent spore germination assay, the optimum temperature range for I. fumosorosea PFR97, B. bassiana ANT-03, and B. bassiana GHA was between 22.5 and 30 °C, with peak spore germination observed at 28 °C for all three pathogens. Results from this project suggest that biopesticides containing strains of B. bassiana can be included in the toolbox for CMBS control, provided that climate and product coverage are considered.

Keywords: Acanthococcus lagerstroemiae, Biological control, Entomopathogen Lagerstroemia spp

Mintu Deyashi[ab], Suman Bhusan Chakraborty[b]. (a. Department of Zoology, Dr. A.P.J. Abdul Kalam Govt. College, New Town, Kolkata, India, b. Department of Zoology, University of Calcutta, Kolkata, India). Acute exposure to a neem based biopesticide and mahua oil cake changes haemocyte parameters in freshwater crab, Varuna litterata (Decapoda, Crustacea). Fish & Shellfish Immunology, Volume 131 (2022): 505-517

Nimbecidine Plus (a neem biopesticide) and mahua oil cake (MOC) on the haemocyte populations of a freshwater crab, Varuna litterata after acute exposure. Four-day static renewal bioassay test was performed where sixteen healthy adult male crabs were exposed to 96-h LC50 values of Nimbecidine Plus (0.006284 ppt) and MOC aqueous extract (7.631 ppt) separately in the laboratory condition. Control groups were maintained throughout the experimental period without any biopesticide exposure. Various haemocyte parameters such as total count (THC),

differential count (DHC), haemocyte density, cytomorphological anomalies and reactive oxygen species (ROS) were measured in the biopesticides-exposed and control crabs after 24, 48, 72, and 96 h of exposure. After treatment with Nimbecidine Plus and MOC, several cytomorphological deformities (cytoplasmic and nuclear membrane disintegration, chromatin condensation, pyknosis, karyorrhexis, karyolysis, nuclear vacuolation, altered cell shape, cellular coagulation, cytoplasmic discharge, vacuolation) were observed in hyalinocytes, small granule haemocytes and large granule haemocytes with modulation of their relative percentages at different exposure times. THC, DHC, haemocyte density and ROS levels were significantly altered ($p < 0.05$) in biopesticides-exposed crabs at different exposure periods. The toxicity of both biopesticides did not persist throughout the entire exposure time. Nimbecidine Plus exhibited nonlinear toxic impacts on different haemocyte parameters at initial, mid and higher exposure periods whereas MOC showed linear toxic effects mostly at initial exposure time. In comparison to MOC, Nimbecidine Plus showed higher immunotoxic effects in V. litterata. Outcome of this experiment might provide useful information to understand the immune responses of V. litterata against biopesticide toxicity.

Keywords: Biopesticide

Biodegradation

Jessica R. Bone[a], Rick Stafford[a], Alice E. Hall[ab], Roger J.H. Herbert[a]. ([a]Department of Life and Environmental Sciences, Faculty of Science and Technology, Bournemouth University, Fern Barrow, Poole, BH12 5BB, UK, [b]School of Biological and Marine Sciences, Faculty of Science and Engineering, University of Plymouth, Drake Circus, Plymouth, PL4 8AA, UK). Biodeterioration and bioprotection of concrete assets in the coastal environment. International Biodeterioration & Biodegradation, Volume 175 (2022): 105507

The deleterious effects (biodeterioration) and the protective benefits (bioprotection) of biological colonisation on manmade structures have long been debated. Lichens, biofilms, algae, bivalves and gastropods contribute both directly and indirectly to damaging substrata in the coastal zone which can enhance abiotic erosive forces that exploit biologically induced superficial damage. There is mounting evidence that these same species may also provide protective benefits. This debate often impacts approaches to managing fouling on concrete assets in the coastal environment. The net benefit or detriment a species or assemblage has on a structure is spatially and temporally dynamic and subject to the influence of various abiotic and biotic factors at different scales. However, the net outcome may be more pronounced under different contexts, particularly under warming and ocean acidifying climate change scenarios which is where further research should focus. Additionally, as bioprotection represents a potentially valuable ecosystem service, it supports the argument for increasing and improving habitat availability and biodiversity on artificial coastal structures via ecological enhancement. Quantifying bioprotection in useful metrics, such as monetary value or time added to serviceable life, would help demonstrate the benefits of bioprotective species in a meaningful way.

Keywords: Biofouling; Bioerosion; Fouling; Bioconstruction; Biodegradation; Biogeomorphology

Zhang-Wen Zhu[a], Shi-Jin Feng[a], Hong-Xin Chen[a], Zhang-Long Chen[a], Xiang-Hong Ding[a], Chun-Hui Peng[ab]. (a. Key Laboratory of Geotechnical and Underground Engineering of Ministry of Education, Department of Geotechnical Engineering, Tongji University, Shanghai, 200092, China, b. School of Architecture and Civil Engineering, Jinggangshan University, Ji'an, Jiangxi, 343009, China). **Approximate analytical model for transient transport and oxygen-limited biodegradation of vapor-phase petroleum hydrocarbon compound in soil. Chemosphere, Volume 300 (2022): 134522**

Volatile organic compounds (VOCs) contamination may occur in subsurface soil due to various reasons and pose great threat to people. Petroleum hydrocarbon compound (PHC) is a typical kind of VOC, which can readily biodegrade in an aerobic environment. The biodegradation of vapor-phase PHC in the vadose zone consumes oxygen in the soil, which leads to the change in aerobic and anaerobic zones but has not been studied by the existing analytical models. In this study, a one-dimensional analytical model is developed to simulate the transient diffusion and oxygen-limited biodegradation of PHC vapor in homogeneous soil. Laplace transformation and Laplace inversion of the Talbot method are adopted to derive the solution. At any given time, the thickness of aerobic zone is determined by the dichotomy method. The analytical model is verified against numerical simulation and experimental results first and parametric study is then conducted. The transient migration of PHC vapor can be divided into three stages including the pure aerobic zone stage (Stage I), aerobic-anaerobic zones co-existence stage (Stage II), and steady-state stage (Stage III). The proposed analytical model should be adopted to accommodate scenarios where the transient effect is significant (Stage II), including high source concentration, deep contaminant source, high biodegradation capacity, and high water saturation. The applicability of this model to determine the breakthrough time for better vapor intrusion assessment is also evaluated. Lower first-order biodegradation rate, higher source concentration, and shallower source depth all lead to smaller breakthrough time.

Keywords: Biodegradation

Majid Rasool Kamli[ab], Adeel Malik[c], Jamal S.M Sabir[ab], Irfan Ahmad Rather[ab], Chang-Bae Kim[d]. (a. Department of Biological Sciences, Faculty of Science, King Abdulaziz University, Jeddah 21589, Saudi Arabia, b. Center of excellence in Bionanoscience Research, King Abdulaziz University, Jeddah 21589, Saudi Arabia, c. Institute of Intelligence Informatics Technology, Sangmyung University, Seoul 03016, Republic of Korea, d. Department of Biotechnology, Sangmyung University, Seoul 03016, Republic of Korea). **Insights into the biodegradation and heavy metal resistance potential of the genus Brevibacillus through comparative genome analyses. Gene, Volume 846 (2022): 146853**

Members of the genus Brevibacillus belonging to the family Paenibacillaceae are Gram-positive/variable, endospore-forming, and rod-shaped bacteria that dwell in various environmental habitats. Brevibacillus spp. have a wide range of enzyme activities such as degradation of various carbohydrates, plastics, and they possess resistance against heavy metals. These characteristics make them encouraging contenders for biotechnological applications. In this work, we analyzed the reference genomes of 19 Brevibacillus species, focusing on discovering the biodegradation and heavy metal resistance capabilities of this little studied genus from genomic data. The results indicate that several strain specific traits were identified. For example Brevibacillus halotolerans s-14, and Brevibacillus laterosporus DSM 25 have more glycoside hydrolases (GHs) compared to other carbohydrate-active enzymes, and therefore might be more suitable for biodegradation of carbohydrates. In contrast, strains such as Brevibacillus antibioticus TGS2-1, with a higher number of glycosyltransfereases (GTs) may aid

in the biosynthesis of complex carbohydrates. Our results also suggest some correlation between heavy metal resistance and polyurethane degradation, thus indicating that heavy metal resistance strains (e.g. Brevibacillus reuszeri J31TS6) can be a promising source of enzymes for polyurethane degradation. These strain specific features make the members of this bacterial group potential candidates for further investigations with industrial implications. This work also represents the first exhaustive study of Brevibacillus at the genome scale.

Keywords: Biodegradation

Natasha R.Gunawan[a], Marissa Tessman[a], Daniel Zhen[a], Lindsey Johnson[a], Payton Evans[b], Samantha M.Clements[c], Robert S.Pomeroy[b], Michael D.Burkart[b], Ryan Simkovsky[a], Stephen P.Mayfield[d]. (a. Algenesis Inc., 1238 Sea Village Dr., Cardiff, CA, USA, b. Department of Chemistry and Biochemistry, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093, USA, c. Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Drive, La Jolla, CA 92093, USA, d. Department of Molecular Biology, and California Center for Algae Biotechnology, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093, USA). Biodegradation of renewable polyurethane foams in marine environments occurs through depolymerization by marine microorganisms. Science of The Total Environment, Volume 850 (2022): 158761

Accumulation of plastics in the Earth's oceans is causing widespread disruption to marine ecosystems. To help mitigate the environmental burden caused by non-degradable plastics, we have previously developed a commercially relevant polyurethane (PU) foam derived from renewable biological materials that can be depolymerized into its constituent monomers and consumed by microorganisms in soil or compost. Here we demonstrate that these same PU foams can be biodegraded by marine microorganisms in the ocean and by isolated marine microorganisms in an ex situ seawater environment. Using Fourier-transform infrared (FTIR) spectroscopy, we tracked molecular changes imparted by microbial breakdown of the PU polymers; and utilized scanning electron microscopy (SEM) to demonstrate the loss of physical structure associated with colonization of microorganisms on the PU foams. We subsequently enriched, isolated, and identified individual microorganisms, from six marine sites around San Diego, CA, that are capable of depolymerizing, metabolizing, and accumulating biomass using these PU foams as a sole carbon source. Analysis using SEM, FTIR, and gas chromatography–mass spectrometry (GCMS) confirmed that these microorganisms depolymerized the PU into its constitutive diols, diacids, and other PU fragments. SEM and FTIR results from isolated organismal biodegradation experiments exactly matched those from ex situ and ocean biodegradation samples, suggesting that these PU foam would undergo biodegradation in a natural ocean environment by enzymatic depolymerization of the PU foams and eventual uptake of the degradation products into biomass by marine microorganisms, should these foams unintentionally end up in the marine environment, as many plastics do.

Keywords: Biopolymers, Seawater, Ocean, Plastics, Biodegradable, Polyester

Mojtaba Maleki Rad, Hamid Moghimi, Ehsan Azin. (Department of Microbial Biotechnology, School of Biology, College of Science, University of Tehran, Tehran, Iran). Biodegradation of thermo-oxidative pretreated low-density polyethylene (LDPE) and polyvinyl chloride (PVC) microplastics by Achromobacter denitrificans Ebl13, Marine. Pollution Bulletin, Volume 181 (2022): 113830

Microplastics pretreatment of prior to biodegradation is an efficient approach for their bioremediation. We isolated Achromobacter denitrificans from compost and used it for biodegradation of thermo-oxidative pretreated polyvinyl chloride (PVC) and low-density polyethylene (LDPE). About 12.3 % and 6.5 % weight loss, and 326.4 and 112.32 mg L−1 extracellular protein were observed in bacterial flasks with PVC and LDPE, respectively. The pH in treated PVC reached to 5.12 and the thermal stability increased by 29 °C. The chemical modification in LDPE was demonstrated through oxidation of antioxidants (Phenol group), formation of new groups (Aldehyde group), and chain fracture in the main backbone by Fourier transform infrared spectroscopy. Formation of peaks at the range of 1700–1850 cm−1 in LDPE attributed to formation of carbonyl groups as the degradation result. Scanning electron microscopy confirmed LDPE and PVC degradation by surface alterations. Consequently, thermo-oxidative pretreatment can be considered as a suitable strategy for improving microplastics biodegradation.

Keywords: Biodegradation, Biomineralization, LDPE, Microplastic, PVC, Thermo-oxidative pretreatment

Qingsong Liu[a], Ye Fu[a], Bin Wu[a], Jingyu Tang[a], Yaoben Wang[a], Yanping Wu[b], Man Zhang[a], Shen Shen[a], Yang Shen[a], Caiyun Gao[a], Jiandong Ding[a], Liangliang Zhu[a]. (a. State Key Laboratory of Molecular Engineering of Polymers, Department of Macromolecular Science, Fudan University, Shanghai, 200438, China, b. State Key Laboratory of Coordination Chemistry, School of Chemistry and Chemical Engineering, Nanjing University, Jiangsu, Nanjing, 210023, China). **Imaging moiety-directed co-assembly for biodegradation control with synchronous four-modal biotracking. Biomaterials, Volume 287 (2022): 121665**

The complexity of existing methods for biodegradation control limits the multi-functionality of biomedical materials. It is urgent to develop simple and straightforward strategies to control the biodegradation rate with precise tracking of various parameters in real-time. Here, we show an imaging moiety-directed co-assembly strategy, in which different imaging moieties bearing non-covalent interaction sites are covalently introduced into the poly (D, l-lactic acid) (PDLLA) chain as end groups, followed by alternate non-covalent interactions with polymer chains upon compression molding. This strategy takes advantage of a variety of bonding types (including CH–π, CH–F, etc.) to firmly integrate the PDLLA chains and strongly control the biodegradation rate, making the amorphous prototype degraded much slower than higher-molecular-weight counterparts, and the local inflammatory response is insignificant. On this basis, a synchronous four-modal (X-ray computed tomography + fluorescence + photoacoustics + ultrasound) imaging was achieved on the single entity in vivo, even within a millimeter-scale thick-skin tissue. These imaging signals can precisely correlate the multi parameter variation trend of material mass, volume and molecular weight, signifying that co-assembly can be utilized to develop advanced theranostic systems.

Single sentence summary

We developed an imaging moiety-directed co-assembly strategy to control the biodegradation rate and achieve the synchronization of real-time four-modal imaging in vivo. These imaging signals can precisely correlate the multi-parameter variation trend of material mass, volume and molecular weight, which provided comprehensive biomedical information accessing both qualitatively and quantitatively.

Keywords: Biodegradation

Ali M.Khan[a], Mehdi Gharasoo[b], Lukas Y.Wick[a], Martin Thullner[a]. (a. Department of Environmental Microbiology, UFZ - Helmholtz Centre for Environmental Research, Leipzig, Germany, b. Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Ontario, Canada). Phase-specific stable isotope fractionation effects during combined gas-liquid phase exchange and biodegradation. Environmental Pollution, Volume 309 (2022): 119737

Stable isotope fractionation of toluene under dynamic phase exchange was studied aiming at ascertaining the effects of gas-liquid partitioning and biodegradation of toluene stable isotope composition in liquid-air phase exchange reactors (Laper). The liquid phase consisted of a mixture of aqueous minimal media, a known amount of a mixture of deuterated (toluene-d) and non-deuterated toluene (toluene-h), and bacteria of toluene degrading strain Pseudomonas putida KT2442. During biodegradation experiments, the liquid and air-phase concentrations of both toluene isotopologues were monitored to determine the observable stable isotope fractionation in each phase. The results show a strong fractionation in both phases with apparent enrichment factors beyond −800‰. An offset was observed between enrichment factors in the liquid and the gas phase with gas-phase values showing a stronger fractionation in the gas than in the liquid phase. Numerical simulation and parameter fitting routine was used to challenge hypotheses to explain the unexpected experimental data. The numerical results showed that either a very strong, yet unlikely, fractionation of the phase exchange process or a – so far unreported – direct consumption of gas phase compounds by aqueous phase microorganisms could explain the observed fractionation effects. The observed effect can be of relevance for the analysis of volatile contaminant biodegradation using stable isotope analysis in unsaturated subsurface compartments or other environmental compartment containing a gas and a liquid phase.

Keywords: Biodegradation

Karima Kameche[a], Said Amrani[b], Samah Mouzaoui[c], Hamid Aït-Amar[a]. (a. Department of Environmental and Pharmaceutical Engineering, Faculty of Mechanical and Process Engineering, University of Sciences and Technology Houari Boumediene USTHB, BP 32, El Alia, Bab Ezzouar, 16111, Algiers, Algeria, b. Department of Biology and Physiology of Organisms, Faculty of Biological Sciences, University of Sciences and Technology Houari Boumediene USTHB, BP 32, El Alia, Bab Ezzouar, 16111, Algiers, Algeria, c. Faculty of Medicine, University of Algiers Benyoucef Benkhedda, Didouche Mourad, 16000, Algiers, Algeria). Biodegradation of diazo dye Evans blue by four strains of Streptomyces isolated from soils of Algeria. Biocatalysis and Agricultural Biotechnology, Volume 46 (2022): 102529

As part of the development of an ecological solution to eliminate azo dyes present in the effluents of textile factories, we have isolated from different soils four Streptomyces strains with high degradation potential against Evans blue (EB). These strains affiliated to Streptomyces maritimus, S. mutabilis, S. ardesiacus and S. sp can also degrade other azo dyes such as Amido black 10B, Chlorazol black E, Congo red, Methyl red and Nigrosine. Study of the effects of incubation time, temperature, pH and addition of small amounts of carbohydrates on the degradation potential of strains allowed reaching an elimination rate of up to 97% of the initial Evans blue concentration (50 mg/l). Furthermore, the degradation potential of strains was only slightly affected by high concentrations of EB, salinity and the presence of some metal ions in the culture medium.

Keywords: Biodegredation

Sinan Zhang[ab], Jihong Wang[b]. (a. Key Laboratory of Straw Biology and Utilization, Ministry of Education, Jilin Agricultural University, Changchun 130118, China, b. College of Resource and Environment, Jilin Agricultural University, Changchun 130118, China). **Biodegradation of chlortetracycline by Bacillus cereus LZ01: Performance, degradative pathway and possible genes involved. Journal of Hazardous Materials, Volume 434 (2022): 128941**

Microbial degradation of chlortetracycline (CTC) is an effective bioremediation method. In the present study, an enrichment technique was used to isolate a Bacillus cereus LZ01 strain capable of effectively degrading CTC from cattle manure. Response surface methodology was used to identify optimized conditions under which strain LZ01 was able to achieve maximal CTC removal (83.58%): temperature of 35.77 °C, solution pH of 7.59, CTC concentration of 57.72 mg/L and microbial inoculum of 0.98%. The antibacterial effect of CTC degradation products on Escherichia coli was investigated by the disk diffusion test, revealing that the products by LZ01 degradation of CTC exhibited lower toxicity than parent compound. Shake flask batch experiments showed that the biodegradation of CTC was a synergistic effect of intracellular and extracellular enzymes, and intracellular enzyme had a better degradation effect on CTC (77.56%). Whole genome sequencing revealed that genes associated with ring-opening hydrolysis, demethylation, deamination and dehydrogenation in strain LZ01 may be involved in the biodegradation of CTC. Subsequent seven possible biodegradation products were identified by LC-MS analyses, and the biodegradation pathways were proposed. Overall, this study provides a theoretical foundation for the characterization and mechanism of CTC degradation in the environment by Bacillus cereus LZ01.

Keywords: Biodegredation

Kristine V.Aleksanyan[a], Svetlana Z.Rogovina[a], Aleksander M.Shakhov[a], Natalya E.Ivanushkin[ab]. (a. N. N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, 119991 Moscow, Russian Federation, b. G. K. Skryabin Institute of Biochemistry and Physiology of Microorganisms, Russian Academy of Sciences, 142290 Pushchino, Moscow Region, Russian Federation). **Effect of biodegradation conditions on morphology of ternary compositions of low density polyethylene with poly(lactic acid) and starch. Mendeleev Communications, Volume 32, Issue 4 (2022): 558-560**

Polyethylene–poly(lactic acid)–starch ternary compositions were obtained in a rotor disperser under conditions of shear deformation. Their biodegradation under the action of mold fungus spores and soil was investigated using IR spectroscopy and SEM. The changes under the fungal action revealed that the ternary blends represented a nutrient medium, while the exposure to soil led to alteration in morphology due to the whole range of numerous environmental factors.

Keywords: low density polyethylene, poly(lactic acid), starch, biodegradation, morphology

Neha Tiwari[a], Deenan Santhiy[ab], Jai Gopal Sharma[a]. (a. Department of Biotechnology, Delhi Technological University, Delhi, India, b. Department of Applied Chemistry, Delhi Technological University, Delhi, India). **Biodegradation of micro sized nylon 6, 6 using Brevibacillus brevis a soil isolate for cleaner ecosystem. Journal of Cleaner Production, Volume 378 (2022): 134457**

The increasing accumulation of microplastic constitutes pathogens and hazardous chemicals posing a great threat to the ecosystem. Biodegradation is an eco-friendly strategy for the removal of these contaminants. The present investigation demonstrates bioremediation of nylon 6, 6

microplastics (NMPs) for the first time using a soil isolate called Brevibacillus brevis (B.brevis) by shake flask assay. 22 w/w % weight loss of nylon 6, 6 microplastics was noticed after 35 d of incubation with B.brevis. Upon interaction with microplastics, a change in the shape of the bacterium (rod to round) could be observed along with the size reduction of the microorganism. In the case of NMPs incubated in presence of this bacterium, irregular shapes of NMPs with cracks and holes could be visualized using SEM and TEM. TGA and FTIR analysis reported the disappearance of intermolecular hydrogen bonding of nylon 6, 6 posts microbial interaction. The release of various organic acids and enzyme/enzymatic activities of the bacterium was found to be higher in the presence of NMPs. The mass spectrometric analysis confirmed the release of adipic acid and hexamethylenediamine derivatives during aerobic biodegradation, indicating NMPs being the only carbon source for the growth of B.brevis in the reaction environment. The study addresses B.brevis as a viable bacterial source for the degradation of NMPs while at the same time attempting to understand the mechanism involved. A biodegradation pathway for B.brevis induced NMP degradation has been also proposed for the first time. This finding promises a potential approach for reducing the accumulation of nylon 6, 6 in the environment.

Keywords: Biodegredation

Hongyang Ren, Yuanpeng Deng, Liang Ma, Zijing Wei, Lingli Ma, Demin Yang, Bing Wang & Zheng-Yu Luo. (College of Chemistry and Chemical Engineering, Southwest Petroleum University, Chengdu, 610500, China, State Environmental Protection Key Laboratory of Collaborative Control and Remediation of Soil and Water Pollution, Chengdu, 610059, China, Oil & Gas Field Applied Chemistry Key Laboratory of Sichuan Province, Chengdu, 610500, China). Enhanced biodegradation of oil-contaminated soil oil in shale gas exploitation by biochar immobilization. Biodegradation, volume 33 (2022): 621–639

The enhanced biodegradation of oil-contaminated soil by fixing microorganisms with corn cob biochar was investigated. It was found that the components of oil in the test soil were mainly straight-chain alkanes and branched alkanes. When using corn cob biochar as a carrier to immobilize microorganisms, the best particle size of corn cob biochar as an immobilization carrier was 0.08 mm, and the best immobilization time was 18 h. SEM analysis confirmed that the microorganisms were immobilized on the corn cob biochar. Immobilized microorganisms exhibited high biodegradability under stress to high concentrations of petroleum pollutants, heavy metals, and organic pollutants. Infrared spectroscopy analysis showed that oxygen-containing groups such as hydroxyl, carboxyl, and methoxy on the surface of biochar were involved in the complexation of heavy metals. The mechanism of immobilization promoted microbial degradation of oil contamination was explained by gas chromatography mass. First, alkanes and aromatics were adsorbed by corn cob biochar and passed to immobilized microorganisms to promote their degradation. Their bioavailability increased, especially for aromatics. Second, biochar provided a more suitable environment for microorganisms to degrade. Third, the conversion of ketones to acids was accelerated during the biodegradation of alkanes, and the biodegradation of alkanes was accelerated by immobilization. The biodegradable efficiency of oil by immobilized microorganisms in soil was 70.10% within 60 days, 28.80% higher than that of free microorganisms. The degradation of immobilized microorganisms was highly correlated with the activities of catalase, urease, and polyphenol oxidase.

Keywords: Bioremediation; Oil-contaminated soils; Corn cob biochar; Immobilization; Soil dehydrogenase

Biosensor

Nianyu Jiang[a], Pranav Shrotriya[a], Rohana P.Dassanayake[b]. (a. Department of Mechanical Engineering, Iowa State University, 2019 Black Engineering Building, Ames, IA, 50011, USA, b. Ruminant Diseases and Immunology Research Unit, United States Department of Agriculture, Agricultural Research Service, National Animal Disease Center, Ames, IA, 50010, USA). NK-lysin antimicrobial peptide-functionalized nanoporous alumina membranes as biosensors for label-free bacterial endotoxin detection. Biochemical and Biophysical Research Communications, Volume 636, Part 2 (2022): 18-23

We report an NK-lysin peptide-functionalized nanoporous anodized aluminum oxide (NAAO) based biosensor to detect bacterial endotoxin. Bovine NK-lysin-derived peptides show antimicrobial activity against bacterial pathogens, and bactericidal activity is primarily due to the membranolysis activity. Antimicrobial activity of NK-lysin NK2A was confirmed against a Gram-negative Mannheimia haemolytica and a Gram-positive Staphylococcus aureus. Electron microscopic examination showed the localization of NK2A conjugated silver nanoparticles, but not unconjugated silver nanoparticles used as control, to the bacterial outer membrane and cell wall. NK2A functionalized NAAO membranes were used in a previously developed four-electrode electrochemical configuration to detect the presence of Gram-negative bacterial lipopolysaccharides (LPS) and Gram-positive bacterial lipoteichoic acid (LTA) molecules. NK2A-functionalized NAAO biosensor could detect LPS with a detection limit of 10 ng/mL within an appreciable signal/noise ratio. Biosensors functionalized with a scrambled amino acid version of NK2A (Sc-NK2A) that lacks antimicrobial activity could not detect the presence of LPS. However, both NK2A and Sc-NK2A functionalized biosensors showed sensing signals with Gram-positive bacterial lipoteichoic acids. These results suggest that the specific binding of NK2A-LPS on the NAAO membrane surface is responsible for the observed biosensor signals. These findings suggest that NK2A-functionalized biosensors can be used for rapid and sensitive label-free LPS detection.

Keywords: Antimicrobial peptides, Bovine NK-lysins, Electrochemical cellLabel-free LPS detection, Nanoporous alumina membrane (NAAO), NK2A

Foroozan Shokri[a], Abdollah Yari[a], Ali R.Jalalvand[b]. (a. Department of Chemistry, Faculty of Science, Lorestan University, Khoramabad, Iran, b. Research Center of Oils and Fats, Research Institute for Health Technology, Kermanshah University of Medical Sciences, Kermanshah, Iran). Simultaneous estimation of rates of DNA damage induced by three important chemotherapy drugs by a novel electrochemical biosensor assisted by chemometric multivariate calibration methods. International Journal of, Biological Macromolecules, Volume 219 (2022): 650-662

In this work, a novel electrochemical biosensor assisted by multivariate calibration methods was developed for simultaneous estimation of rates of DNA damage induced by doxorubicin (DX), daunorubicin (DR) and idarubicin (ID), and also to simultaneous determination of the drugs. A glassy carbon electrode was efficiently modified and used as the biosensing platform. Binding and interactions of DX, DR and ID with DNA were modeled by molecular docking methods, and theoretical information was completed by experimental results. The methylene blue was able to

intercalate within the DNA structure and by incubation of the biosensor with DX or DR or ID, the methylene blue was replaced by drug and therefore, the voltammetric signal of the biosensor was changed due to the exposed DNA and repelling the electrochemical probe molecules carrying negative charge. The DNA damage induced by each drug was individually monitored by differential pulse voltammetry and then, rates of DNA damage were calibrated and validated by mixture design and multivariate calibration methods. The developed multivariate calibration model constructed based on vectorization of the data was able to simultaneous detection of the rates of DNA damage induced by all the three drugs. The change in the biosensor response in the presence of the drugs was also modeled by multivariate calibration methods to simultaneous determination of the drugs.

Keywords: DNA damage, Biosensor, Multivariate calibration, Simultaneous determination

Chunli Wan[a], Aoxuan Qu[ab], Liyan Deng[c], Xiang Liu[a], Changyong Wu[c]. (a. Department of Environmental Science and Engineering, Fudan University, Shanghai 200433, China, b. Shanghai Chengtou Environmental Ecological Restoration Technology Co., Ltd., Shanghai 200232,China, c. Research Center of Environmental Pollution Control Technology, Chinese Research Academy of Environmental Sciences, Beijing 100012, China). **Preparation of an electrochemical biosensor based on indium tin oxide and its performance in detecting antibiotic resistance genes. Microchemical Journal, Volume 182(2022): 107953**

In this study, an antibiotic resistance genes (ARGs) detection biosensor was successfully fabricated by assembling the hairpin DNA probe on an indium tin oxide (ITO) electrode deposited with gold nanoparticles. Three methods of potentiostatic, galvanostatic and cyclic voltammetric for deposition were compared, and the cyclic voltammetric was proved to be the most effective one. The optimal voltage range for it was −0.9 to −0.2 V with 40 cycles, which can deposit uniform and dense nano-gold film on the ITO electrode. In addition, DNA with mismatched bases was applied to study the specificity of the sensor. Results of DPV showed that the current significantly reduced to 281.0 μA only when the biosensor was hybridized with completely complementary DNA. What's more, there was a strong correlation between the concentration of ARGs and electrochemical signal. The correlation coefficient reached 0.987, and the detection limit was 30.0 pg/μl, which met the demand for monitoring ARGs in the water environment. All in all, the biosensor prepared in this study possesses satisfactory specificity and sensitivity, which is beneficial for practical application.

Keywords: Antibiotic resistance genes detection, Electrochemical biosensor, Indium tin oxide, Gold nanoparticles

Chester Pham[1], Peter J.Stogios[1], Alexei Savchenko[12], Radhakrishnan Mahadevan[13]. (1.Department of Chemical Engineering and Applied Chemistry, University of Toronto, ON, Canada, 2. Department of Microbiology, Immunology and Infectious Disease, University of Calgary, AB, Canada, 3. The Institute of Biomedical Engineering, University of Toronto, ON, Canada). **Advances in engineering and optimization of transcription factor-based biosensors for plug-and-play small molecule detection. Current Opinion in Biotechnology, Volume 76 (2022): 102753**

Transcription factor (TF)-based biosensors have been applied in biotechnology for a variety of functions, including protein engineering, dynamic control, environmental detection, and point-of-care diagnostics. Such biosensors are promising analytical tools due to their wide range of

detectable ligands and modular nature. However, designing biosensors tailored for applications of interest with the desired performance parameters, including ligand specificity, remains challenging. Biosensors often require significant engineering and tuning to meet desired specificity, sensitivity, dynamic range, and operating range parameters. Another limitation is the orthogonality of biosensors across hosts, given the role of the cellular context. Here, we describe recent advances and examples in the engineering and optimization of TF-based biosensors for plug-and-play small molecule detection. We highlight novel developments in TF discovery and biosensor design, TF specificity engineering, and biosensor tuning, with emphasis on emerging computational methods.

Keywords: Biosensor

Liqi Wang[a], Hairong Zhang[a], Ziyue Li[b], Jiayao Qu[b], Kaiwen Xing[b], Minghao Wang[b], Cuiping Han[b], Zeguo Qiu[a], Dianyu Yu[b]. (a. School of Computer and Information Engineering, Heilongjiang Provincial Key Laboratory of Electronic Commerce and Information Processing, Harbin University of Commerce, Harbin, 150028, China, b. School of Food Science, Northeast Agricultural University, Harbin, 150030, China). **Development of a three-dimensional graphene-based photoelectrochemical biosensor and its use for monitoring lipase activity. LWT, Volume 170 (2022): 114076**

In recent years, photoelectrochemical (PEC) biosensors have shown great application prospects in biological analysis and food detection. In this work, we developed and tested a new PEC biosensor. Three-dimensional graphene oxide (3DGO) was generated and deposited on an indium tin oxides (ITO) electrode. The photoelectrically active poly[Nile blue] (PNb) was formed on this electrode by electropolymerization, and glycerol dehydrogenase (GDH) was immobilised to generate the GDH-PNb-3DGO-ITO biosensor. This newly developed PEC biosensor exhibited excellent photoelectric response to lipase activity under light conditions, with a detection range of 0.1–6 U/mL and a lower detection limit of 0.069 U/mL. When the GDH-PNb-3DGO-ITO sensor was used for PEC detection of lipase activity by the standard addition recovery method, the recovery rate of the standard addition was 98.68–105.41%, and the relative standard deviation (RSD) was 2.1–3.5%, with good storage stability and repeatability. Therefore, this work provides new ideas for the design and preparation of PEC biosensors and introduces a new detection method for monitoring lipase activity.

Keywords: Photoelectrochemical biosensor, Three-dimensional graphene oxide, Lipase activity, Detection

Anne Yau[a], Zizheng Wang[b], Nadya Ponthempilly[a], Yi Zhang[a], Xueju Wang[b], Yupeng Chen[a]. (a. Department of Biomedical Engineering, USA, b. Institute of Materials Science, University of Connecticut, Storrs, CT, 06296, USA). **Biosensor integrated tissue chips and their applications on Earth and in space. Biosensors and Bioelectronics, Available online (2022): 114820**

The development of space exploration technologies has positively impacted everyday life on Earth in terms of communication, environmental, social, and economic perspectives. The human body constantly fluctuates during spaceflight, even for a short-term mission. Unfortunately, technology is evolving faster than humans' ability to adapt, and many therapeutics entering clinical trials fail even after being subjected to vigorous in vivo testing due to toxicity and lack of efficacy. Therefore, tissue chips (also mentioned as organ-on-a-chip) with biosensors are being developed to compensate for the lack of relevant models to help improve the drug development process. There has been a push to monitor cell and tissue functions, based on their biological signals and utilize the integration of biosensors into tissue chips in space to monitor

and assess cell microenvironment in real-time. With the collaboration between the Center for the Advancement of Science in Space (CASIS), the National Aeronautics and Space Administration (NASA) and other partners, they are providing the opportunities to study the effects of microgravity environment has on the human body. Institutions such as the National Institute of Health (NIH) and National Science Foundation (NSF) are partnering with CASIS and NASA to utilize tissue chips onboard the International Space Station (ISS). This article reviews the endless benefits of space technology, the development of integrated biosensors in tissue chips and their applications to better understand human biology, physiology, and diseases in space and on Earth, followed by future perspectives of tissue chip applications on Earth and in space.

Keywords: Biosensors, Tissue chips, Organ-on-a-chip, Tissue engineering, In-space applications

Hongfen Zhang, Fangmiao Liang, Baiyan Zhang, Sihan Li, Hongyuan Shang. (School of Pharmacy, Shanxi Medical University, Jinzhong 030619, Shanxi, China). Precisely controlled CdS/NiO nanomaterials by atomic layer deposition for excellent photoelectrochemical biosensor. Journal of Alloys and Compounds, Volume 928 (2022): 167052

It is an effective strategy to enhance the photoelectrochemical (PEC) performance of nano-semiconductor materials by preventing recombination of the photogenerated carriers. Herein, the precisely regulated CdS/xNiO nano-semiconductor materials are successfully synthesized by a facile atomic layer deposition (ALD) technique (x presents the number of ALD cycles). The experimental results showed that the high carrier recombination rate of CdS could be effectively inhibited after 80 ALD cycles with NiO deposited on its surface. Furthermore, the PEC biosensor targeting glucose was regarded as a model to discuss the application of nano-semiconductor materials precisely regulated by ALD in biosensors. Based on the excellent PEC performance of CdS/80NiO and the high specificity and affinity of glucose oxidase, a simple, fast, sensitive and label-free PEC biosensor for glucose detection was successfully developed. In conclusion, the CdS/80NiO-based biosensor has excellent characteristics such as high sensitivity, low detection limit, good anti-interference and good stability, suggesting that nano-semiconductor materials precisely regulated by ALD is a promising nanomaterial for constructing excellent PEC biosensors in clinical applications.

Keywords: Biosensors

Brayan Viana Ribeiro[a], Lucas Franco Ferreira[b], Diego Leoni Franco[a]. (a. Institute of Chemistry, Federal University of Uberlândia, Patos de Minas, MG 38700-128, Brazil, b. Institute of Science and Technology, Federal University of the Jequitinhonha and Mucuri Valleys, Diamantina, MG 39100-000, Brazil). Advances in biosensor development for the determination of antibiotics in cow's milk - A review. Talanta Open, Volume 6 (2022): 100145

Biosensors provide analysis with high sensitivity and selectivity associated with portability and easy handling compared with the traditional methods. These devices have gained interest in the scientific field with application in the agroindustry, mainly in the dairy farming sector, because of their possible use to detect antibiotic residues used to treat mastitis and dry cow therapy. The use of antibiotics for this sector is estimated at 63.000 tons/year, and biosensors can be a viable alternative in the detection of such contamination in the milk, to alert the producers regarding the

contamination level in loco, and thus reducing the indiscriminate use and the risk for the consumer. Therefore, this work presents a review of the main proof-of-concept biosensors applied in dairy farming in the past ten years, seeking to improve the discussions regarding the implications of antibiotic use in cattle and their consequences in humans.

Keywords: Biosensor, Milk, Antibiotic, Residue, Cow

Fariba Lotfi[a], Nafiseh Sang-Nourpour[b], Reza Kheradmand[a]. (a. Optics and Laser Department, Faculty of Physics, University of Tabriz, Tabriz, Iran, b. Department of Mechanical Engineering, University of Alberta, Edmonton, Canada). **Graphene-based plasmonic U-shaped nanofiber biosensor: Design and analysis. Optik, Volume 270 (2022): 169890**

We theoretically design and analyze a novel, real-time and label-free highly sensitive biosensor made of a plasmonic nanofiber waveguide. We employ metal, metamaterial and graphene interfaces with dielectrics in waveguides to introduce two different biosensor configurations. Both configurations consist of a U-shape nanofiber structure; the first configuration is coupled to a sample housing and the second configuration is dipped into the sample. To check the capability and functionality of the biosensors, we employ three different cancerous cells including blood, adrenal glands and cervical cancers. The presence of graphene in the biosensor structures facilitates the design of tunable sensors with the capability to operate at different frequencies with different sensitivities. Our structure has a high sensitivity of 2565.7THZ/RIU for adrenal gland, and 2575THZ/RIU for the blood cancer. The proposed biosensor structures are compact and easy to fabricate with applications in disease diagnosis and chemical sensing.

Keywords: Biosensor

Yidan Hu[a], Xi Han[a], Liang Shi[ab], Bin Cao[cd]. (a. Department of Biological Sciences and Technology, School of Environmental Studies, China University of Geosciences, Wuhan 430074, China, b. Hubei Key Laboratory of Yangtze Catchment Environmental Aquatic Science, China University of Geosciences, Wuhan 430074, China, c. Singapore Centre for Environmental Life Sciences Engineering, Nanyang Technological University, 637551, Singapore, d. School of Civil and Environmental Engineering, Nanyang Technological University, 639798, Singapore). **Electrochemically active biofilm-enabled biosensors: Current status and opportunities for biofilm engineering. Electrochimica Acta, Volume 428 (2022): 140917**

Electrochemically active biofilms (EABs) are formed by electroactive bacteria capable of exchanging electrons with electrodes. EABs have been employed as bio-elements in bioelectrochemical sensors which sense analytes of interest by converting metabolic changes to easily detectable electrical signals. Although EAB-enabled biosensors have shown promise in environmental applications, such as water quality monitoring, their most perceived practical applications are limited by low sensitivity, low specificity and short-term stability. Engineering EABs could be an effective strategy to improve the performance of EAB-enabled biosensors. In this review, we briefly introduce EAB with the focus on its extracellular electron transfer, development and matrix, as well as EAB-enabled biosensors including their general principle and potential applications. We then discuss key limitations of EAB-enabled biosensors and the opportunities that biofilm engineering may provide to address these limitations.

Keywords: Electrochemically active biofilm (EAB), EAB-enabled biosensors, Biofilm engineering, Microbial fuel cell

Bioengineering

Vishnu Sunil, Jia Heng Teoh, Babu Cadiam Mohan, Anbu Mozhi, Chi-Hwa Wang. (Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore 117585, Singapore). Bioengineered immunomodulatory organelle targeted nanozymes for photodynamic immunometabolic therapy. Journal of Controlled Release, Volume 350 (2022): 215-227

Intelligent nanomedicines integrated with stimuli-responsive components enable on-demand customizable treatment options which would improve therapeutic outcome and reduce systemic toxicity. In this work, we explore the synergistic therapeutic potential of photodynamic therapy and immunometabolic modulation to achieve tumour regression and to trigger an adaptive immunity to prevent tumour recurrence. The therapeutic potential of the fabricated Bioengineered Immunomodulatory Organelle targeted Nanozymes (BIONs) was tested on 3D printed mini-brains which could effectively recapitulate the biologically relevant interactions between glioblastoma cells and macrophages. In the presence of glioblastoma organotypic brain slices, activated BIONs upregulated the cell surface expression of CD86, a costimulatory molecule and CD83, maturation marker, on monocyte derived dendritic cells, suggesting its ability to elicit a strong immune response. Furthermore, the antigen pulsed dendritic cells by chemotaxis and transendothelial migration readily relocate into the draining lymph node where they present the antigenic cargo to enable the proliferation of T lymphocytes. The stealth and tunable catalytic activity of BIONs prevent ROS mediated diseases such as acute kidney injury by providing environment dependent protection without compromising on its promising anti-cancer activity.

Keywords: Bioengineering

B. Krishna Rao[a], Gaurav Singh[a], Gopal Kumar[b], V.C.Pande[a], Narendra K.Lenka[c], D.Dinesh[a], P.K.Mishra[b], A.K.Singh[a]. (a. ICAR, Indian Institute of Soil and Water Conservation, Research Centre, Vasad 388306, Gujarat, India, b. ICAR-Indian Institute of Soil and Water Conservation, Dehradun 248195, Uttarakhand, India, c. ICAR-Indian Institute of Soil Science, Nabibagh, Bhopal, Madya Pradesh, India). Effect of selected bioengineering measures on runoff, soil loss, and cotton (Gossypium hirsutum L.) productivity in the semi-arid region of western India. Industrial Crops and Products, Volume 184 (2022): 115029

Soil erosion and associated loss of soil nutrients and organic carbon are one of the major reasons for low crop productivity in major cotton (Gossypium hirsutum L.) growing areas of India. This calls for designing acceptable and low-cost bioengineering measures to enhance system productivity and soil health. Thus, a field study was conducted at Vasad, Gujarat, India from 2014 to 2017 to evaluate the efficacy of selected bioengineering treatments on cotton crop production and runoff and soil loss. The eight experimental treatments consisted of bio-filters of three grass species, viz.Para (Brachiaria mutica), Guinea (Megathyrsus maximus),and Napier (Pennisetum purpureum) at two strip widths (1 m and 2 m), field bund, and the conventional system as practiced by the farmers of the region. The treatments were tested in 45 × 10 m plots having the gauging facility for recording runoff and soil loss data. Rainfall, runoff, sediment concentration, soil loss, organic carbon, nutrient loss, and growth and yield parameters of grass barrier species and the cotton crop were recorded and analysed. The filter strip of Guinea sp. at 2 m width was most effective, reducing runoff by 30%, soil loss by 66%, nutrients loss by 69%,

sediment concentration to 1/3rd, and soil organic carbon loss by 65%. The lowest runoff coefficient value of 0.209 observed among the filter strips in this treatment, indicated about 79% of rainwater was conserved in situ. The available soil nutrients increased by up to 42% and SOC concentration by 61%, and cotton equivalent yield by 25% than that of the conventional system. We concluded that Guinea grass filter strips of 2 m width planted at 45 m spacing in cultivable lands having 2% slope minimized runoff, soil loss, nutrient loss, improved soil fertility and enhanced cotton productivity.

Keywords: Bioengineering

A.Poerio[ab], V.Mashanov[a], D.Lai[ac], M.Kim[a], Y.M.Ju[a], J.H.Kim[a], S.J.Lee[a], F.Cleymand[b], J.F.Mano[d], A.Atala[a], J.J.Yoo[a]. (a. Wake Forest Institute for Regenerative Medicine, Winston-Salem, North Carolina, USA, b. Institut Jean Lamour, Université de Lorraine, Nancy, France, c. Department of Urology, Fifth Affiliated Hospital of Guangzhou Medical University, Guangzhou, China, d. Department of Chemistry, CICECO – Aveiro Institute of Materials, University of Aveiro, Aveiro, Portugal). Towards innervation of bioengineered muscle constructs: Development of a sustained neurotrophic factor delivery and release system. Bioprinting, Volume 27 (2022): e00220

Surgical implantation of biomanufactured skeletal muscle constructs has recently emerged as a promising strategy to treat volumetric muscle defects. However, due to the slow rate of neural regeneration and integration, timely innervation of the implanted constructs with the host peripheral nerves remains an unresolved challenge. This study aims to develop a sustained release neurotrophic factor (NF) delivery system to accelerate peripheral nerve regeneration and innervation of three-dimensional (3D) bioprinted skeletal muscle constructs. Poly (lactic-co-glycolic acid) (PLGA) microspheres were selected as a delivery system for efficient loading and sustained release of two potent NFs: ciliary neurotrophic factor (CNTF) and glial cell line-derived neurotrophic factor (GDNF). We demonstrate that the NFs can be loaded within the PLGA microspheres with a high encapsulation efficiency (75.4% ± 12.6%). The NF-loaded microspheres were incorporated into the fibrinogen-based bioink used to produce biomanufactured skeletal muscle constructs and tested for printability. The microspheres did not change the viscoelastic properties of the bioink, nor did they affect the viability of human muscle progenitor cells. The release kinetic test confirmed that the bioprinted muscle constructs with the NFs-loaded microspheres released the NFs in a sustained manner compared to the bioprinted muscle construct without microspheres. The released NFs maintained their biological activities. In an in vitro neurite outgrowth assay, the NFs released from the PLGA microspheres facilitated the neurite growth over a longer time scale than the NFs directly loaded in the hydrogel. These results demonstrate the feasibility of incorporating the microsphere-based NF delivery system for accelerating neural regeneration in future in vivo applications involving biomanufactured muscle constructs.

Keywords: PLGA microspheres, Neurotrophic factor delivery, 3D bioprinting, Skeletal muscle regeneration, Peripheral neve regeneration

Tomasz Jakimowicz[a], Stanislaw Przywara[b], Jakub Turek[c], Alison Pilgrim[d], Michal Macech[e], Norbert Zapotoczny[c], Tomasz Zubilewicz[b], Jeffrey H.Lawson[df], Laura E.Niklason[d]. (a. Medical University of Warsaw, Department of General, Vascular and Transplant Surgery, Warszawa, Poland, b. Medical University in Lublin, Department of Vascular Surgery and Angiology, Lublin, Poland, c. Regional Hospital at Wrocław, Vascular Surgery Department, Wrocław, Poland, d, Humacyte, Inc., Durham, NC, USA, e. Medical University of Warsaw; Department of General, Vascular and Transplant Surgery,

ul. 10 Banacha 1A, 02-091 Warszawa, Poland, f, Duke University, Department of Surgery, Durham, NC, USA). Five Year Outcomes in Patients with End Stage Renal Disease Who Received a Bioengineered Human Acellular Vessel for Dialysis Access. EJVES Vascular Forum, Volume 54 (2022): 58-63

Objective

Patients with end stage renal failure who require haemodialysis suffer morbidity and mortality due to vascular access. Bioengineered human acellular vessels (HAVs) may provide a haemodialysis access option with fewer complications than other grafts. In a prospective phase II trial from 2012 to 2014 (NCT01744418), HAVs were implanted into 40 haemodialysis patients at three sites in Poland. The trial protocol for this "first in man" use of the HAV contemplated only two years of follow up, and the trial results were initially reported in 2016. In light of the retained HAV function seen in many of the patients at the two year time point, follow up for patients who were still alive was extended to a total of 10 years. This interim follow up report, at the long term time point of five years, assessed patient and conduit status in those who continued routine dialysis with the HAV.

Methods

HAVs are bioengineered by culturing human vascular smooth muscle cells on a biodegradable polymer matrix. In this study, patients with patent HAV implants at 24 months were followed every three months, starting at month 27 through to month 60, or at least five years post-implantation. This report contains the follow up functional and histological data on 29 of the original 40 patients who demonstrated HAV function at the 24 month time point.

Results

Eleven patients completed at month 60. One patient maintained primary patency, and 10 maintained secondary patency. Secondary patency was estimated at 58.2% (95% confidence interval 39.2–73.1) at five years, after censoring for deaths (n = 8) and withdrawals (n = 1). No HAV conduit infections were reported during the follow up period.

Conclusion

This phase II long term follow up shows that the human acellular vessel (HAV) may provide durable and functional haemodialysis access for patients with end stage renal disease.

Keywords: Blood vessel prosthesis, Haemodialysis, Regenerative medicine, Tissue engineering, Vascular access

Simone Capuani[ab], Nathanael Hernandez[a], Jesus Paez-Mayorga[ac], Prashant Dogra[de], Zhihui Wang[def], Vittorio Cristini[defg], Corrine Ying Xuan Chua[a,] Joan E.Nichols[h]i, Alessandro Grattoni[aij]. (a. Department of Nanomedicine, Houston Methodist Research Institute, Houston, TX, USA, b. University of Chinese Academy of Science (UCAS), 19 Yuquan Road, Beijing 100049, China, c. School of Medicine and Health Sciences, Tecnologico de Monterrey, Monterrey, NL, Mexico, d. Mathematics in Medicine Program, Houston Methodist Research Institute, Houston, TX, 77030, USA, e. Department of Physiology and Biophysics, Weill Cornell Medical College, New York, NY, 10022, USA, f. Neal Cancer Center, Houston Methodist Research Institute, Houston, TX, 77030, USA, g. Department of Imaging Physics, University of Texas MD Anderson Cancer Center, Houston, TX, 77230, USA, h. Center for Tissue Engineering, Houston Methodist Research

Institute, Houston, TX, USA, i. Department of Surgery, Houston Methodist Hospital, Houston, TX, USA, j. Department of Radiation Oncology, Houston Methodist Hospital, Houston, TX, USA). Localization of drug biodistribution in a 3D-bioengineered subcutaneous neovascularized microenvironment. Materials Today Bio, Volume 16 (2022): 100390

Local immunomodulation has shown the potential to control the immune response in a site-specific manner for wound healing, cancer, allergy, and cell transplantation, thus abrogating adverse effects associated with systemic administration of immunotherapeutics. Localized immunomodulation requires confining the biodistribution of immunotherapeutics on-site for maximal immune control and minimal systemic drug exposure. To this end, we developed a 3D-printed subcutaneous implant termed 'NICHE', consisting of a bioengineered vascularized microenvironment enabled by sustained drug delivery on-site. The NICHE was designed as a platform technology for investigating local immunomodulation in the context of cell therapeutics and cancer vaccines. Here we studied the ability of the NICHE to localize the PK and biodistribution of different model immunomodulatory agents in vivo. For this, we first performed a mechanistic evaluation of the microenvironment generated within and surrounding the NICHE, with emphasis on the parameters related to molecular transport. Second, we longitudinally studied the biodistribution of ovalbumin, cytotoxic T lymphocyte-associated antigen-4-Ig (CTLA4Ig), and IgG delivered locally via NICHE over 30 days. Third, we used our findings to develop a physiologically-based pharmacokinetic (PBPK) model. Despite dense and mature vascularization within and surrounding the NICHE, we showed sustained orders of magnitude higher molecular drug concentrations within its microenvironment as compared to systemic circulation and major organs. Further, the PBPK model was able to recapitulate the biodistribution of the 3 molecules with high accuracy ($r > 0.98$). Overall, the NICHE and the PBPK model represent an adaptable platform for the investigation of local immunomodulation strategies for a wide range of biomedical applications.

Keywords: Biodistribution, Drug delivery, Pharmacokinetics, PBPK, Sustained release, Cell macroencapsulation

Yinbo Xiao[a], ChanelleA.S.McGuinness[a], W. Sebastian Doherty-Boyd[a], Manuel Salmeron-Sanchez[b], Hannah Donnelly[a], Matthew J.Dalby[a]. (a. Centre for the Cellular Microenvironment, Institute of Molecular, Cell & Systems Biology, College of Medical, Veterinary and Life Sciences, Joseph Black Building, University of Glasgow, Glasgow, G12 8QQ, United Kingdom, b. Centre for the Cellular Microenvironment, Division of Biomedical Engineering, School of Engineering, University of Glasgow, Glasgow, G12 8QQ, United Kingdom). Current insights into the bone marrow niche: From biology in vivo to bioengineering ex vivo. Biomaterials, Volume 286 (2022): 121568

Hematopoietic stem cells (HSCs) are fundamental to the generation of the body's blood and immune cells. They reside primarily within the bone marrow (BM) niche microenvironment, which provides signals responsible for the regulation of HSC activities. While our understanding of these signalling mechanisms continues to improve, our ability to recapitulate them in vitro to harness the clinical potential of the HSC populations is still lacking. Recent studies have applied novel engineering techniques combined with traditional in vitro work to establish ex vivo BM niche models. These models exhibit promising potential for research and clinical applications. In this review, BM niche factors that regulate the HSCs in vivo are discussed and their applications in the engineering of BM biomaterial-based platforms are considered. Many questions remain regarding the heterogeneity of niche components and the interactions of HSCs with their

microenvironment. A greater understanding of the niche would help to elucidate these remaining questions, leading to the development of novel therapeutic tools.

Keywords: Hematopoietic stem cells, Bone marrow niche, Niche engineering, Biomaterials

Cláudia S.Oliveira, Sara Nadine, Maria C.Gomes, Clara R.Correia, João F.Mano. (Department of Chemistry, CICECO–Aveiro Institute of Materials, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal). Bioengineering the human bone marrow microenvironment in liquefied compartments: A promising approach for the recapitulation of osteovascular niches. Acta Biomaterialia, Volume 149 (2022): 167-178

Recreating the biological complexity of living bone marrow (BM) in a single in vitro strategy has faced many challenges. Most bioengineered strategies propose the co-culture of BM cellular components entrapped in different matrices limiting their migration and self-organization capacity or in open scaffolds enabling their escaping. We propose a methodology for fabricating a "human bone marrow–in–a–liquefied-capsule" to overcome these challenges, embracing the most important BM components in a single platform. Since free dispersion of the cells within the BM is an essential feature to maintain their in vivo properties, this platform provides a liquefied environment for the encapsulated cells to move freely and self-organize. Inside liquefied capsules, an engineered endosteal niche (eEN) is co-cultured with human umbilical cord cells, including endothelial cells and hematopoietic stem and progenitor cells (HSPCs). Two different human-like BM niches were recreated under static and dynamic systems. Although the culture of the engineered BM capsules (eBMC) in these different environments did not change the structural and compositional features of the BM niches, the biophysical stimulation potentiated the cellular intercommunication and the biomolecules secretion, demonstrating an enhanced in vitro bio performance. Moreover, while the eBMC without HSPCs provided the secretion of hematopoietic supportive factors, the presence of these cells recapitulated more closely the biological complexity of the native BM niches. This functional eBMC approach is an innovative platform capable of investigating several components and interactions of BM niches and how they regulate BM homeostasis and hematopoiesis.

Statement of significance

The recapitulation of the multifaceted bone marrow (BM) microenvironment under in vitro conditions has gained intensive recognition to understand the intrinsic complexity of the native BM. While conventional strategies do not recapitulate the BM osteovascular niches nor give the cellular components a free movement, we report for the first time the development of human bone marrow–in–a–liquefied-capsule to overcome such limitations. Our engineered BM capsules (eBMC) partially mimic the complex structure, composition, and spatial organization of the native osteovascular niches present in the BM. This strategy offers a platform with physiological relevance to exploit the niches' components/networks and how they regulate the hematopoiesis and the initiation/progression of various BM-related pathologies.

Keywords: Bioengineering

Yunsong Jiang[ab], Tugce Torun[ab], Sara M.Maffioletti[a], Andrea Serio[bd], Francesco Saverio Tedesco[abc]. (a. Department of Cell and Developmental Biology, University College London, WC1E 6DE, London, United Kingdom, b. The Francis Crick Institute, 1 Midland Road, London, NW1 1AT, United Kingdom, c. Dubowitz Neuromuscular Centre, UCL Great Ormond Street Institute of Child Health & Great Ormond Street Hospital for Children,

London, United Kingdom, d. Centre for Craniofacial & Regenerative Biology, King's College London, United Kingdom). Bioengineering human skeletal muscle models: Recent advances, current challenges and future perspectives. Experimental Cell Research, Volume 416, Issue 2 (2022): 113133

Engineering models of human skeletal muscle tissue provides unique translational opportunities to investigate and develop therapeutic strategies for acute muscle injuries, and to establish personalised and precision medicine platforms for in vitro studies of severe neuromuscular and musculoskeletal disorders. Several myogenic and non-myogenic cell types can be isolated, generated, amplified and combined with scaffolds and biomaterials to achieve this aim. Novel bio-fabrication strategies, which include exogenous stimuli to enhance tissue maturation, promise to achieve an ever-increasing degree of tissue functionalisation both in vivo and in vitro. Here we review recent advances, current challenges and future perspectives to build human skeletal muscle tissue “in a dish”, focusing on the cellular constituents and on applications for in vitro disease modelling. We also briefly discuss the impact that emerging technologies such as 3D bioprinting, organ-on-chip and organoids might have to circumvent technical hurdles in future studies.

Keywords: Tissue engineering, Human skeletal muscle, 3D scaffolds, Myogenic cells, Biomaterials

Quang Tuan Che[a], Korakot Charoensri[a], Jeong Wook Seo[b], Minh Hiep Nguyen[c], Goo Jang[d], Hojae Bae[b], Hyun Jin Park[a]. (a. Department of Biotechnology, College of Life Science and Biotechnology, Korea University, Anam-dong, Seongbuk-gu, Seoul 02841, Republic of Korea, b. Department of Stem Cell and Regenerative Biotechnology, KU Convergence Science and Technology Institute, Konkuk University, Seoul 05029, Republic of Korea, c. Center of Radiation Technology and Biotechnology, Nuclear Research Institute, Dalat 670000, Viet Nam, d. Laboratory of Theriogenology and Biotechnology, Department of Veterinary Clinical Science, College of Veterinary Medicine and the Research Institute of Veterinary Science, Seoul National University, Seoul 08826, Republic of Korea). Triple-conjugated photo-/temperature-/pH-sensitive chitosan with an intelligent response for bioengineering applications. Carbohydrate Polymers, Volume 298 (2022): 120066

Hybrid-crosslinked systems, which can be formed using heat and visible light, are significant for improving the stability of hydrogels under physiological conditions. However, several challenges for their practical application remain, such as shrinking under culture medium conditions or the neutral pH in the small intestine. Therefore, a multi-sensitive hydrogel with response to external conditions has been designed and prepared, which could be employed as a biopolymer ink formulation for three-dimensional printing in bioengineering applications. When exposed to body temperature and visible light, the N-succinyl hydroxybutyl methacrylated chitosan (NS-HBC-MA) undergoes a sol-gel phase transition. The NS-HBC-MA hydrogel exhibits pH-responsive swelling, effectively preventing shrinkage at a neutral pH. Furthermore, NS-HBC-MA hydrogel demonstrates excellent biocompatibility and biodegradability. This study demonstrates that the NS-HBC-MA hydrogel has significant potential for various applications, including wound healing, delivery systems, and tissue engineering.

Keywords: 3D printing, Chitosan, Hydroxybutylation, Methacrylation, Succinylation, Multi-sensitive hydrogel

Daphika S.Dkhar[a], Rohini Kumari[a], Supratim Mahapatra[a], Divyaa Rahul Kumar[a], Timir Tripathi[bc], Pranjal Chandra[a]. (a. Laboratory of Bio-Physio Sensors and Nano-

bioengineering, School of Biochemical Engineering, Indian Institute of Technology (BHU) Varanasi, Uttar Pradesh 221005, India, b. Molecular and Structural Biophysics Laboratory, Department of Biochemistry, North-Eastern Hill University, Shillong 793022, India, c. Regional Director's Office, Indira Gandhi National Open University (IGNOU), Regional Centre Kohima, Kenuozou, Kohima 797001, India). Antibody-receptor bioengineering and its implications in designing bioelectronic devices. International Journal of Biological Macromolecules, Volume 218 (2022): 225-242

Antibodies play a crucial role in the defense mechanism countering pathogens or foreign antigens in eukaryotes. Its potential as an analytical and diagnostic tool has been exploited for over a century. It forms immunocomplexes with a specific antigen, which is the basis of immunoassays and aids in developing potent biosensors. Antibody-based sensors allow for the quick and accurate detection of various analytes. Though classical antibodies have prolonged been used as bioreceptors in biosensors fabrication due to their increased fragility, they have been engineered into more stable fragments with increased exposure of their antigen-binding sites in the recent era. In biosensing, the formats constructed by antibody engineering can enhance the signal since the resistance offered by a conventional antibody is much more than these fragments. Hence, signal amplification can be observed when antibody fragments are utilized as bioreceptors instead of full-length antibodies. We present the first systematic review on engineered antibodies as bioreceptors with the description of their engineering methods. The detection of various target analytes, including small molecules, macromolecules, and cells using antibody-based biosensors, has been discussed. A comparison of the classical polyclonal, monoclonal, and engineered antibodies as bioreceptors to construct highly accurate, sensitive, and specific sensors is also discussed.

Keywords: Bioengineered antibody fragments, Biosensors Bioreceptors, Clinical diagnostics, Nanobodies, Healthcare, Antibodies, Antigen-antibody complex

Pollen Biotechnology

Mingliang Gao[a], Jinshan Lan[a], Yuling Zha[a], Weifeng Yao[a], Beihua Bao[a], Mingqiu Shan[a], Fang Zhang[ab], Guisheng Zhou[ab], Sheng Yu[a] Fangfang Cheng[a], Yudan Cao[a], Hui Yan[ab], Li Zhang[ab], Peidong Chen[ab]. (a. School of Pharmacy, Nanjing University of Chinese Medicine, Nanjing 210023, PR China, b. Jiangsu Collaborative Innovation Center of Chinese Medicinal Resources Industrialization, School of Pharmacy, Nanjing University of Chinese Medicine, Nanjing 210023, PR China). Structural determination and pro-angiogenic effect of polysaccharide from the pollen of Typha angustifolia L.. International Journal of Biological Macromolecules, Volume 222, Part B (2022): 2028-2040

Four fractions of polysaccharides (TPP-1, TPP-2, TPP-3, and TPP-4) were isolated and purified from the pollen of Typha angustifolia L., and the structure of TPP-3 was furtherly determined by HPGPC (High Performance Gel Permeation Chromatography), monosaccharide composition analysis, methylation analysis and NMR (Nuclear Magnetic Resonance). TPP-3 was found to be a homogeneous heteropolysaccharide with an average molecular weight of 5.5 × 104 Da and composed of eight types of monosaccharides. The pro-angiogenic activities of TPP-3 were verified on HUVECs and VEGFR tyrosine kinase inhibitor II (VRI)-induced vascular defect

zebrafish model. Furthermore, the underlying mechanism investigation showed that its pro-angiogenic activities were closely related with the activation of VEGF/PI3K/Akt signaling pathway.

Keywords: Polysaccharide, Typha angustifolia L., Structural determination, Pro-angiogenic, VEGF/PI3K/Akt signaling pathway

Syeda Maryam Zahid[ab], Muhammad Farooq[ab], Memona Yasmin[a], Muhammad Qasim Aslam[a], Shahid Mansoor[a], Imran Amin[a]. (a. National Institute for Biotechnology and Genetic Engineering (NIBGE), P.O. Box No. 577, Jhang Road, Faisalabad, Pakistan, b. Pakistan Institute of Engineering and Applied Sciences, Nilore, Islamabad, Pakistan). **Alternative splicing plays a vital role in regulating pollen allergen (Ole e 1) P19963 protein in Gossypium arboretum. Plant Gene, Volume 31 (2022): 100362**

Alternative splicing regulation (AS) is an important post-transcriptional gene regulatory mechanism for increasing the complexity and diversity of transcriptomes and subsequently proteomes. In this study, we performed transcriptomic analysis of Gossypium arboreum to explore the process of alternative splicing regulation in pollen allergen (Ole e 1) P19963 protein. The P19963 causes skin allergies because of its acidic properties. The P19963 protein was observed to undergo intron retention at seedling stage (IR); a type of alternative splicing regulation events when intron is not spliced out after the action of splicing machinery. Experimental validation using RT-PCR and sanger sequencing also proved retention of intronic region in the mature mRNA transcript of P19963 protein. We observed that even if this gene was expressing at later stages of plant development i.e., pollen producing stage, but due to alternative splicing it became disrupted at the seedling stage. The non-functionality of protein can be beneficial or harmful but in our case as the gene is having IR and becomes non-functional, it is beneficial as the pollen allergies and skin allergies can be minimized at this stage or not required at all.

Keywords: Gossypium arboreum, Alternative splicing regulation, Intron retention, Splicing junctions, Alternative splicing regulation events

Roghayeh Salmani[a], Khadijeh Nasiri[b], Yousef Javadzadeh[c], Roya Salmani[d], Cain C.T.Clark[e], Vahideh Aghamohammadi[f]. (a. Instructor of Midwifery, Department of Midwifery, Khalkhal University of Medical Sciences, Khalkhal 6581761351, Iran, b. Instructor of Nursing, Department of Nursing, Khalkhal University of Medical Sciences, Khalkhal 6581761351, Iran, c. Biotechnology Research Center and Faculty of Pharmacy, Tabriz University of Medical Science, Tabriz 5166616471, Iran, d. Department of Midwifery, Khalkhal University of Medical Sciences, Khalkhal 6581761351, Iran, e. Centre for Intelligent Healthcare, Coventry University, Coventry CV1 5FB cv13rw, UK, f. Nutritional Sciences, Department of Nutrition, Khalkhal University of Medical Sciences, Khalkhal 6581761351, Iran). **Effect of date palm pollen supplementation on female sexual function in non-menopausal women: A double blind randomized clinical trial. Chinese Herbal Medicines, Volume 14, Issue 4 (2022): 643 - 648**

Objective

Despite numerous experimental studies in the literature, there are few clinical trials regarding the effect of date palm pollen (DPP) supplementation on sexual function improvement. In the present study, we sought to evaluate the impact of DPP on female sexual function in Iranian non-menopausal women.

Methods

Between October 2019 and December 2019, health centers in the city of Khalkhal, volunteers meeting the inclusion criteria were recruited in randomized clinical trials. Sixty-eight women were randomly stratified and assigned to one of the two study groups: placebo group (n = 35) and palm pollen group (n = 35), and received a starch or palm pollen capsule (300 mg per day), respectively, for 35 d. The Female Sexual Function Index (FSFI) instrument was used to assess female sexual function.

Results

After DPP supplementation, the increase in desire, lubrication, and the overall score, was statistically significant compared to the placebo group (P = 0.002, P = 0.000, and P = 0.042; respectively); Whilst there was no significant differences in the remaining domains (arousal: P = 0.763; orgasm: P = 0.370; satisfaction: P = 0.474; pain: P = 0.259). There was a statistically significant positive correlation between the coitus and preintervention levels of desire (r = 0.298, P = 0.038), arousal (r = 0.328, P = 0.021), lubrication (r = 0.361, P = 0.011), orgasm (r = 0.320, P = 0.025), satisfaction (r = 0.327, P = 0.022), and overall scores (r = 0.338, P = 0.018).

Conclusion

This study suggests that DPP (300 mg supplementation for 35 d), given to non-menopausal women, could improve the lubrication and desire domains of FSFI.

Keywords: date palm polle, female lubrication, randomized controlled trial, sexual dysfunction

Lise Hansted[a], Christoph Crocoll[b], Zahra Bitarafana[c], Christian Andreasen[ac]. (a. Department of Plant and Environmental Sciences, University of Copenhagen, Højbakkegaard Allé 13, DK-2630, Taastrup, Denmark, b. DynaMo Center, Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, DK-1871, Frederiksberg C, Denmark, c. Norwegian Institute of Bioeconomy Research (NIBIO), Division of Biotechnology and Plant Health, Høgskoleveien 7, NO-1433, Ås, Norway). **Clopyralid applied to winter oilseed rape (Brassica napus L.) contaminates the food products nectar, honey and pollen. Food Control, Volume 140 (2022): 109124**

Clopyralid is a systemic herbicide used in oilseed rape and other crops. It was found in Danish honey from 2016 in concentrations exceeding the maximum residue level (MRL) of 0.05 mg kg−1. About 50% of the Danish honey is based on nectar from winter oilseed rape. In 2019 and 2020, winter oilseed rape fields were sprayed with clopyralid just before the assigned spraying deadline. At flowering, nectar and pollen samples were collected and the content of clopyralid was measured. Honey and pollen samples were also collected from beehives next to ten conventional winter oilseed rape fields sprayed with clopyralid. Clopyralid was found in nectar and pollen from the experimental fields, and in honey and pollen from beehives next to the conventional fields. For most samples the content in nectar and honey exceeded the MRL. The concentrations found, may not pose any health risk for consumers, as the MRL is based on the original detection limit and not on toxicological tests. However, it can have a significant economical consequence for the beekeepers, who are not allowed to sell the honey if the concentration of clopyralid exceeds 0.1 mg kg−1. Reducing the acceptable applicable rate of clopyralid or implementing an earlier deadline for spraying of clopyralid may reduce the risk of contaminating bee food products. However, if it is not possible to obtain a satisfactory effect of clopyralid on the weed flora under these conditions, spraying with pesticides containing clopyralid should be restricted in winter oilseed rape. Determination of an MRL value based on

toxicological tests might result in a higher value and make it acceptable selling the honey containing higher levels of clopyralid.

Keywords: Food safety, Pesticide contamination, Pesticides in food, Pesticide pollution, Pesticide residues, Pollinators

Xingxia Geng, Xiaoxia Wang, Jingchen Wang, Xuetong Yang, Lingli Zhang, Xiyue Song. (College of Agronomy, Northwest A&F University, Yangling 712100, Shaanxi, China). TaEXPB5 functions as a gene related to pollen development in thermo-sensitive male-sterility wheat with Aegilops kotschyi cytoplasm. Plant Science, Volume 323 (2022): 111377

The thermo-sensitive cytoplasmic male-sterility line with Aegilops kotschyi cytoplasm (K-TCMS) is completely male sterile under low temperature (< 18 °C) during Zadoks growth stages 45–52, whereas its fertility can be restored under hot temperature (≥ 20 °C). The K-TCMS line may facilitate hybrid breeding and hybrid wheat production. Therefore, to elucidate the molecular mechanisms of its male sterility/fertility conversion, we conducted the association analysis of proteins and transcript expression to screen fertility related genes using RNA-seq, iTRAQ, and PRM-based assay. A gene encoding expansin protein in wheat, TaEXPB5, was isolated in K-TCMS line KTM3315A, which upregulated expression in the fertility anthers. Subcellular localization analysis suggested that TaEXPB5 protein localized to nucleus and cell wall. The silencing of TaEXPB5 displayed pollen abortion and the declination of fertility. Further, cytological investigation indicated that the silencing of TaEXPB5 induced the early degradation of tapetum and abnormal development of pollen wall. These results implied that TaEXPB5 may be essential for anther or pollen development and male fertility of KTM3315A. These findings provide a novel insight into molecular mechanism of fertility conversion for thermo-sensitive cytoplasmic male-sterility wheat, and contribute to the molecular breeding of hybrid wheat in the future.

Keywords: Aegilops kotschyi, Expansin protein, Hybrid wheat, Thermo-sensitive cytoplasmic male sterility

Tatiane Eberling[a], Fabíola Villa[a], Luciana Alves Fogaça[b], Daniel Fernandes da Silva[a], Luciana Sabinida Silva[a], Giovana Ritter[a]. (a. Western Paraná State University (Unioeste), Rua Pernambuco, 1777, Centro, 85960-000 Marechal Cândido Rondon, Paraná 85960-000, Brazil, b. Pontifícia Universidade Católica (PUC), Campus Toledo, Avenida União, 500, Vila Becker, Toledo, Paraná P85902-532, Brazil). Definition of a growth medium to evaluate pollen viability in Hemerocallis cultivars. South African Journal of Botany, Volume 147 (2022): 319-324

Hemerocallis is a floriferous species, which presents numerous genotypes that are constantly crossed, generating new cultivars. The germination and viability of pollen are influenced both by factors that are intrinsic and extrinsic to the pollen. In view of the above, the purpose of this study was to establish a growth medium for the germination of pollen grains. Cultivar Morgana was used in the experiments performed to establish the growth medium, in which four pH ranges were tested alongside four agar concentrations. For the next test, five sucrose concentrations were tested. Afterwards, four boric acid concentrations were added to the medium, finally followed by four calcium nitrate concentrations. After the definition of the growth medium, the incubation time for pollen grains germination of the species was evaluated. The results were then applied to four cultivars in order to verify the respective germination percentages. It was noted that the highest percentage of in vitro germination occurred with the concentrations of 4 g L−1 agar, 74.6 g L−1 sucrose, 800 mg L−1 boric acid and 590 mg L−1 calcium nitrate, with a pH of

5.74 and ideal incubation time of 3 h. Regina being to cultivar with the highest germination percentage.

Keywords: Hemerocallis x hybrida Hort.Daylily, Genetic improvement, Ornamental plantIn vitro germination

Yaning Bu[a], Fuqiang Niu[a], Mengting He[a], Jiali Ye[a], Xuetong Yang[a], Zhejun Du[b], Lingli Zhang[a], Xiyue Song[a]. (a. College of Agronomy, Northwest A&F University, Yangling 712100, Shaanxi, China, b. Weiyang Extension Station for Agricultural Science and Technology, Xi'an, 710016 Shaanxi, China). **The gene TaPG encoding a polygalacturonase is critical for pollen development and male fertility in thermo-sensitive cytoplasmic male-sterility wheat. Gene, Volume 833 (2022): 146596**

Thermo-sensitive cytoplasmic male sterility is of great significance to heterosis and hybrid seed production in wheat. Consequently, it is worthwhile to research the genes associated with male sterility. Although polygalacturonases (PGs) have been studied to play a crucial role in male reproduction of many plants, their functions in the reproductive development of wheat remain unclear. Here, TaPG (TraesCS7A02G404900) encoding a polygalacturonase was isolated from the anthers of KTM3315A, a wheat thermo-sensitive cytoplasmic male sterile with Aegilops kotschyi cytoplasm. Expression pattern analyses showed that TaPG was strongly expressed in fertile anthers and its protein was localized in the cell wall. Further verification via barley stripe mosaic virus revealed that the silencing of TaPG exhibited abnormal anthers, premature degradation of tapetum, pollen abortion, and defective pollen wall formation, resulting in the declination of fertility. Conclusively, our research suggested that TaPG contributed to the pollen development and male fertility, which will provide a novel insight into the fertility conversion of thermo-sensitive cytoplasmic male sterility in wheat.

Kyewords: Pollen Biotechnology

Felipe Martelli[a], Tiago Falcon[a], Daniel G.Pinheiro[a], Zilá L.P.Simõesa[b], Francis M.F.Nunes[ac]. (a. Departamento de Genética, Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Av. Bandeirantes 3900, 14049-900, Ribeirão Preto, SP, Brazil, b. Departamento de Biologia, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Av. Bandeirantes 3900, 14049-900, Ribeirão Preto, SP, Brazil, c. Departamento de Genética e Evolução, Centro de Ciências Biológicas e da Saúde, Universidade Federal de São Carlos, Rod. Washington Luís - km 235, 13565-905, São Carlos, SP, Brazil). **Worker bees (Apis mellifera) deprived of pollen in the first week of adulthood exhibit signs of premature aging. Insect Biochemistry and Molecular Biology, Volume 146 (2022): 103774**

Pollinator populations, including bees, are in rapid decline in many parts of the world, raising concerns over the future of ecosystems and food production. Among the factors involved in these declines, poor nutrition deserves attention. The diet consumed by adult worker honeybees (Apis mellifera) is crucial for their behavioral maturation, i.e., the progressive division of labor they perform, such as nurse bees initially and later in life as foragers. Poor pollen nutrition is known to reduce the workers' lifespan, but the underlying physiological and genetic mechanisms are not fully understood. Here we investigate how the lack of pollen in the diet of workers during their first week of adult life can affect age-related phenotypes. During the first seven days of adult life, newly emerged workers were fed either a pollen-deprived (PD) diet mimicking that of

an older bee, or a control pollen-rich (PR) diet, as typically consumed by young bees. The PD-fed bees showed alterations in their fat body transcriptome, such as a switch from a protein-lipid based metabolism to a carbohydrate-based metabolism, and a reduced expression of genes involved with immune response. The absence of pollen in the diet also led to an accumulation of oxidative stress markers in fat body tissue and alterations in the cuticular hydrocarbon profiles, which became similar to those of chronologically older bees. Together, our data indicate that the absence of pollen during first week of adulthood triggers the premature onset of an aging-related worker phenotype.

Kyewords: Pollen Biotechnology

Joana Candeias[a], Elias J.Zimmermann[bc], Christoph Bisig[b], Nadine Gawlitt[abc], Sebastian Oeder[b], Thomas Gröger[b], Ralf Zimmermann[bc], Carsten B.Schmidt-Weber[a], Jeroen Buters[a]. (a. Center Allergy & Environment (ZAUM), Member of the German Center for Lung Research (DZL), Technical University Munich / Helmholtz Center Munich, Germany, b. Joint Mass Spectrometry Center (JMSC) at Comprehensive Molecular Analytics (CMA), Helmholtz Center Munich, Ingolstädter Landstraße 1, D-85764, Neuherberg, Germany, c. Joint Mass Spectrometry Center (JMSC) at Analytical Chemistry, Institute of Chemistry, University of Rostock, Dr. Lorenzweg 2, D-18051, Rostock, Germany).**The priming effect of diesel exhaust on native pollen exposure at the air-liquid interface. Environmental Research, Volume 211 (2022): 112968**

Pollen related allergic diseases have been increasing for decades. The reasons for this increase are unknown, but environmental pollution like diesel exhaust seem to play a role. While previous studies explored the effects of pollen extracts, we studied here for the first time priming effects of diesel exhaust on native pollen exposure using a novel experimental setup.

Methods

Human bronchial epithelial BEAS-2B cells were exposed to native birch pollen (real life intact pollen, not pollen extracts) at the air-liquid interface (pollen-ALI). BEAS-2B cells were also pre-exposed in a diesel-ALI to diesel CAST for 2 h (a model for diesel exhaust) and then to pollen in the pollen-ALI 24 h later. Effects were analysed by genome wide transcriptome analysis after 2 h 25 min, 6 h 50 min and 24 h. Selected genes were confirmed by qRT-PCR.

Results

Bronchial epithelial cells exposed to native pollen showed the highest transcriptomic changes after about 24 h. About 3157 genes were significantly up- or down-regulated for all time points combined. After pre-exposure to diesel exhaust the maximum reaction to pollen had shifted to about 2.5 h after exposure, plus the reaction to pollen was desensitised as only 560 genes were differentially regulated. Only 97 genes were affected synergistically. Of these, enrichment analysis showed that genes involved in immune and inflammatory response were involved.

Conclusion

Diesel exhaust seems to prime cells to react more rapidly to native pollen exposure, especially inflammation related genes, a factor known to facilitate the development of allergic sensitization. The marker genes here detected could guide studies in humans when investigating whether modern and outdoor diesel exhaust exposure is still detrimental for the development of allergic disease.

Keywords: BEAS-2B, Air-liquid interface, Native pollen, Fresh diesel model exhaust, Pollen chamber

Xiao-Jing Ling[ag], Yan-JunZhou[h], Yong-Shi Yang[d], Zhi-Qiang Xu[c], Ye Wang[f], Jin-Lyu Sun[d], Ying Zhu[e], Ji-Fu Wei[abc]. (a. Department of Pharmacy, Jiangsu Cancer Hospital & Jiangsu Institute of Cancer Research & The Affiliated Cancer Hospital of Nanjing Medical University, Nanjing, China, b. Clinical Allergy Center, The First Affiliated Hospital of Nanjing Medical University, Nanjing, China, c. Research Division of Clinical Pharmacology, The First Affiliated Hospital of Nanjing Medical University, Nanjing, China, d. Department of Allergy, State Key Laboratory of Complex Severe and Rare Diseases, Peking Union Medical College Hospital, Chinese Academy of Medical Science and Peking Union Medical College, Beijing, China, e. Department of Blood Transfusion, The First Affiliated Hospital of Gannan Medical University, Ganzhou, China, f. Department of Respiratory Medicine, Children's Hospital of Nanjing Medical University, Nanjing, China, g. Department of Clinical Pharmacy, School of Pharmacy, Nanjing Medical University, Nanjing, China, h. Department of Pharmacy, The Affiliated Suzhou Hospital of Nanjing Medical University, Suzhou, China). **A new cysteine protease allergen from Ambrosia trifida pollen: proforms and mature forms. Molecular Immunology, Volume 147 (2022): 170-179**

Giant ragweed (Ambrosia trifida) pollen is closely associated with respiratory allergy in late summer and autumn, and the prevalence of giant ragweed pollen allergy progressively increases. Compared with short ragweed (Ambrosia artemisiifolia), allergenic components from giant ragweed pollen are poorly investigated. To promote component-resolved diagnosis and treatment for giant ragweed pollen allergy, it becomes necessary to identify and characterize unknown allergens from giant ragweed pollen. In the present study, we identified and characterized a new cysteine-protease (CP) allergen from giant ragweed pollen, named as Amb t CP. The cloned Amb t CP gene encoded 387 amino acids. Recombinant Amb t CP (rAmb t CP) and natural Amb t CP (nAmb t CP) were purified by high-affinity Ni2+ resin and immunoaffinity chromatography respectively. During refolding, purified rAmb t CP could autocatalytically converted to its mature forms displaying a higher enzymatic activity. Moreover, the autocatalytic conversion of proforms to mature forms of nAmb t CP could cause their amount to change in giant ragweed pollen extracts. Then, the allergenicity of Amb t CP was characterized: 23 (33.8%) of 68 Chinese patients with ragweed pollen allergy showed positive IgE binding to nAmb t CP by enzyme-linked immunosorbent assay (ELISA); the result of subsequent ELISA showed that IgE-binding activity of proforms and mature forms of rAmb t CP was different, with positive rate of 39.1% (9/23) and 47.8% (11/23) respectively; Amb t CP showed IgE cross-reactivity with the CP components from short ragweed, Artemisia annua and Artemisia sieversiana pollen. Our findings will help to promote component-resolved diagnosis and treatment for giant ragweed pollen allergy, standardize allergen products and individualize allergen-specific immunotherapy.

Kyewords: Pollen Biotechnology

Biotechnology Policy Issue

Nkhensani Ngwenya, Christopher Gaszynski, David Ikumi. (Future Water Institute, New Engineering Building, University of Cape Town, Rondebosch, 7701 Cape Town, South Africa). A review of winery wastewater treatment: A focus on UASB biotechnology

optimisation and recovery strategies. Journal of Environmental Chemical Engineering, Volume 10, Issue 4 (2022): 108172

The upflow anaerobic sludge blanket (UASB) bioreactor was reviewed in search of a sustainable biotechnology solution for the management of winery wastewater (WWW) accumulation. Aerobic wastewater treatment systems are notorious for heavily exploiting energy and water resources, wasting residual materials, and depending on commercialised chemicals for winery wastewater treatment (WWWT). In comparison, anaerobic digestion (AD) and accelerated anaerobic bioprocesses, such as the UASB bioreactor, holds the potential to save electric kWh (kWh-e), water, sludge waste, and chemical residue generated during WWWT. The successful implementation of the UASB bioreactor at the wineries and wastewater treatment plants (WWTPs) is dependent on the preparedness of the biotechnology to manage the fluctuating discharge of raw WWW and meet the legislative demands for high product quality at a low cost. A rapid analysis approach and post-treatment options are proposed in the literature as a possible aid for inexpensive WWW quality control and hence effective WWW management. The conditions for optimum biogas production and the removal of chemical oxygen demand (COD) in the UASB bioreactor were also reviewed. Optimal COD removal and biogas production for reactors operating under mesophilic bioreactors (30–35 °C) were observed when OLR and HRT were 6 kg/m3/d and 22 h, respectively, while submesophilic bioreactors (19–21 °C) required an OLR and HRT of 7 kg/m3/d and 16 h, respectively.

Keywords: Biotechnology policy issue

Francisco J. Egea González[a], Roberto García Torrente[b]. (a. Cajamar Chair in Circular Bioeconomy, University of Almeria, CAESCG, 04120 Almeria, Spain, b. Cooperative Agro-Food Business, Cajamar, 04001 Almería, Spain). Deployment of bioeconomy at local scale: Institutions, policies and actors. EFB Bioeconomy Journal, Volume 2 (2022): 100030

Institutions, policies and companies are the main drivers of the transition of production systems towards a circular bioeconomy. However, it is sometimes necessary to recognise the important role of certain individuals in the success of such important initiatives. This article looks at the main actors in the deployment of the circular bioeconomy in Spain's leading fresh fruit and vegetable producing province, with special recognition for Dr. Christian Patermann.

Keywords: Patermann, Local bioeconomy, Almeria region, Sustainable agriculture

Linde F.C.Kampers[a], Enrique Asin-Garcia[a], Peter J.Schaap[a], Annemarie Wagemakers[b], Vitor A.P.Martins dos Santos[acd]. (a, Laboratory of Systems and Synthetic Biology, Wageningen University & Research, Wageningen, 6708 WE, The Netherlands, b. Health and Society, Department of Social Sciences, Wageningen University & Research, Wageningen, 6700 EW, The Netherlands, c. LifeGlimmer GmbH, 12163, Berlin, Germany, d. Bioprocess Engineering Group, Wageningen University & Research, Wageningen, 6700 AA, The Netherlands). Navigating the Valley of Death: Perceptions of Industry and Academia on Production Platforms and Opportunities in Biotechnology. EFB Bioeconomy Journal, Volume 2 (2022): 100033

Rational lifestyle engineering has improved performance of microbial cell factories in Industrial Biotechnology. However, few innovations make it through the Valley of Death to market implementation. To gain insights into the views of industry and academia on key bottlenecks and opportunities to reach market implementation, interviews were conducted with industrial and academic participants, helping us gathering the characteristics that any cell factory and bioprocess must have as well as commonly recognised opportunities. We found that academics

are limited by technical factors, whereas industry is restricted by technical, sector-dependent and societal ones, leading to misalignments of interest which often result in miscommunication and missed cooperation opportunities. Although both consider that academia must perform curiosity-driven research, there is pressure for short-term industrial applications, which widens the Valley of Death in Biotechnology. In this context, start-ups could be the answer to traverse this valley more effectively, particularly when embedded in adequate innovation ecosystems.

Keywords: Biotechnological valley of death, Academic innovation, Biotechnology industry, Biotech start-ups, Technology transfer

Philip Zuccaro[a], David C.Thompson[b], Jacobde Boer[c], Andrew Watterson[d], Qiong Wang[e], Song Tang[ef], Xiaoming Shi[ef], Maria Llompart[g], Nuno Ratola[hi], Vasilis Vasiliou[b]. (a. Yale University, New Haven, CT, USA, b. Department of Environmental Health Sciences, Yale School of Public Health, New Haven, CT, USA, c. Department of Environment and Health, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands, d. Faculty of Health Sciences and Sport, University of Stirling, Stirling, Scotland, e. China CDC Key Laboratory of Environment and Population Health, National Institute of Environmental Health, Chinese Center for Disease Control and Prevention, Beijing, China, f. Center for Global Health, School of Public Health, Nanjing Medical University, Nanjing, Jiangsu, China, g. CRETUS, Department of Analytical Chemistry, Nutrition, and Food Sciences, Universidade de Santiago de Compostela, Santiago de Compostela, Spain, h. LEPABE-Laboratory for Process Engineering, Environment, Biotechnology, and Energy, Faculty of Engineering, University of Porto, Porto, Portugal, i. ALiCE - Associate Laboratory in Chemical Engineering, Faculty of Engineering, University of Porto, Porto, Portugal). **Artificial turf and crumb rubber infill: An international policy review concerning the current state of regulations. Environmental Challenges, Volume 9 (2022): 100620**

Background

Although artificial turf fields are utilized widely around the world, sufficient research has not yet been conducted to assess the potential human and environmental health risks posed by the chemicals contained in the fields' fibers, backing, and often-used crumb rubber infill. Consequently, there is wide variation in governmental policies.

Objective

Review the notable policies concerning artificial turf and crumb rubber infill in the European Union, United Kingdom, United States of America, Canada, China, Qatar, and the Global Stockholm Convention of the United Nations.

Methods

Information was collected that included published papers, technical and policy reports, and grey literature. These were then analyzed by a collaborative group familiar with the environmental policies in their respective countries to extract the pertinent legislative or regulatory information. The group members were primarily identified through their involvement in publications pertinent to artificial turf and crumb rubber infill health research and included environmental health professors, active researchers, and governmental agency officials. Most information on direct policies was taken directly from reports provided to the public by various governmental agencies responsible for their countries' regulations, often available within the respective agency's online archives.

Results

There are significant differences in the regulatory approaches adopted by the investigated countries with regards to artificial turf and its crumb rubber infill. Some regions, such as the European Union, have taken substantial steps to limit the fields' chemical components to which the public and environment are exposed. Other regions and countries have done far less to address the issue. Most policies relate directly to (i) the fields themselves, (ii) the microplastic components of crumb rubber infill, or (iii) the concentrations of harmful polycyclic aromatic hydrocarbons (PAHs), perfluoroalkyl and polyfluoroalkyl substances (PFAS), and heavy metals.

Conclusion

While nearly every country acknowledges the potential health risks posed by heavy metals, microplastics, PAHs, and PFAS chemicals, very few have actually implemented artificial turf and crumb rubber infill regulations and/or established adequate surveillance measures to protect those regularly exposed to the fields.

Keywords: Artificial turf, Crumb rubber, Policy Infill

Joachim Boldt[a], Elisa Orrù[b]. (a. Department of Medical Ethics and the History of Medicine, CIBSS – Centre for Integrative Biological Signalling Studies, University of Freiburg, 79104, Freiburg, Germany, b. Centre for Security and Society and Philosophy Department, University of Freiburg, 79098, Freiburg, Germany). **Towards a unified list of ethical principles for emerging technologies. An analysis of four European reports on molecular biotechnology and artificial intelligence. Sustainable Futures, Volume 4 (2022): 100086**

Artificial intelligence (AI) and molecular biotechnologies (MB) are among the most promising, but also ethically hotly debated emerging technologies. In both fields, several ethics reports, which invoke lists of ethics principles, have been put forward. These reports and the principles lists are technology specific. This article aims to contribute to the ongoing debate on ethics of emerging technologies by comparatively analysing four European ethics reports from the two technology fields. Adopting a qualitative and in-depth approach, the article highlights how ethics principles from MB can inform AI ethics and vice versa. By synthesizing the respective ethical cores of the principles included in the analysed reports, the article derives, moreover, a unified list of principles for assessing emerging technologies. The suggested list consists of nine principles: autonomy; individual and social well-being and prevention of harm; reliability, safety and security; informational privacy; transparency; accountability; communication, participation and democracy; justice, fairness, and non-discrimination; sustainability.

Keywords: Technology governance, Technology assessment framework, Artificial intelligence ethics, Bioethics, Emerging technologies

Lien De Wannemaeker[a], Indra Bervoets[b], Marjan De Mey[a]. (a. Centre for Synthetic Biology (CSB), Ghent University, Coupure links 653, 9000 Ghent, Belgium, b. Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium). **Unlocking the bacterial domain for industrial biotechnology applications using universal parts and tools. Biotechnology Advances, Volume 60 (2022): 108028**

Synthetic biology can play a major role in the development of sustainable industrial biotechnology processes. However, the development of economically viable production processes is currently hampered by the limited availability of host organisms that can be engineered for a specific production process. To date, standard hosts such as Escherichia coli

and Saccharomyces cerevisiae are often used as starting points for process development since parts and tools allowing their engineering are readily available. However, their suboptimal metabolic background or impaired performance at industrial scale for a desired production process, can result in increased costs associated with process development and/or disappointing production titres. Building a universal and portable gene expression system allowing genetic engineering of hosts across the bacterial domain would unlock the bacterial domain for industrial biotechnology applications in a highly standardized manner and, doing so, render industrial biotechnology processes more competitive compared to the current polluting chemical processes. This review gives an overview of a selection of bacterial hosts highly interesting for industrial biotechnology based on both their metabolic and process optimization properties. Moreover, the requirements and progress made so far to enable universal, standardized, and portable gene expression across the bacterial domain is discussed.

Keywords: Universal bacterial gene expression system, Standardization, Synthetic biology, Industrial biotechnology

Enrico Baraldi, Sofia Wagrell. (Department of Civil and Industrial Engineering, Uppsala University, S-751 21 Uppsala, Sweden). Applying the resource interaction approach to policy analysis – Insights from the antibiotic resistance challenge. Industrial Marketing Management, Volume 106 (2022): 376-391

This paper explores how the Resource Interaction Approach (RIA), namely the 4Rs model and the three settings of developing-producing-using, can be applied to complex policy analyses. We use the global sustainability challenge of antibiotic resistance as an example to define an agenda about how these analytical tools can frame and analyze such problems systematically. We find that these tools offer benefits to policymakers, including flexibility in framing problems, by selecting the focal resources and values to be prioritized, and the ability to visualize the direct and indirect interdependencies that enable or hinder value creation. Moreover, the RIA can point at the resource interfaces that need to change through specific policy interventions, as well as the potential network-level barriers to such changes. We also find that the RIA needs to be complemented by network-level analyses of deal structures and monetary flows in order to better capture the legal and financial dimensions of policy problems and solutions.

Keywords: Industrial networks, IMP (industrial marketing and purchasing), Policy, 4Rs model, Resource interface, Deal structures, Monetary flows, AMR

Chao-chen Chung[a], Lina Liu[a], Yapeng Zhang[b], Yixuan Wang[c], Ziji Wei[d]. (a. School of Political Science and Public Administration, Wuhan University, PR China, b. Central China Normal University, PR China, c. Peking University, PR China, d. Fudan University, PR China). Evolution of biogas policies in China (2001–2019): Dynamics of policy instruments towards energy transitions. Journal of Cleaner Production, Volume 379, Part 1 (2022): 134642

China has emerged as global significant producer of biogas during the last two decades. The Chinese government promoted various types of policy instruments to facilitate the emergence and further development of biogas. This article used the method of content analysis to study the transitions of biogas policy instruments in China. The article in sum surveyed 108 policy documents issued by the central government of China from 2001 to 2019. The article analyzed the number, stringency, forms and institutions of these biogas policies and compared the

evolution of different types of policy instruments in the different periods of time. The results showed that the Chinese government continuously prioritized Environmental-type instruments, while Supply and Demand types of instruments have been supplementary. The actual implementation of policy instruments remained gaps with the ideal policy promotion. A balance of different types of policy instruments and mechanisms for policy coordination should be strengthened to constantly support biogas production in the country.

Keywords: Biotecnology Policy Issue

Aidan R Mouat. (Hazel Technologies, Inc., 320 N Sangamon Dr., Chicago, IL 60646, United States). Sustainability in food-waste reduction biotechnology: a critical review. Current Opinion in Biotechnology, Volume 77 (2022): 102781

Reduction of the $2.625 trillion USD global food-waste problem is a critical goal in combatting climate change and world hunger. However, the outcome analysis of theoretically 'sustainable' individual biotechnological approaches to food-waste reduction is neglected. This critical review applies the principles of the circular economy to the broader context of biotechnology innovations for food-waste reduction. The evaluation of sustainability and relationship to the food-waste management hierarchy are discussed with relevance to recent innovations in biotransformation of food waste and food-waste prevention. Comparison of these innovation categories reveals the challenges of impact at scale for food-waste reduction biotechnology, particularly in food-waste prevention technologies having low technology-readiness levels, and points to illustrative examples of efforts to meet and overcome these challenges.

Keywords: Biotecnology Policy Issue

Jack AHeinemann, Tessa CHiscox. (School of Biological Sciences, University of Canterbury, Christchurch 8140, New Zealand). Rethinking the drivers of biotechnologies: a paradigm for holistic climate change solutions. Current Opinion in Environmental Sustainability, Volume 59 (2022): 101222

Humanity is under pressure to identify sustainable climate change mitigation strategies that also progress developmental and environmental goals. Urgency creates greater risk of superficial actions that could accelerate climate change. We use recent advances in plant productivity through enhanced photosynthesis to demonstrate the pitfalls of defining objectives as a vacant biotechnological service. Recast as a goal to improve well-being and nutrition, climate change-exacerbating trade-offs are easier to avoid and payoffs include climate change mitigation. These insights emerge from linking new work in both molecular biology and anthropology. We suggest a strategy for addressing the adverse effects of climate change that better accommodates the voices of nontechnical public and has a superior navigational memory that optimises progress towards sustainable solutions.

Keywords: Biotecnology Policy Issue

Jose Priya, T.A.Sudha Kappalli. (Department of Zoology, School of Biological Sciences, Central University of Kerala, Kasaragod, Kerala 671 316, India). Modern biotechnological strategies for vaccine development in aquaculture – Prospects and challenges. Vaccine, Volume 40, Issue 41 (2022): 5873-5881

Advances in genomics and the gradual reduction of cost for technologies like whole-genome sequencing have provided exciting opportunities for developing modern biotechnological-based vaccines in aquaculture. This systemic review describes the prospects and challenges of implementing these high-tech vaccines in fish species. The majority of the commercial vaccines

in aquaculture utilize conventional procedures for which cost of administration, protective immunity and safety issues are the major challenges. In recent years, more efficient vaccines are being developed by adopting the advances in vaccine technology. Vaccines based on surface antigens, protein/peptide/polysaccharide subunits, recombinant DNA/mRNA/plasmids, novel antigen expression and delivery systems (bacteriophage particles, virus like particles/VLPs, recombinant yeast, mucosal vaccines), novel molecular adjuvants (IL-8, IL-12, HSPs), and encapsulation polymers and polysaccharides like chitosan nanoparticles and PLGA microcapsule were successfully developed. These biotechnology-based vaccines have proved to be very efficient in field trials, but are always in the research pipeline or as patents. Only very few of them are licensed for use, that too, in high-valued fishes like salmonids. Currently, commercial aquaculture vaccines are available for Aeromonas salmonicida, Vibrio salmonicida, Yersinia ruckeri, Vibrio anguillarum, Edwardsiella ictalurid, and for certain Betanodaviruses. Nevertheless, no registered vaccines are available for other major infectious diseases/pathogens such as viral hemorrhagic septicemia virus (VHSV), viral nervous necrosis virus (VNN) and certain other betanodaviruses, channel catfish virus (CCV), gill disease bacteria, mycobacteria, flavobacterium, Edwardsiella tarda, and certain streptococci. Despite the important economic losses that the pathogens cause to aquaculture worldwide, the commercialization of vaccines remains limited due to immunological pitfalls in aquatic species, large-scale vaccination issues, unregulated use of antibiotics and chemicals, gene-based vaccine regulations and commercial viability. If attempts are to be made to develop novel delivery methods, cost-effective procedures, and relaxations in DNA vaccine regulations, biotechnology-based vaccination could circumvent the emerging disease challenges in aquaculture.

Keywords: Aquatic animal vaccine, Biotechnology, Strategies Protective immunity, Prospects Challenges

Danielle J.Ufer[a], David L.Orteg[ab], Christopher A.Wolf[c], Melissa McKendree[b], Janice Swanson[d]. (a. USDA Economic Research Service, 805 Pennsylvania Ave, Kansas City, MO 64105, United States, b. Dept. of Agricultural, Food and Resource Economics, Michigan State University, United States, c. Dyson School of Applied Economics and Management, Cornell University, United States, d. Dept. of Animal Science, Michigan State University, United States). **Getting past the gatekeeper: Key motivations of dairy farmer intent to adopt animal health and welfare-improving biotechnology. Food Policy, Volume 112 (2022): 102358**

The complexities of the decision to adopt gene-editing technology at the farm gate are likely to be greater than a simple matter of profitability. We investigate ex ante technology adoption intentions to address how non-pecuniary motivations influence a dairy producer's decision to adopt gene-editing (GE) technology with animal health and welfare-improving benefits. Experimental vignette methodology and a correlated random parameters ordered logit modeling approach are employed to investigate U.S. dairy farmer intent to adopt GE genetics that confer resistance to Johne's disease (M. avium ssp. paratuberculosis), a disease that costs the U.S. dairy industry close to $200 million per year. Findings point to a general resistance among dairy farmers towards GE genetics, even with an animal health and welfare-improving application. We find that profitability is a necessary, but not sufficient condition for adoption. Farmers can, however, become more amenable to the prospect of adopting GE genetics through situational influences. Our results indicate that the successful uptake of GE technologies may be influenced

by policies which protect adopters from adverse market impacts but also consider the complexities of the producer's decision-making process.

Keywords: Biotecnology Policy Issue

Mariam Elgabry[ab], Darren Nesbeth[b], Shane Johnson[a]. (a. DAWES Center for Future Crime at UCL, Jill Dando Institute for Security and Crime Science, 35 Tavistock Square, London WC1H 9EZ, United Kingdom, b. UCL Biochemical Engineering, Bernard Katz, London WC1E 6BT, United Kingdom). The future of biotechnology crime: A parallel Delphi study with non-traditional experts. Futures, Volume 141 (2022): 102970

Background

The way science is practiced is changing and forecasting biotechnology crime trends remains a challenge as future misuses become more sophisticated.

Methods

A parallel Delphi study was conducted to elicit future biotechnology scenarios from two groups of experts. Traditional experts, such as professionals in national security/intelligence, were interviewed. They were asked to forecast emerging crime trends facilitated by biotechnology and what should be done to safeguard against them. Non-traditional experts, such as "biohackers" who experiment with biotechnology in unexpected ways, were also interviewed. The study entailed three rounds to obtain consensus on (i) biotechnology misuse anticipated and (ii) potential prevention strategies expected.

Results

Traditional and non-traditional experts strongly agreed that misuse is anticipated within the cyber-infrastructure of, for example, medical devices and hospitals, through breaches and corporate espionage. Preventative steps that both groups strongly advocated involved increasing public biosecurity literacy, and funding towards addressing biotechnology security. Both groups agreed that the responsibility for mitigation includes government bodies. Non-traditional experts generated more scenarios and had a greater diversity of views.

Discussion

A systematic, anonymous and independent interaction with a diverse panel of experts provided meaningful insights for anticipating emerging trends in biotechnology crime. A multi-sector intervention strategy is proposed.

Keywords: Delphi, Synthetic biology, Crime Biotechnology, Futures Biohackers

Agricultural Biotechnology

Lenka Burketová[a], Jan Martinec[a], Jakub Siegel[c], Anna Macůrková[b], Lukáš Maryška[ab], Olga Valentová[b]. (a. Institute of Experimental Botany of the Czech Academy of Sciences, Rozvojová 313, 165 02, Prague 6, Lysolaje, Czech Republic, b. Department of Biochemistry and Microbiology, University of Chemistry and Technology, Prague, Technická 5, 166 28 Prague 6, Czech Republic, c. Department of Solid State Engineering, University of Chemistry and Technology, Prague, Technická 5, 166 28 Prague 6, Czech Republic). Noble metal nanoparticles in agriculture: impacts on plants, associated microorganisms, and biotechnological practices. Biotechnology Advances, Volume 58 (2022): 107929

Within the past decades, nanoparticles (NPs) have become common components of electronics, batteries, cosmetics, clothing, and even dietary supplements. Despite their undisputed advantages consisting in the possibility of engineering their novel physical, thermal, optical, and biological properties, safety questions arise concerning their wide exploitation. NPs interact with living organisms, which can interfere with essential life processes. The aim of this paper is to critically review the current literature dealing with noble metals' NPs (NM-NPs) and their effects on plants and associated microorganisms. Particular attention has been given to the less studied NPs of platinum group elements, which can be considered a neglected pollutant, since they are released from vehicles' catalysts. In addition, we have provided a comprehensive overview of the biotechnology exploitation of NM-NPs in plant cultivation, where prospective nanomaterials developed as nanofertilizers and nanopesticides are introduced, and both the pros and the cons of nanomaterial plant treatments have been discussed.

Keywords: Silver nanoparticles, Gold nanoparticles, Platinum group elements' nanoparticles, Microbiome

Niloufar Hagh-Doust[ab], Sanni M.A.Färkkilä[a], Mahdieh S.Hosseyni Moghaddam[a], Leho Tedersoo[ab]. (a. Institute of Ecology and Earth Sciences, University of Tartu, Tartu, Estonia, b. Mycology and Microbiology Center, University of Tartu, Tartu, Estonia). **Symbiotic fungi as biotechnological tools: Methodological challenges and relative benefits in agriculture and forestry. Fungal Biology Reviews, Volume 42 (2022): 34-55**

Environmental conditions are becoming increasingly challenging in managed ecosystems, especially in agricultural fields, where environmentally friendly solutions are urgently needed. Fungal symbionts offer great opportunities to enhance crop production and ecosystem sustainability under environmental stress. Some fungi are relatively well investigated (e.g., arbuscular mycorrhiza) and regularly used in commercial products, while others, such as fungal endophytes, are not well-known in this market, yet. Here, we review I) the characteristics and benefits, II) the advantages and challenges of principal isolation, preservation, inoculation, and field applications methods, and III) the environmental stress resistance mechanisms for different beneficial fungi. Utilization of mycorrhizae is still facing many challenges, particularly in terms of acquiring pure cultures and successfully establishing their symbiosis in the field. Effects of mycorrhizal associations on the above-ground organs through molecular mechanisms are not fully understood. Although biochemical values of some endophytes are well recognized, molecular mechanisms involved in endophytic-induced stress tolerance are poorly known. Fungal endophytes present several important advantages over mycorrhizal fungi including broader host range as well as straightforward isolation and application protocols. Further studies are necessary for selecting the best strains and communities, producing inoculum on a large-scale, and understanding the potential environmental hazards.

Keywords: Crop production, Fungal endophytes, Growth promotion, Inoculum production, Mycorrhizal fungi, Stress resistance

Ricardo Pelai, Shannon M.Hagerman, Robert Kozak. (Faculty of Forestry, University of British Columbia, Canada). Biotechnologies in agriculture and forestry: Governance insights from a comparative systematic review of barriers and recommendations. Forest Policy and Economics, Volume 117 (2020): 102191

The application of biotechnological innovations has increased in agriculture and forestry over the past two decades. Numerous benefits of biotechnologies are documented; however, implementation is controversial and continues to face technical, biophysical and societal barriers. The longer history of agricultural biotechnology holds potential lessons for emerging proposals in forestry, and vice versa. Using a systematic review and content analysis of the scholarly literature in agriculture and forestry (235 articles) between 1989 and 2017, we compare these two sectors in terms of justifications for the use of biotechnologies, barriers to and recommendations for implementation, and types of evidence considered. The primary benefit of biotechnologies identified in the agricultural literature is food security, whereas forest productivity and adaptation to climate change are the most common motivating justifications in a forest context. We find a relatively greater emphasis in the forestry literature on regulatory and legal barriers. Both fields emphasize recommendations to address barriers related to lack of knowledge and governance processes despite relatively less emphasis on these items as identified barriers. Relatively few (32%) forestry articles were informed by insights from the social sciences and humanities as compared with 51% of those in agriculture. We discuss the implications of anticipated public opposition to tree biotechnology and associated perceptions of risk unique to trees. We also discuss biotechnology governance dilemmas within an “upstream” approach, highlighting the need for meaningful ways of involving stakeholders, rights holders and different publics at the earliest possible stage of the implementation of biotechnologies.

Keywords: Agricultural Biotechnology

Robert L.Zimdahl. (Colorado State University, Fort Collins, CO, United States). 8 - Agricultural biotechnology—opportunities and strengths, Agriculture's Ethical Horizon (Third Edition) (2022): 165-190

Biotechnology has changed the debate about the criteria used to determine the acceptability of any agricultural technology by introducing new questions: Do we need it? Should we do it? The debate continues. Several arguments in favor of agricultural biotechnology are presented, and the crops and countries using it are shown in this chapter. The concept of substantial equivalence is presented. Adoption of the technology has been very rapid, but it has not led to widespread societal approval.

Keywords: Agriculture biotechnology, environment, hybridization, environmental extremism, GMO

Robert L.Zimdahl. (Colorado State University, Fort Collins, CO, United States). 9 - Agricultural biotechnology—challenges and cautions. Agriculture's Ethical Horizon (Third Edition) (2022): 191-225

This chapter presents and discusses arguments opposed to agricultural biotechnology. It remains a subjective of serious concern and debate. The debate is hindered by the fact that there is little agreement on what the problem is. The chapter suggests a lot can be accomplished with what we already know. The chapter presents some of the arguments against and outlines some moral arguments against agricultural biotechnology. Eating is a biological necessity, a daily ritual, and a cultural experience. It is something all creatures must do. How could people who must eat not be concerned about what and how they eat and what is being done to their food? Agricultural biotechnology has been and will continue to be a scientific success story. It remains to be seen if it will also be a cultural success.

Keywords: Agriculture biotechnology, genetic engineering, GMO, environment ethics

Bartholomew Saanu Adeleke, Olubukola Oluranti Babalola. (Food Security and Safety Focus Area, Faculty of Natural and Agricultural Sciences, North-West University, Private Bag X2046, Mmabatho, 2735, South Africa). Meta-omics of endophytic microbes in agricultural biotechnology. Biocatalysis and Agricultural Biotechnology, Volume 42 (2022): 102332

Endophytic studies are becoming popular with the current advancement in microbial ecology. The internal tissue of the plant represents a discreet region for diverse endophytic microbes to flourish for plant nutrition through the uptake of essential nutrient (i.e. nitrogen, phosphorus, and potassium) synthesis of phytohormones, metabolic compounds, organic acids, siderophores, and hydrolytic enzymes. Nevertheless, these microbes are less explored than expected. The mechanisms of endophytic microbes that best explain their interactions with the host plant and other microbes can unravel their functional role in agricultural biotechnology based on gene specificity and competence under biotic and abiotic stress conditions. The establishment of microbial communities in plants contributes to plant health for yield enhancement. The dominant bacterial phyla, Proteobacteria, Firmicutes, Actinobacteria, Bacteroidetes, and Chloroflexi; and fungal phyla Ascomycota, Basidiomycota, and Zygomycota previously reported from sunflower, maize, rice, and wheat using meta-omics approaches form the basis of understanding the endophytic concept in the present and future studies. Meta-omics approaches create opportunities to unravel, explore and incorporate endophytic bioproducts in developing eco-friendly agriculture. Despite the established prospects of meta-omics approaches in agricultural biotechnology and industry, providing information on the reality of endophytic microbial bioproducts in assisting stress tolerance and disease control in plants is important with the view of combating current agricultural challenges for crop production. Hence, this review focuses on the endophytic bacteria and fungi, structural diversity, meta-omics approaches, and their agricultural, biotechnological, and industrial importance.

Keywords: Agricultural Biotechnology

Bioenergy

Jianguo Du[a], Guanghui Chang[a], Daniel Adu[ab], Agnes Abbey[c], Ransford Darko[d]. (a . School of Management Science & Engineering, Jiangsu University, Zhenjiang 212013, China, b. Faculty of Engineering, Accra Technical University, Barnes Road, PMB 233, Accra, Ghana, c. Department of Engineering, Cape Coast Technical University, PMB 233, Ghana, d. Department of Agricultural Engineering University of Cape Coast, PMB 233, Cape Coast, Ghana). Development of solar and bioenergy technology in Africa for green development—Addressing barriers and untapped potential. Energy Reports, Volume 7, Supplement 5 (2021): 506-518

Globally, over quarter of population experiences energy crisis, particularly those living in rural communities of developing countries. Many of such victims are the people within the Africa continent. More than 600 million people lives in Africa without access to electricity. Energy use is a requirement for physical and socio-economic development of every country. Bioenergy and solar energy has currently seen an increase in its development in many countries in Africa.

However, their major concern is its technological development and finance as well as impact on the environment. The study evaluates the solar and bioenergy potential utilization and future prospects in Africa. It also discusses some of the principal challenges negatively influencing its development. Conclusions are drawn on the need for effective international cooperation on inputs from financial, resources and technological advance mechanisms for solar and bio energies development in Africa. For example Development of new businesses should be linked with solar PV and bioenergy infrastructure to promote effective rural electrification. This study provides beneficial information, which will serve as a reference to help improve bioenergy and solar power development.

Keywords: Bioenergy, Solar power, Electricity, Renewable energy, Energy generation

Habu Iyodo Mohammed[ac], Kabir Garba[a], Saeed I.Ahmed[a], Lawan G.Abubakar[b]. (a.Department of Chemical Engineering, Abubakar Tafawa Balewa University, P.M.B, 0248, Bauchi, Nigeria, b. Department of Agricultural and Bioresource Engineering, Abubakar Tafawa Balewa University, P.M.B 0248, Bauchi, Nigeria, c. Department of Chemical Engineering, University of Maiduguri, P.M.B, 1068, Maiduguri, Nigeria). **Thermodynamics and kinetics of Doum (Hyphaene thebaica) shell using thermogravimetric analysis: A study on pyrolysis pathway to produce bioenergy. Renewable Energy, Volume 200 (2022): 1275-1285**

Doum (Hyphaene thebaica) palm pulp used to produce local beverages left behind enormous, difficult to manage Hyphaene thebaica Shell (HTS) wastes. To pioneer the determination of HTS bioenergy potential, compositional and thermogravimetric analyses to determine the kinetic and thermodynamic characteristics were employed. The HTS had 5.50 wt% hydrogen, 42.50 wt% carbon, and 74.31 wt% volatile matter. The FTIR functional groups matched those found in other recognised biomass sources. Thermogravimetry revealed that HTS pyrolysis occurred in three stages. In total, nearly 70% of the biomass was lost between 32 and 900 °C, with 50% of the loss in the active pyrolysis zone. The average activation energies for the Iso-conversional methods' Kissinger-Akahira-Sunose, Flynn-Wall-Ozawa, and Starink models respectively, were 118.15, 142.81 and 139.56 kJ/mol. The Flynn-Wall-Ozawa technique best fit the pyrolysis data according to the Akaike information criterion (AIC). The multi-step pyrolysis reactions were controlled by the diffusion and contraction mechanisms of Coats-Redfern method, with activation energies of 38.83 and 16.62 kJ/mol, respectively. According to the AIC, the pyrolysis can be accurately predicted by the Gistling-Brounshtein kinetic model. The pyrolysis reactions have a high-degree of disorder, are endothermic, irreversible, and non-spontaneous. The outcome of the study ascertained the HTS viability for bioenergy production.

Keywords: Doum (Hyphaene thebaica) shell, Kinetics, Pyrolysis Thermodynamics, Thermogravimetric analysis

Oriol Gavaldà[a], Arnau González[a], Mariana Raya[a], Matthew Owen[b], Francis Kemausuor[c], Pol Arranz-Piera[a]. (a. AIGUASOL Sistemes Avançats d'Energia Solar Tèrmica, SCCL., Roger de Llúria 29, 3r 2a, 08009 Barcelona, Spain, b. Kikenni Consulting, Barn Cottage, Axbridge, BS26 2BA, United Kingdom, c. Kwame Nkrumah University of Science & Technology (KNUST), Kumasi, Ghana). **Life Cycle Cost analysis for industrial bioenergy projects: Development of a simulation tool and application to three demand sectors in Africa. Energy Reports, Volume 8 (2022): 2908-2923**

Publicly available toolkits for cost calculation in renewable energy projects were reviewed, and their main characteristics, strengths and weaknesses identified. An original Life-Cycle Cost (LCC) modelling toolkit was developed to address some of the identified shortcomings, and to

facilitate the calculation of costs of electrical and thermal energy from biomass-based processing pathways. The toolkit was used to compare the Levelized Cost of Energy (LCOE) for electricity and/or heat generation for a 'Bioenergy Case', after the adoption of bioenergy technology, and compared with equivalent costs under a business-as-usual 'Base Case', for selected commercial demand sectors in Sub-Saharan Africa, within a 10 kW to 5 MW scale range. Case Studies of the toolkit's application are described for a smallholder tea factory in Kenya, a wood processing enterprise in Tanzania and an oil palm mill in Ghana, which illustrate its ability to model energy production based on both combustion and anaerobic digestion, under various heat, power and combined heat and power configurations. Sensitivity analysis was carried out to determine the effect on LCOE and LCOE of adjustments in key operating parameters, such as biomass feedstock cost, feed-in tariff for export of surplus power to the grid or on-site energy demand. The versatility of the LCC toolkit enables bioenergy projects to be modelled from different perspectives (biomass feedstock diversification, conversion pathways or business models) and for different users (plant managers, project developers or potential investors), and it can be customised and adapted as prices, legislation and technical aspects evolve with time.

Keywords: Bioenergy, Life Cycle Costing, Levelized Cost of Energy, Combined heat and power, Anaerobic digestion, Combustion, Sub-Saharan Africa

Giuseppe Pulighe, Filiberto Altobelli, Guido Bonati, Flavio Lupia. (CREA—Research Centre for Agricultural Policies and Bioeconomy, Rome, Italy). 5.02 - Challenges and Opportunities for Growing Bioenergy Crops in the EU: Linking Support Schemes With Sustainability Issues Towards Carbon Neutrality. Comprehensive Renewable Energy (Second Edition) Volume 5 (2022): 22-33

Bioenergy from renewable resources plays a central role in the transition toward net-zero emission of carbon dioxide and low-energy circular economy. The main objective of this work was to examine the main challenges and opportunities for producing renewable biomass feedstocks and developing realistic bioenergy value chain

s in the European Union. The main support schemes and regulatory instruments were investigated, linking sustainability issues, certification schemes and smart farming examples for promoting market uptake in a framework of the sustainable energy cropping system.

Keywords: Biodiesel, Biofuels, Biogas, Biomass, Biomethane, Certification schemes, Climate change, Ethanol, Feedstock, Land cover, Land use, Landscape design, Policies Subsidies, Sustainability indicators

Miraj Ahmed Bhuiyan[a], Hasan Dinçer[b], Serhat Yüksel[b], Alexey Mikhaylov[c], Mir Sayed Shah Danish[d], Gabor Pinter[e], Daniel Dooyum Uyeh[f], Diana Stepanova[g]. (a. School of Economics, Guangdong University of Finance & Economics, Guangzhou, 510320, China, b. School of Business, Istanbul Medipol University, Istanbul, 34810, Turkey, c. Research Center of Monetary Relations, Financial University under the Government of the Russian Federation, Moscow, 124167, Russian Federation, d. Department of Electrical and Electronics Engineering, University of the Ryukyus, Okinawa, 903-0213, Japan, e. Faculty of Engineering, Soós Ernő, Research and Development Center, Renewable Energy Research Group, University of Pannonia, Veszprém, 8200, Hungary, f. Department of Bio-Industrial Machinery Engineering, Kyungpook National University, Daegu, 41566, Republic of Korea, g. Plekhanov Russian University of Economics, Moscow, 115903,

Russian Federation). Economic indicators and bioenergy supply in developed economies: QROF-DEMATEL and random forest models. Energy Reports, Volume 8 (2022): 561-570

Bioenergy is a renewable energy source that saves from fossil fuel dependence. Therefore, it is important to increase the efficiency of bioenergy investments to create an environmentally sustainable energy supply. This paper aims to identify economic indicators significant in forecasting the supply of bioenergy. Considering this goal, an integrated evaluation has been performed for 17 developed economies using the Random Forest method and the Fuzzy Decision-Making Trial and Evaluation Laboratory (QROF-DEMATEL) method. The main contribution of this study is conducting analysis by using both quantitative and qualitative data. Additionally, the coherence of the results made with the QROF-DEMATEL method is also verified by implementing a sensitivity analysis. The results of both approaches are quite similar and provide information about the reliability of the findings. This situation demonstrates that for the development of bioenergy investments, firstly, countries' macroeconomic conditions should be improved. Consequently, economic growth and unemployment (weighting results - 0.159 and 0.155) should be primarily considered for the bioenergy supply forecast.

Keywords: Biomass economy, Demand and supply, Economic growth, Q-rung orthopair fuzzy sets, DEMATEL

Shan-Shan Kung[a], Hai-Ling Li[b], Si-Ru Li[c], Li-Guo Zhang[d], Chih-Chun Kung[d]. (a. College of Foreign Studies, Hubei University of Economics, Wuhan 430205, China, b. Office of Postdoctoral Management, Jiangxi University of Finance and Economics, Nanchang 330013, China, c. School of International Trade & Economics, University of International Business & Economics, Beijing 100021, China, d. School of Economics, Jiangxi University of Finance & Economics, Nanchang 330013, China). Effects of green bonds on bioenergy development under climate change: A case study in Taiwan province, China. Advances in Climate Change Research, Volume 13, Issue 1 (2022): 97-106

Bioenergy development improves energy security and mitigates climate change. Because the stable supply of agricultural resources provides a solid basis for efficient bioenergy production, the climate-induced impacts such as changes in temperature and precipitation that potentially alter the farming decisions and cropping patterns should be taken into account. This study designs two-stage stochastic programming with recourse model to investigate the net bioenergy production and emission reduction, as well as the bioenergy producers' strategies under various market operations and climate scenarios. The results show that the net production of biopower and biofuel are relatively stable because the supply of bioenergy feedstocks could remain at a constant level, but the farming decisions, cropping pattern, and resource utilization are likely to be altered by climate-induced impacts. The results also indicate that for efficient bioenergy production, approximately 41.5 billion TWD (9.65 billion CNY) and 33.6 billion TWD (7.81 billion CNY) of bond principal should be invested in crop-based and residual-based technology, respectively. In the face of strict environmental regulations and emission management, biopower technology becomes more competitive, and under such a circumstance, more than 98.3% of the low-cost bond should be invested in biopower development to achieve development efficiency.

Keywords: Climate change mitigation, Financial mechanism, Renewable energy, Sustainable development

Henrik Lund[a], Iva Ridjan Skov[b], Jakob Zinck Thellufsen[a], Peter Sorknæs[a], Andrei David Korberg[b], Miguel Chang[a], Brian Vad Mathiesen[b], Mikkel Strunge Kany[b]. (a. Aalborg University, Rendsburggade 14, 9000, Aalborg, Denmark, b. Aalborg University, A.C.

Meyers Vænge 15, 2450, Copenhagen, Denmark). The role of sustainable bioenergy in a fully decarbonised society. Renewable Energy, Volume 196 (2022): 195-203

With the Danish government's goals of decreasing 70% of CO2 emissions by 2030 and reaching a fully decarbonised society in the years after, this paper aims to identify the role of sustainable bioenergy in achieving this goal. The methodology and approach presented are relevant for other countries heading in the same direction. The focus is on strategies to further develop the sustainable biomass resources and conversion technologies within energy and transport paired with CCUS (carbon capture utilisation and storage) to coordinate with other sectors and achieve a fully decarbonised society. By using hourly energy system modelling and a Smart Energy Systems approach, it is possible to create a robust multiple technology strategy and keep the sustainable bioenergy levels. The results are presented as principles and guidelines on how to include the use of sustainable biomass in the individual country as an integrated part of global decarbonisation.

Keywords: Bioenergy, Biomass, CCUS, Fully decarbonized society, 100% Renewable energy, International shipping and aviation

Akash Deep Singh, Bhautik Gajera, A.K.Sarma. (Chemical Conversion Division, Sardar Swaran Singh National Institute of Bio-Energy, (An Autonomous Institute of the Ministry of New and Renewable Energy, Government of India), Kapurthala, Punjab, India). Appraising the availability of biomass residues in India and their bioenergy potential. Waste Management, Volume 152 (2022): 38-47

Biomass produced from agriculture at present provides most energy services in developing nations. In India, enormous quantities of biomass are produced for conversion into valuable energy. Bioenergy production from agricultural leftovers, animal manure, and municipal waste has the potential to meet of the rising need sustainable energy. It is a practical and sustainable option since the energy produced from the above mentioned sources can minimise the use of fossil fuels, reduce greenhouse gas emissions, and alleviate the effects of climate change. In addition, it can boost marginal and small farmers in terms of income and job opportunities. Evaluating agricultural leftovers, animal manure, and municipal waste as bioenergy resources can provide a method of tapping renewable energy opportunities. It is possible to minimise constraints for using agricultural leftovers, animal manure, and municipal waste, support investment decisions, and maximise the utilisation of biomass resources available. This study is intended to establish the amount of energy demand in India that can be met by using crop residues, animal manure, logging residues, and municipal waste. The annual energy potential of these biomass waste was quantified and assessed in the study. It has been determined that the technical bioenergy potential of these biomass resources is 1.29 × 103 PJ in 2.31 × 104 Mm3 of biogas and 7.79 × 102 PJ in 3.49 × 104 Ml of cellulosic ethanol. However, the country must overcome techno-economic barriers to handle the projects likely to be initiated soon.

Keywords: Bioenergy

Makarand Ghangrekar[ab], Shreeniwas Sathe[a], Swati Das[b]. (a. Department of Civil Engineering, Indian Institute of Technology Kharagpur, Kharagpur, India, b. PK Sinha Centre for Bioenergy & Renewables, Indian Institute of Technology Kharagpur, Kharagpur, India). 5.12 - Bioenergy and Valuables Recovery During Wastewater

Treatment Using Bio-Electrochemical Systems. Comprehensive Renewable Energy (Second Edition), Volume 5 (2022): 259-272

Production of bioenergy with concomitant value-added products recovery is considered as one of the promising ways of sustainable wastewater treatment owing to the upfront energy crisis and limited resource availability. The bio-electrochemical system (BES) is one of the potential techniques that possess the capability of bioenergy production and resource recovery while simultaneously treating the wastewater. The overview on the recovery of nutrients, heavy metals, industrial chemicals, and bioenergy recovery from the wastewater using BES has been elaborated in this article. Additionally, a brief future scope to overcome current bottlenecks and potential upcoming research areas of BES have been described.

Keywords: Bio-electrochemical systems, Bioenergy production, Heavy metal removal, Microbial fuel cell, Nutrient recovery, Waste water treatment

Suani T.Coelho[ab], Danilo Perecin[cd], Fernando Rei[ef], Javier Farago Escobar[g], Rafael Costa Freiria[hi], Willian Jun Kimura[c]. (a. Energy Graduation Program, Institute of Energy and Environment and PhD Program on Bioenergy, University of São Paulo, São Paulo, Brazil, b. Research Group on Bioenergy, Institute of Energy and Environment, University of São Paulo (GBIO/IEE/USP), São Paulo, Brazil, c. Institute of Energy and Environment, University of São Paulo (IEE/USP), São Paulo, Brazil, d. Centre for Environmental Policy, Imperial College London, London, United Kingdom, e. International Environmental Law, Catholic University of Santos, Santos, Brazil, f. Environmental Law, Armando Alvares Penteado Foundation (FAAP), São Paulo, Brazil, g. Environmental Science and Engineering, Harvard John A. Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, United States, h. School of Technology, University of Campinas (FT/Unicamp), São Paulo, Brazil, i. Public Policies Laboratory, School of Technology, University of Campinas (LAPPA/FT/Unicamp), São Paulo, Brazil). 5.01 - Bioenergy Policies Worldwide. Comprehensive Renewable Energy (Second Edition), Volume 5 (2022): 1-21

Biomass energy can be produced from different feedstocks of biological origin, through several different processes to produce heat, electricity, and transport fuels. The advantages of bioenergy are quite well known, considering its environmental, strategic, and social impacts. In addition, bioenergy contributes to reduce GHG emissions, mainly when coupled to carbon capture and storage (BECCS) or utilization (BECCU/BECCUS). However, bioenergy share in world energy matrix is still reduced and this requires better policies in different countries. In this chapter, an extensive discussion of existing bioenergy policies worldwide is presented, with focus in experiences from several industrialized and developing countries.

Keywords: BECCS, Bioenergy, Biofuels, Biogas, Biomethane, Climate change mitigation, Energy markets, Energy planning, Energy systems, Low carbon fuel policies, Power generation, Solid biomass, Sugarcane ethanol

Nano Biotechnology

Kyeongsoon Park[a], Jae Won Ahn[a], Jin Hyuk Kim[b], Jin Won Kim[b]. (a. Department of Systems Biotechnology, Chung-Ang University, Anseong, Gyeonggi 17546, Republic of Korea, b. Multimodal Imaging and Theranostic Laboratory, Cardiovascular Center, Korea University Guro Hospital, 148 Gurodong-ro, Guro-gu, Seoul 08308, Republic of

Korea). Tumor-associated macrophage-targeted photodynamic cancer therapy using a dextran sulfate-based nano-photosensitizer. International Journal of Biological Macromolecules, Volume 218 (2022): 384-393

The M2-like phenotype of tumor-associated macrophages (TAMs) present in tumors promotes tumor growth and metastasis. Therefore, targeting M2-like TAMs is a potential strategy for cancer therapy. Herein, we fabricated a dextran sulfate-based nano-photosensitizer (dextran sulfate-conjugated chlorin e6, DS-Ce6) to specifically target M2-like TAMs for enhanced photodynamic therapy (PDT). DS-Ce6 was preferentially taken up by interleukin-4-derived M2 macrophages, which overexpressed scavenger receptor-A and selectively targeted macrophages in co-cultured 4T1 tumors/macrophages. The nano-photosensitizer also effectively induced the apoptosis of tumor cells in both monolayer co-culture and three-dimensional co-culture spheroids of tumors/macrophages under laser irradiation. Moreover, the nano-photosensitizer specifically targeted F4/80 and CD206 double-positive M2-like TAMs within tumor tissues. Therefore, the specifically targeted delivery of DS-Ce6 to M2-like TAMs prominently induced tumor apoptosis, leading to excellent phototherapeutic effects in 4T1 tumor-bearing mice after PDT, suggesting the potential of DS-Ce6 for specific targeting of M2-like TAMs and enhanced PDT.

Keywords: Tumor-associated macrophages, Dextran sulfate, Nano-photosensitizers, 4T1 breast cancer, Photodynamic cancer therapy

Jose Priya, T.A.Sudha Kappalli. (Department of Zoology, School of Biological Sciences, Central University of Kerala, Kasaragod, Kerala 671 316, India). Modern biotechnological strategies for vaccine development in aquaculture – Prospects and challenges. Vaccine, Volume 40, Issue 41 (2022): 5873-5881

Advances in genomics and the gradual reduction of cost for technologies like whole-genome sequencing have provided exciting opportunities for developing modern biotechnological-based vaccines in aquaculture. This systemic review describes the prospects and challenges of implementing these high-tech vaccines in fish species. The majority of the commercial vaccines in aquaculture utilize conventional procedures for which cost of administration, protective immunity and safety issues are the major challenges. In recent years, more efficient vaccines are being developed by adopting the advances in vaccine technology. Vaccines based on surface antigens, protein/peptide/polysaccharide subunits, recombinant DNA/mRNA/plasmids, novel antigen expression and delivery systems (bacteriophage particles, virus like particles/VLPs, recombinant yeast, mucosal vaccines), novel molecular adjuvants (IL-8, IL-12, HSPs), and encapsulation polymers and polysaccharides like chitosan nanoparticles and PLGA microcapsule were successfully developed. These biotechnology-based vaccines have proved to be very efficient in field trials, but are always in the research pipeline or as patents. Only very few of them are licensed for use, that too, in high-valued fishes like salmonids. Currently, commercial aquaculture vaccines are available for Aeromonas salmonicida, Vibrio salmonicida, Yersinia ruckeri, Vibrio anguillarum, Edwardsiella ictalurid, and for certain Betanodaviruses. Nevertheless, no registered vaccines are available for other major infectious diseases/pathogens such as viral hemorrhagic septicemia virus (VHSV), viral nervous necrosis virus (VNN) and certain other betanodaviruses, channel catfish virus (CCV), gill disease bacteria, mycobacteria, flavobacterium, Edwardsiella tarda, and certain streptococci. Despite the important economic losses that the pathogens cause to aquaculture worldwide, the commercialization of vaccines

remains limited due to immunological pitfalls in aquatic species, large-scale vaccination issues, unregulated use of antibiotics and chemicals, gene-based vaccine regulations and commercial viability. If attempts are to be made to develop novel delivery methods, cost-effective procedures, and relaxations in DNA vaccine regulations, biotechnology-based vaccination could circumvent the emerging disease challenges in aquaculture.

Keywords: Aquatic animal vaccine, Biotechnology, Strategies, Protective immunity, Prospects, Challenges

Arun K.Upadhyay[a], Niklaus H.Mueller[b], J. Mark Petrash[b], Uday B.Kompella[abc]. ([a.]Nanomedicine and Drug Delivery Laboratory, Department of Pharmaceutical Sciences, University of Colorado Anschutz Medical Campus, Aurora, CO, USA, b. Department of Ophthalmology, University of Colorado Anschutz Medical Campus, Aurora, CO, USA, c. Department of Bioengineering, University of Colorado Anschutz Medical Campus, Aurora, CO, USA). Nano-assemblies enhance chaperone activity, stability and delivery of alpha B-crystallin-D3 (αB-D3). Journal of Controlled Release, Volume 352 (2022): 411-421

Crystallins, small heat shock chaperone proteins that prevent protein aggregation, are of potential value in treating protein aggregation disorders. However, their therapeutic use is limited by their low potency and poor intracellular delivery. One approach to facilitate the development of crystallins is to improve their activity, stability, and delivery. In this study, zinc addition to αB-crystallin-D3 (αB-D3) formed supramolecular nano- and micro- assemblies, induced dose-dependent changes in structure (beta-sheet to alpha-helix) and increased surface hydrophobicity and chemical stability. Further, crystallin assemblies exhibited a size-dependent chaperone activity, with the nano-assemblies being superior to micro-assemblies and 4.3-fold more effective than the native protein in preventing β-mercaptoethanol induced aggregation of insulin. Insulin rescued by crystallin assemblies retained the activity as evidenced by glucose uptake in 3T3-L1 cells. The most active nano-assemblies enhanced protein stability, in the presence of urea, by 1.6-fold, whereas intracellular delivery was enhanced by 3.0-fold. The αB-D3 crystallin nano-assemblies exhibit uniquely enhanced stability, activity, and delivery compared to the native protein.

Keywords: Nano Biotechnology

Zhongqing Xiao[a], Xin Huang[b], Jie Wu[a], Ting Liu[c], Lingyun Zhao[d], Qi Wang[a], Minyu Wang[a], Meng Shen[a], Shaoyi Miao[a], Di Guo[a], Hongyun Li[a]. (a. Department of Respiratory and Critical Care Medicine, The Fifth Affiliated Hospital of Zhengzhou University, Zhengzhou, 450052, China, b. Department of Light Chemical Engineering, School of Textiles, Zhongyuan University of Technology, Zhengzhou, 450007, China, c. The Affiliated Children Hospital of Xi'an Jiaotong University, Xi'an, 710002, China, d. Department of Endocrinology of People's Hospital of Zhengzhou University, Henan Provincial People's Hospital, Zhengzhou, 450008, China). The endocytosis of nano-Pt into non-small cell lung cancer H1299 cells and intravital therapeutic effect in vivo. Biochemical and Biophysical Research Communications, Volume 606, (2022): 80-86

Lung cancer remains the most common fatal malignant disease, and the 5-year survival rate of patients with metastasis is merely 6%. In this research, the platinum nanocluster (short for nano-Pt) was used for optical imaging without the help of other fluorescent probes and possess targeted antitumor activity as well as low systemic toxicity. The endocytic pathway and distribution of nano-Pt in non-small cell lung cancer NSCLC H1299 cells was explored by the means of quantitative and qualitative tests. Furthermore, the targeting capability and antitumor efficiency of nano-Pt was detected by intravital imaging experiment and antitumor experiment.

The research implies that nano-Pt entered H1299 cells dominatingly through macropinocytosis and clathrin-dependent endocytosis pathway, and has significant antitumor efficiency, targeting properties and reliable safety for mouse tumor, indicating this nano-Pt has great potential for clinical diagnosis and therapy of NSCLC H1299 cells.

Keywords: Nano Biotechnology

Shaodan Wang[a], Shaolin Xie[ab], Chaonan Zhang[a], Zhengkun Pan[a], Di Sun[a], Aiguo Zhou[ab], Guohuan Xu[c], Jixing Zou[ab]. (a. Joint Laboratory of Guangdong Province and Hong Kong Region on Marine Bioresource Conservation and Exploitation, College of Marine Sciences, South China Agricultural University, Guangzhou, 510642, China, b. Guangdong Laboratory for Lingnan Modern Agriculture, South China Agricultural University, Guangzhou, 510642, China, c. State Key Laboratory of Applied Microbiology Southern China, Guangdong Provincial Key Laboratory of Microbial Culture Collection and Application, Institute of Microbiology, Guangdong Academy of Sciences, Guangzhou, 510070, China). Interactions effects of nano-microplastics and heavy metals in hybrid snakehead. Fish & Shellfish Immunology, Volume 124(2022): 74-81

The interaction between microplastics and contaminants has potentially generated new undefined risks on animals and ecosystems, and nano-microplastics are considered to be more harmful than microplastics. This experiment investigated the interactions and effects of nano-microplastics with heavy metals cadmium in hybrid snakehead. Different concentrations of nano-microplastics 80 nm (50 μg/L and 500 μg/L) and Cd (50 μg/L) were used for exposure, and four sampling points were set for 24 h, 48 h, 96 h and clear-48 h. Results indicated that the morphology of gill was altered under the influence of nano-microplastics and cadmium, and the damage was aggravated with time. Nano-microplastics and Cd can cause oxidative damage to fish liver partly by effect the activities of antioxidant enzyme, and significantly suppressed the expressions of genes related to the inflammation (IL-1β and TNF-α) and as well as significantly up-regulated the expression of genes HSP70 and SOD. Additionally, the mRNA levels of MT gene can be speculated that the heavy metal cadmium may accumulated in the body over time. And the concentration of heavy metals will also affect their accumulation in the body. Our study elucidated the nano-microplastics and Cd will increase the impact on environmental and organisms that the nano-microplastics contribute to the bioaccumulation of metals, which served as a new support for study the interaction between environmental contaminants.

Keywords: Nano Biotechnology

Fanglin Gong[a], Zibin Wang[a], Rui Mo[a], Yutong Wang[c], Jin Su[a], Xianglong Li[a], Charos Tuychi Qizi Omonova[a], Amari Mohamed Khamis[a], Qing Zhang[d], Mei Dong[bc], Zhigui Su[a]. (a. State Key Laboratory of Natural Medicines, Center of Advanced Pharmaceuticals and Biomaterials, School of Pharmacy, China Pharmaceutical University, Nanjing 210009, PR China, b. Jiangsu Provincial Enginerring Research Center of TCM External Medication Development and Application, Nanjing University of Chinese Medicine, Nanjing 210023, PR China, c. School of Pharmacy, Nanjing University of Chinese Medicine, Nanjing 210023, PR China, d. Department of Urology, Affiliated Drum Tower Hospital, Medical School of Nanjing University, Institute of Urology, Nanjing University, PR China). Nano-sponge-like liposomes remove cholesterol crystals for antiatherosclerosis. Journal of Controlled Release, Volume 349(2022): 940-953

Atherosclerotic cardiovascular diseases remain the leading causes of morbidity and mortality worldwide. Cholesterol crystals in atherosclerotic plaques play an essential role in atherosclerosis progression. However, no clinical drugs have been used for removing cholesterol crystals from plaque to counter atherosclerosis. Previous studies identified the hydrophobic domain of lipid bilayer in liposomes acted as sinks for solubilizing hydrophobic cholesterol. Moreover, adjusting the composition of the lipid bilayer in liposomes can enhance its hydrophobic molecule loading capacity. Therefore, in this study, ginsenosides Rb1 (Rb1), one of main active components of ginseng which has a similar structure to cholesterol, is anchored into soy phospholipids bilayer with its hydrophobic region to prepare nano-sponge-like liposomes (Rb1-LPs), aiming to amplify the solubilization of cholesterol in lipid bilayer. For targeting delivery to atherosclerotic plaques, Annexin V (AnxV), a protein that can specifically recognize phosphatidylserine upregulated in atherosclerotic plaques, is applied to decorate the surface of Rb1-LPs by click reaction to obtain the final preparation of AnxV-Rb1-LPs. The in vitro studies showed that incorporating Rb1 into lipid bilayer remarkably increased the affinity of the lipid bilayer to free cholesterol and the solubilization of cholesterol crystals. Additionally, nano-sponge-like liposomes could efficiently reduce the accumulation of cholesterol crystals and improve cholesterol efflux, finally inhibiting inflammation and apoptosis in cholesterol-laden cells. Furthermore, AnxV-Rb1-LPs could efficiently accumulate in atherosclerotic plaques after intravenous injection, exert nano-sponge-like functions to remove intra- and extracellular cholesterol crystals, ultimately alleviating inflammation and apoptosis in atherosclerotic plaques for antiatherosclerosis. Therefore, AnxV-Rb1-LPs provide a potential strategy for removing cholesterol crystals in atherosclerotic plaques and can be further utilized in other diseases with excessive cholesterol accumulation.

Keywords: Nano Biotechnology

Biomimicry

Jan-Hendrik Groth[ac], Mirco Magnini[b], Christopher Tuck[c], Adam Clare[a.] (a. Advanced Manufacturing Group, Faculty of Engineering, The University of Nottingham, NG7 2RD Nottingham, UK, b. Fluids and Thermal Engineering Research Group, Faculty of Engineering, The University of Nottingham, Nottingham, NG7 2RD, UK, c. Centre for Additive Manufacturing, Faculty of Engineering, The University of Nottingham, Nottingham, NG7 2RD, UK). **Stochastic design for additive manufacture of true biomimetic populations. Additive Manufacturing, Volume 55(2022):102739**

Current biomimetic designs do not incorporate naturally occurring variance. Instead, the same unit cell is repeatedly copied and pasted to create a pattern. Existing stochastic designs use the same randomness for all parameters. However, nature teaches us that unit cells vary over several geometry defining parameters and that unit cells rarely overlap. Here, we present a methodology where a Gaussian distribution can be superimposed on any regular array of parametric unit cells. The standard deviation controls the randomness. The distance between unit cells is evaluated and used to define different parameters. This allows using different randomness for each parameter and prevents overlaps. Aspect ratios are introduced to define interdependent parameters. The methodology presented here provides a template for researchers to more accurately mimic the engineering performance of biological structures across multi-physics problems. This new design methodology lends itself perfectly to additive manufacturing.

Keywords: Biomimetics, True biomimicry, Stochastic design, Additive manufacturing

Yuhe Yang[a], Jingdong Rao[a], Huaqian Liu[a], Zhifei Dong[ab], Zhen Zhang[a], Ho-Pan Bei[a], Chunyi Wen[a], Xin Zhao[a].(a. Department of Biomedical Engineering, The Hong Kong Polytechnic University, Hung Hom, Hong Kong, China, b. Faculty of Science, University of Waterloo, Waterloo, Ontario, Canada). Biomimicking design of artificial periosteum for promoting bone healing. Journal of Orthopaedic Translation, Volume 36(2022): 18-32

Background

Periosteum is a vascularized tissue membrane covering the bone surface and plays a decisive role in bone reconstruction process after fracture. Various artificial periosteum has been developed to assist the allografts or bionic bone scaffolds in accelerating bone healing. Recently, the biomimicking design of artificial periosteum has attracted increasing attention due to the recapitulation of the natural extracellular microenvironment of the periosteum and has presented unique capacity to modulate the cell fates and ultimately enhance the bone formation and improve neovascularization.

Methods

A systematic literature search is performed and relevant findings in biomimicking design of artificial periosteum have been reviewed and cited.

Results

We give a systematical overview of current development of biomimicking design of artificial periosteum. We first summarize the universal strategies for designing biomimicking artificial periosteum including biochemical biomimicry and biophysical biomimicry aspects. We then discuss three types of novel versatile biomimicking artificial periosteum including physical-chemical combined artificial periosteum, heterogeneous structured biomimicking periosteum, and healing phase-targeting biomimicking periosteum. Finally, we comment on the potential implications and prospects in the future design of biomimicking artificial periosteum.

Conclusion

This review summarizes the preparation strategies of biomimicking artificial periosteum in recent years with a discussion of material selection, animal model adoption, biophysical and biochemical cues to regulate the cell fates as well as three types of latest developed versatile biomimicking artificial periosteum. In future, integration of innervation, osteochondral regeneration, and osteoimmunomodulation, should be taken into consideration when fabricating multifunctional artificial periosteum.

The Translational Potential of this Article: This study provides a holistic view on the design strategy and the therapeutic potential of biomimicking artificial periosteum to promote bone healing. It is hoped to open a new avenue of artificial periosteum design with biomimicking considerations and reposition of the current strategy for accelerated bone healing.

Keywords: Artificial periosteum, Biomimicking design, Biochemical biomimicry, Biophysical biomimicry, Bone regeneration

Alessandro Parodi[ab], Dmitry Kostyushev[acd], Sergey Brezgin[acd], Anastasiya Kostyusheva[cd], Tatiana Borodina[ae], Roman Akasov[be], Anastasia Frolova[ab], Vladimir Chulanov[acd], Andrey A.Zamyatnin Jr.[abfg] (a. Scientific Center for Genetics and Life Sciences, Division of Biotechnology, Sirius University of Science and Technology, 354340 Sochi, Russia, b.

Institute of Molecular Medicine, Sechenov First Moscow State Medical University, 119991 Moscow, Russia, c. National Medical Research Center of Tuberculosis and Infectious Diseases, Ministry of Health, 127994 Moscow, Russia, d. Infectious Diseases Depaertment, Sechenov First Moscow State Medical University, 119991 Moscow, Russia, e. Federal Scientific Research Centre "Crystallography and Photonics" of Russian Academy of Sciences, 119333 Moscow, Russia, f. Belozersky Institute of Physico-Chemical Biology, Lomonosov Moscow State University, 119992 Moscow, Russia, g. Faculty of Health and Medical Sciences, University of Surrey, Guildford UK GU2 7X, United Kingdom). Biomimetic approaches for targeting tumor-promoting inflammation. Seminars in Cancer Biology, Volume 86, Part 2 (2022): 555-567

With the ultimate goal of increasing tumor accumulation of therapeutics, various nanocarriers have been designed to overcome biological barriers encountered at each stage, from drug administration to the cancerous lesion. Stabilizing circulation and functionalization of the targeting surface impart high tumor accumulation properties to nanocarriers. However, various cells can recognize and infiltrate the tumor microenvironment more efficiently than synthetic carriers via overexpression of adhesive ligands, particularly in inflamed stroma of tumors. Thus, a new field of nanomedicine, called biomimicry, has evolved to generate nanoparticles with the same biological characteristics as cells that naturally infiltrate tumors. Revolutionary synthetic processes have been developed to transfer the cell membrane of leukocytes and mesenchymal cells to synthetic carriers. In addition, cells can generate their own "nanocarriers," known as exosomes, to transport molecular messages to distant sites, while biomimicry of viral and bacterial agents allows high targeting efficiency towards inflammatory immune cells. Alterations in the protein expression in cancer cells caused by inflammation can also be exploited for drug delivery. Finally, new developments in biomimetic drug delivery focus on turning the infiltrating cells into microcarriers that can actively perfuse the tumor and eventually release their therapeutic payload. In this review, we summarize recent developments in biomimetic drug delivery with a particular focus on targeting the tumor inflammatory microenvironment.

Keywords: Biomimicry

Aurélien Carré[a], Pierre Gasnier[b], Émile Roux[a], Laurent Tabourot[a,] (a. Université Savoie Mont Blanc, SYMME, F-74000 Annecy, France, b. Université Grenoble Alpes, CEA-LETI, MINATEC, F-38000 Grenoble, France). Extending the operating limits and performances of centimetre-scale wind turbines through biomimicry. Applied Energy, Volume 326(2022): 119996

This paper reports the design and fabrication of an innovative small-size propeller and its experimental testing once assembled with an electromagnetic generator. The bioinspired rotor is based on the shape and behaviour of maple samaras that optimise the aerodynamics at low Reynolds numbers. To the authors' knowledge, it is the first samara-based wind energy harvester reported to date and one of the smallest wind turbines in the literature. The different blade angles and the number of propeller blades are optimised. A permanent magnet miniature generator with low friction ceramic bearings is used to convert rotation into electrical power. The performance of this 44 mm diameter horizontal-axis wind turbine is tested under wind speeds from 1.2 to 8 m s−1. The output electrical power measured in resistive load is between 41 W and 81.7 mW, which leads to an overall efficiency between 2.6 (1.2 m s−1) and 17.8% (4 m s−1). Estimates of different losses in the harvester make it possible to determine power coefficient which reaches 28.4%. Among the miniature wind turbines in the literature, this device demonstrates one of the highest rates in terms of efficiency and power density. Moreover, thanks to its operating speed

decreased to 1.2 m s−1 – the lowest in the state of the art – it presents one of the largest ranges of airspeeds for energy harvesting.

Keywords: Biomimetics, Wind turbine, Centimetre-scale, Energy harvesting, Low wind speeds

Warut Srisuwan[a], Chayodom Sabhasri[d], Nantarika Chansue[b], Thanida Haetrakul[bc]. (a. Technopreneurship and Innovation Management Program, Graduate School, Chulalongkorn University, Chaloem Rajakumari 60 Building, 10th Floor, Phayathai Rd., Phatumwan, Bangkok, 10330, Thailand, b. Veterinary Medical Aquatic Animal Research Center of Excellence (VMARCE), Chulalongkorn University, 39 Henry Dunant Rd., Wangmai, Pathumwan, Bangkok, 10330, Thailand, c. Department of Veterinary Medicine, Faculty of Veterinary Science, Chulalongkorn University, 39 Henry Dunant Rd., Wangmai, Pathumwan, Bangkok, 10330, Thailand, d. Faculty of Economics, Chulalongkorn University, 254 Phayathai Rd., Pathumwan, Bangkok, 10330, Thailand). **Using biomimicry and bibliometric mapping to guide design and production of artificial coral reefs. Marine, Environmental Research, Volume 180(2022): 105685**

Worldwide, artificial reefs are being installed to simultaneously attract recreational divers and protect deteriorating natural reefs. This study uses a bibliometric review of artificial coral reefs to identify five clusters as gate criteria for artificial reef design. These clusters enable the conceptualization and testing of artificial reefs for optimum integration of sociotechnical requirements, biological integrity, and ecological marine health. The five clusters are: (1) applications, solutions, and performance; (2) management, technology, and science; (3) calcification, biomineralization, chemistry, and ocean acidification; (4) coral species survival, mortality, and photosynthesis; and (5) artificial reef development, and coral and fish recruitment. The six biomimicry design stages are: define, biologize, discover, abstract, emulate, and evaluate. The 3D printing and hard corals design attracted a large number of planula larvae and different inhabitant corals, and a high species diversity in the surrounding waters. Practical implications include biomimicry-based means for coral reef restoration and recreational ecosystem services.

Keywords: Artificial coral reef, Artificial habitats, Biomimicry, Bibliometric study, Coastal structures, Innovation, New product development, Recreational waters, Stage-gate, Thailand

Amir Lebdioui[ab]. (a. Department of Development Studies, School of Oriental and African Studies, University of London, United Kingdom, b. Latin American and Caribbean Centre, London School of Economics and Political Science, United Kingdom). **Nature-inspired innovation policy: Biomimicry as a pathway to leverage biodiversity for economic development. Ecological Economics, Volume 202(2022): 107585**

One of the most important challenges of the 21st century is the quest for economic development models that respect the planet's ecosystem. Rather than imposing our industrial systems on nature, why not let nature influence our industrial and innovation systems?

From wind turbine blades to bullet trains and solar cells, many of the technologies we rely on today have been inspired by solutions found in nature. Although relatively widespread in the fields of architecture and engineering, biomimicry/biomimetics remains largely overlooked in economics, public policy, and development studies. This is paradoxical because the world's remaining biodiversity stock-a knowledge bank of solutions to both current and unknown challenges- is largely held in developing economies and can be leveraged as a source of

inspiration for -and entry door to- industrial innovation. This paper, therefore, investigates the relevance of biomimicry in the formulation of sustainable development strategies in biodiverse developing countries and maps out the national policy landscapes that can advance it.

Several findings arise from this study. First, despite the exponential growth of biomimicry as a field and our understanding of its economic impact, what drives nature-inspired innovation remains elusive. Second, the biomimicry innovation landscape is dominated by industrialised economies that have relied on proactive policy interventions, while virtually no developing country has adopted biomimicry as an innovation strategy, consolidating the exploitation of the biodiversity in the developing world by firms in high-income nations. Third, by drawing on empirical evidence from a selection of Latin American countries, this paper shows that while biomimicry presents tremendous opportunities to leapfrog towards high value-added knowledge-intensive activities by using local biodiversity and related expertise as factor endowments, policy, and institutional factors have led to the persistence of important coordination failures that hinder the expansion and commercialization of biomimicry-based R&D. This paper concludes by discussing the public policies needed to support the integration of developing nations at the innovation frontier through biomimicry.

Keywords: Biodiversity, Innovation Economic upgrading, Biomimicry, Ecosystem services, Sustainability economics

Name of Journals

1. Acta Biotechnologica
2. Aerobiologia
3. Annual Review-Plant Pathology
4. Annual Review- Ecology and Systematics
5. Annual Review-Biochemistry
6. Annual Review-Biomedical Engineering
7. Annual Review-Biophysics and Biomolecular Structure
8. Annual Review-Microbiology
9. Annual Review-Pharmacology and Toxicology
10. Annual Review-Phytopathology
11. Annual Review-Physiology
12. Annual Review-Plant Physiology
13. Annual Review-Public Health
14. African Journal of Biotechnology
15. Applied and Environmental Microbiology
16. Applied Microbiology & Biotechnology
17. Aquaculture
18. Allergy
19. Australian Journal of Plant Physiology
20. Biocatalysis and Transformation
21. Biocontrol
22. Biocontrol Potential and its exploitation in sustainable Agriculture
23. Biodegradation
24. Biodeterioration & Biodegradation
25. Biodiversity and Conservation
26. Biological Agriculture and Horticulture
27. Biomass and Bioenergy
28. Biomedical and Environmental Sciences
29. Biomedical Engineering
30. Bioresource Technology
31. Bioscience, Biotechnology and Biochemistry
32. Biosensors-and –Bioelectronics
33. Bioseperation
34. Biotechnolgy Letters
35. Biotechnology Advances
36. Biotechnology and Applied Biochemistry
37. Biotechnology and Bioengineering

38. Botanical Review
39. Canadian Journal of Microbiology
40. Cell & Tissue Banking
41. Clinical Microbiology Reviews
42. Critical Reviews in Biotechnology
43. Crop Research Hisar
44. Current Microbiology
45. Current Opinion in Biotechnology
46. Current Science
47. Cytotechnology
48. Ecology and Environmental Corner
49. Ecological Engineering
50. Ecotoxicology
51. Environmental Conservation
52. Environmental Research
53. Environmental Pollution
54. Enzyme and Microbial Techynology
55. Every Man's Science
56. Environmental Imapct Assessment Review
57. Fems Microbiology & Ecology
58. Food & Agricultural Immunology
59. Global Environmental Change
60. Hydrometallurgy
61. Immunological Research
62. Indian Agriculturist
63. Indian Biologist
64. Indian Farming
65. Indian Journal of Agricultural Science
66. Indian Journal of Biotechnology
67. Indian Journal of Ecology
68. Indian Journal of Experimental Biology
69. Indian Journal of Environmental Toxicology
70. Indian Journal of Environmental Health
71. Indian Journal of Plant Physiology
72. International Biodeterioration & Biodegradation
73. International Journal of Biotechnology
74. International Journal of Phytoremediation
75. Journal of Applied Sciences and Environmental Management
76. Journal of Agriculture and Environmental Ethics
77. Journal Biological Control
78. Journal of Bacteriology
79. Journal of Chemical Technology & Biotechnology

80. Journal of Environmental Management
81. Journal of Food Science and Technology-Mysore
82. Journal of Hazardous Materials
83. Journal Indian Association Environment Management
84. Journal Indian Pollution Control
85. Journal of Indian Soil Science
86. Journal of Industrial Microbiology & Biotechnology
87. Journal of Scientific and Industrial Research
88. Microbial Review
89. Microbiological Research
90. Molecular Biotechnology
91. Mycological Research
92. Mycorrhizal Biology
93. Nature
94. Nature Biotechnology
95. New Biotechnology
96. Perspectives-in-Biotechnology
97. Pesticide research Journal
98. Pestology
99. Plants and Soil
100. Process Biochemistry
101. Pollution
102. Pollution Research
103. Reviews in Environmental Science and Biotechnology
104. Research Journal Chemistry & Environment
105. Sciences
106. Science & Culture
107. Shaspa
108. The Indian Forester
109. Trends in Biotechnology
110. Water, Air and Soil Pollution
111. World Journal of Biotechnology
112. World Journal of Microbiology and Biotechnology
113. Bio-metallurgy and Hydro-metallurgy
114. Nano Biotechnology

Authors Index