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ENVIS RESOURCE PARTNER

On

ENVIRONMENTAL BIOTECHBNOLOGY

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BACKGROUND

Environmental Information System (ENVIS) is established in the year 1984 as a network of Information Centers. It is planned by the Ministry of Environment and Forest. Aim of this centre is to provide descriptive and environmental subject related numerical data.

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

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

This is the 39th publication of Abstract Volume of this ENVIS Resource Partner. This contains the abstracts of research papers collected from the various areas of Environmental Biotechnology from different journals published in last six months up to December 2021. In this issue, various topics like Bioenergy, Bioengineering, Bio-degradation, Bio-remediation, Bio-transformation etc. have been covered. We are grateful to the various libraries and their staff for their cooperation extended to us during the collection of the articles.

Abstract Format

The format of the abstract is as follows:

Abstract: *The abstracts are arranged in different subheads.*

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

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

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

GENERAL INFORMATION

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

Abstract are broadly classified and arranged under the following 15 heads:

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

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

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

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

Bio-Transformation: This is a process of Biological changes of complex compounds to simpler one or toxic to non-toxic and vice-versa. Several microorganisms are capable of transforming a verity of compounds found in nature but generally in case of synthetic compounds they are unable to show any

appropriate action. Biotransfer appears to be one of the major detoxication methods known so far

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

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

1. Bacterial Biofertilizer
2. Algal Biofertilizer

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

Biopesticide: Pest control by biological antagonism appears to be very useful tool in recent years. Bacterial pesticides are being developed. Heliothis complex, which lives in close association with plant roots, consists of two major crop pests'

budworm and ball warm. Biological insecticides against both these insects are being prepared by transfer of a gene from Bacillus thuringiensis

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

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

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

Biosensor: Biosensor represents biophysical devices, which can detect the presence and measure the quantities of specific substances in a verity of environments. These specific substances may include sugars, proteins, or humas and verity 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 specialty featuring a multidisciplinary approach to the solution of problems in medicine and biology, based on the application of advances in science, engineering and technology. It generally engineers the biological processes through biotechnological or genetic engineering interventions. It may also be broad-based engineering disciplines that involve product design, sustainability and analysis of biological systems.

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

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

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

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

Nano Biotechnology: Bionanotechnology, nanobiotechnology, and nanobiology are terms that refer to the intersection of nanotechnology and biology. Given that the subject is one that has only emerged very recently, bionanotechnology and nanobiotechnology serve as blanket terms for various related technologies. This discipline helps to indicate the merger of biological research with various fields of nanotechnology. Concepts that are enhanced through nanobiology include: nanodevices, nanoparticles, and nanoscale phenomena that occurs within the disciple of nanotechnology. This technical approach to biology allows scientists to imagine and create systems that can be used for biological research

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

ABBREVIATIONS USED IN ADDRESSES AND CITED JOURNALS

Acad	Adm	Admn	Adv
Agri	Agricl	Amer	An
Analyt	Anat	Anim	Ann
Appl	Arch	Archaeo	Archaeol
Architect	Assoc	Asst	Atom
Bacterio	Bacteriol	Bd	Bio
Biochem	Biocheml	Bioengg	Biol
Biometeo	Biophys	Biometeol	Biotech
Biotechno	Biotechnol	Bldg	Bot
Botl	Br	Bull	Cent
Centl	Academy	Administration	Administrative

Advance	Agriculture	Agricultural	American
Annual	Analytical	Anatomy	Animal
Annals	Applied	Archives	Archaeology
Archaeological	Architecture	Association	Assistant
Atomic	Bacteriology	Bacteriological	Board
Biology	Biochemistry	Biochemical	Bioengineering
Biological	Biometeorology	Biophysics	Biometeorological
Biotechnique(s)	Biotechnology	Bitechnological	Building
Botany	Botanical	Branch	Bulletin
Centre	Central	Chem	Cheml
Clinl	Co	Coll	Comm
Commn	Comp	Conf	Conv
Conserv	Contl	Contam	Corpn
Coun	Cult	Cultl	Curr
Chemistry	Chemical	Clinical	Company
College	Committee	Commission	Comparative
Conference	Convention	Conservation	Control
Contamination	Corporation	Council	Culture
Cultural	Current	Department	Development
Developmental	Digest	Division	Divisional
Directorate	Deputy	Dept	Dev
Develop	Dig	Div	lDte
Dy	Eco	Ecol	Econ
Ecosys	Ecotoxico	Endocrinol	Engg
Engrs	Env	Environ	Epidemic
Epidemiol	Estd	Ethnopharmaco	Expt
Ecology	Ecological	Economics	Ecosystem
Ecotoxicology	Endocrinological	Engineering	Engineers
Environment	Environmental	Epidemiology	Epidemiological
Establishment	Ethnopharmacology	Experiment	Exptl
Experimental	Fac	Fd	Fedn
Fert	Fmg	Faculty	Food
Federation	Fertiliser	Farming	Gaz
Genet	Geo	Geogr	Geogrl
Geol	Geosci	Govt	Gazette
Genetics	Geology	Geography	Geographical
Geological	Geoscience	Government	Hist
Hlth	Hort	Hosp	Hydro
Hydrol	History	Health	Horticulture
Hospital	Hydrology	Hydrological	Immuno
Immunol	Ind	Inf	Inst
Instn	Int	Irrig	Immunology
Immunlogical	Industry	Information	Institute
Institution	International	Irrigation	Journal
Lab	Lett	Ltd	Laboratory
Letter(s)	Limited	Malario	Malariol
Manag	Med	Medl	Metab

Metall	Metallurg	Meteo	Meteol
Microbio	Malariology	Malariological	Management
Medicine	Medical	Metabolism	Metallurgy
Metallurgical	Meteorology	Meteorological	Microbiology
Microbiol	Min	Monit	Myco
Mycol	Microbiological	Ministry	Monitoring
Mycology	Mycological	Nat	Natl
N-E	Nut	No	Natural
National	North Eastern	Nutrition	Number
Occ	Occassional	Occupational	Oceanogoraphy
Original	Organic	Organisation	Occupl
Oceanogr	Org	Orgc	Orgn
Pharmaco	Pharmacol	Phyl	Patho
Pathol	Petrochem	Petro	PG
Phys	Physio	Phytopath	Phytopathol
Plang	Polln	Proc	Prot
Pub	Pvt	Pharmacology	Pharmacological
Physical	Pathology	Pathological	Petrochemical
Petrology	Post Graduate	Physics	Physiology
Phytopathology	Phytopathological	Planning	Pollution
Proceedings	Protection	Publication	Private
Qlty	Qr	Quality	Quarter
Rad	Radio	Radiol	Rd
Recd	Reg	Regl	Radiation
Radiology	Radiological	Road	Received
Region	Regional	Rep	Reptr
Res	Rev	Report	Reporter
Research	Review	Sch	Sci
Scient	S-E	Sec	Sect
Semin	Ser	Soc	Socl
Stat	Statl	Stnd	Stud
School(s)	Sciences(s)	Scientific	South East
Section	Sector	Seminar	Services
Society	Social	Statistics	Statistical
Standard(s)	Study/ (eis)	Surv	Syst
Survey	System	Tax	Techl
Techno	Technol	Toxico	Toxicol
Transc	Transpt	Trng	Trop
Taxonomy	Technical	Technology	Technological
Toxicology	Toxicological	Transcations	Transportation
Training	Tropical	Univ	Util
University	Utilisation	Vet	Veterinary
Zoo	Zool	Zoology	Zoological

Bioaccumulation

Bingbing Sun, Eddy Y.Zeng (Guangdong Key Laboratory of Environmental Pollution and Health, School of Environment, Jinan University, Guangzhou, 511443, China) Leaching of PBDEs from microplastics under simulated gut conditions: Chemical diffusion and bioaccumulation Environmental Pollution Volume 292, Part A, January 2022, 118318

Considerable efforts on exposure assessment of microplastics (MPs) as an agent in transport of toxic contaminants have been performed in organisms. However, chemical diffusion of inherent hydrophobic organic contaminants from MPs under simulated gut conditions is poorly examined. The present study examined the transfer kinetics of polybrominated diphenyl ethers (PBDEs) from polystyrene (PS), acrylonitrile butadiene styrene (ABS), and polypropylene (PP) MPs under gut surfactants (sodium taurocholate) at two relevant body temperatures of marine organisms, and evaluated the importance of MP ingestion in bioaccumulation of PBDEs in lugworm by a biodynamic model. Diffusion coefficients of PBDEs range from 5.82×10^{-23} to 7.96×10^{-20} m^2 s^{-1} in PS, 5.49×10^{-23} to 3.45×10^{-20} m^2 s^{-1} in ABS, and 5.58×10^{-21} to 5.79×10^{-17} m^2 s^{-1} in PP, with apparent activation energies in the range of 33–148 kJ mol−1. The biota–plastic accumulation factors of PBDEs leached from these plastics range from 1.44×10^{-8} to 7.15×10^{-5}. Although ingestion of MPs with the common size (>0.5 mm) showed the negligible contribution to bioaccumulation of PBDEs in lugworm, their contribution in PBDEs transfer can be increased with gradual breakdown of MPs.

Keywords: Microplastics, Polybrominated diphenyl ethers, Transfer kinetics, Diffusion coefficient, Bioaccumulation

FilipeCosta[a], João P.Coelho[b], Joana Baptista[a], FilipeMartinho[a], Eduarda Pereira[c], Miguel A.Pardal[a] (a. Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal, b. Department of Biology, CESAM, ECOMARE, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal, c. Department of Chemistry, REQUIMTE, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal) Lifelong mercury bioaccumulation in Atlantic horse mackerel (Trachurus trachurus) and the potential risks to human consumption, Marine Pollution Bulletin, Volume 173, Part A, December 2021, 113015

Atlantic horse mackerel is one of the most commercially important species in Europe. It can reach a longevity of 30 years, with potential implications in lifespan mercury contamination. This study conducted along the Portuguese coast aimed at evaluating the total Hg content and tissue distribution, to determine the annual mercury bioaccumulation patterns and the associated risk for consumption. The T-Hg accumulation patterns observed followed the order: muscle (0.34) > liver (0.28) > heart (0.19) > gills (0.11) > brain (0.041 mg kg−1). Significant differences between tissues reflect the role of the different tissues in storage and redistribution. Significant relationships observed between age and T-Hg for all tissues highlight the continuous nature of the bioaccumulation process. European food safety guidelines signalled significant risk of consumption in about 30% of the samples. Still, there was an overall low risk from the consumption of this species, which can be further minimized through consumer options to avoid health issues.

Keywords: Trachurus trachurus, Mercury, Lifespan bioaccumulation, Tissue distribution, Food safety

Xujia Wu, Pei Huang, Chenyang Dong, Xu Deng (College of Life Sciences and Oceanography, Shenzhen University, Shenzhen 518060, China) Nickel bioaccumulation by a marine bacterium Brevibacterium sp. (X6) isolated from Shenzhen Bay, China, Marine Pollution Bulletin Volume 170, September 2021, 112656

Nickel bioaccumulation capacity of a marine Brevibacterium sp., designated as X6, was evaluated to explore its potential application in the bioremediation of Ni2+ pollutants in marine environments. The minimum Ni2+ inhibitory concentration and maximum Ni2+ bioaccumulation of X6 were 1000 mg/L and 100.95 mg/g, respectively, higher than most reported strains. Among the co-existing metal ions in seawater, K+ caused a slight adverse impact on Ni2+ uptake, followed by Na+ and Ca2+, whereas Mg2+ drastically inhibited Ni2+ bioaccumulation. Other heavy metals such as Co2+, Zn2+ and Cd2+ moderately affected Ni2+ binding, but the adverse effect of Cu2+ was severe. The investigation of the mechanism of Ni2+ bioaccumulation revealed that 66.34% of the accumulated Ni2+ was bound to the cell surface. Carboxylic, hydroxyl, amino and thiol groups participated in Ni2+ binding, while carboxylic group contributed the most, while thiol group may be more involved in Ni2+ binding at low Ni2+ concentrations.

Keywords: Bioaccumulation, Brevibacterium sp., Marine bacterium, Nickel ion, Heavy metal pollution

Julie Jarjour[a], Bei Yan[a], Gabriel Munoz[b], Mélanie Desrosiers[c], Sébastien Sauvé[b], Jinxia Liu[a] (a. Department of Civil Engineering, McGill University, Montréal, QC, Canada, b. Department of Chemistry, Université de Montréal, Montréal, QC, Canada, c. Centre d'expertise en analyse environnementale du Québec, ministère de l'Environnement et de la Lutte contre les changements climatiques, Québec, QC, Canada) **Reduced bioaccumulation of fluorotelomer sulfonates and perfluoroalkyl acids in earthworms (Eisenia fetida) from soils amended with modified clays, Journal of Hazardous Materials, Volume 423, Part A, 5 February 2022, 126999**

Soils contaminated by per- and polyfluoroalkyl substances (PFAS) pose long-term sources to adjacent water bodies and soil invertebrates. The study investigated the stabilization using a modified clay adsorbent (FLUORO-SORB100®) in reducing the bioaccumulation of 13 anionic PFAS by earthworms (Eisenia fetida), as compared to coal-based granular activated carbon. The target PFAS included four perfluoroalkyl sulfonates such as perfluorooctane sulfonate (PFOS), six perfluoroalkyl carboxylates (e.g., perfluorooctanoate PFOA), and three (X:2) fluorotelomer sulfonates. Laboratory-spiked surface soil and the soil collected from a site contaminated by aqueous film-forming foams were examined. Both adsorbents resulted in reduced earthworm PFAS body burdens at the end of the 28-day uptake phase. The highest adsorbent amendment concentration (4 w/w%) was most effective, achieving >95% reduction of PFAS body burden. Soil leaching tests indicated better immobilization performance by the clay adsorbent for most analytes; in comparison, the activated carbon performed better at reducing total PFAS body burdens, possibly owing to the avoidance of larger-sized particles by earthworms. Strong positive logarithm relationships were observed between leachate concentrations and earthworm body burdens for most PFAS in the spiked soil. The study demonstrated that stabilization of PFAS using modified clay adsorbents can achieve concurrent benefits of lowering leachability and reducing bioaccumulation.

Keywords: PFAS, Aqueous film-forming foams (AFFFs), Earthworm bioaccumulation, Modified clays, Soil amendment

M.C.Mata[a], V.Castro[b], J.B.Quintana[b], R.Rodil[b], R.Beiras[a], L.Vidal-Liñán[a] (a. ECIMAT-CIM, University of Vigo, Illa de Toralla s/n, Vigo E-36390, Galicia, Spain, b. Department of Analytical Chemistry, Nutrition and Food Sciences, IAQBUS - Institute of Research on Chemical and Biological Analysis, Universidade de Santiago de Compostela, Constantino Candeira 5, Santiago de Compostela E-15782, Galicia, Spain) **Bioaccumulation of organophosphorus flame retardants in the marine mussel Mytilus galloprovincialis, Science of The Total Environment, Volume 805, 20 January 2022, 150384**

The bioaccumulation and depuration of seven organophosphorus flame retardants (OPFRs) in marine mussel Mytilus galloprovincialis were studied. OPFRs showed to be bioavailable in aquatic environments. When mussels are exposed to environmentally relevant concentrations of OPFRs, uptake kinetics fit well to a first-order model with a single compartment; in contrast depuration rates were generally underestimated by that

model, most likely because it does not take into account the biotransformation of OPFRs by the organisms. The highest bioaccumulation rates were observed for tricresyl phosphate (TCrP), triphenyl phosphate (TPhP) and 2-ethylhexyldiphenylphosphate (EHDPP). This could be due to the presence of aryl groups in these compounds, their low solubility in water, and their affinity for fat tissues. According to these findings TCrP, with a BCF value of 4042 L kg−1 wet weight, should be classified in environmental regulations as an accumulative chemical.

Keywords: OPFRs, MSPD, Kinetics, Kow

Peng Liu[ab], Xiaowei Wu[b], Huanhuan Shi[c], Hanyu Wang[b], Hexinyue Huang[b], Yanqi Shi[b], Shixiang Gao[b] (a. Key Laboratory of Plant Nutrition and the Agri-Environment in Northwest China, Ministry of Agriculture, College of Natural Resources and Environment, Northwest A&F University, Yangling, Shaanxi, 712100, China, b. State Key Laboratory of Pollution Control and Resource Reuse, School of the Environment, Nanjing University, Nanjing, 210093, China, c. School of Ecology and Environment, Zhengzhou University, Zhengzhou, Henan, 450001, PR China) **Contribution of aged polystyrene microplastics to the bioaccumulation of pharmaceuticals in marine organisms using experimental and model analysis, Chemosphere, Volume 287, Part 4, January 2022, 132412**

Microplastics (MPs) in the environment would undergo extensive weathering, which can act as a vector affecting the accumulation of pollutants in organisms. However, the risk of organic pollutants adsorbed on aged MPs to marine organisms is poorly understood. This study revealed the contribution of aged polystyrene (PS) MPs to the total bioaccumulation of atorvastatin (ATV) and amlodipine (AML), and assessed the environmental risks via experimental and model analysis. The results showed that pharmaceuticals were more easily released in gastrointestinal fluids from aged MPs relative to that in simulated seawater. The hydrophobic pharmaceuticals were more bioaccessible than hydrophilic ones by organisms. Model analysis showed that ingestion of water and food were the most important uptake routes for pharmaceuticals in marine fish and seabirds, while aged PS MPs could decrease the bioaccumulation of pharmaceuticals (contributed for −2.9% and −1.2% for the total uptake of ATV, and −25.8% and −4.4% for AML), indicating the cleaning effect of aged MPs, and the potential higher exposure risks of pharmaceuticals in warm-blooded organisms than that in cold-blooded ones via ingested MPs. The study revealed the effect of aged MPs to the bioaccumulation of pharmaceuticals in marine organisms, and highlighted the combined risks of aged MPs and pharmaceuticals in the environment.

Keywords: Aged MPs, Gastrointestinal tract, Pharmaceuticals, Risks, Bioaccumulation model

Liqiang Zhao[a], Feng Yang[b], Xiwu Yan[b] (a. College of Fisheries, Guangdong Ocean University, Zhanjiang 524088, China, b. College of Fisheries and Life Science, Dalian Ocean University, Dalian 116023, China) **Eutrophication likely prompts metal bioaccumulation in edible clams, Ecotoxicology and Environmental Safety, Volume 224, November 2021, 112671**

Coastal eutrophication is an indisputable reality and becoming a worldwide concern. However, whether and how eutrophication affects metal bioaccumulation in marine bivalves have not yet been elucidated. Here, we present the potential influence of coastal eutrophication on metal bioaccumulation in the Manila clam Ruditapes philippinarum. The degree of coastal eutrophication was examined monthly over a 1-year period at three sampling sites. The bioconcentration factor (BCF), biosediment accumulation factor (BSAF) and metal pollution index (MPI) were applied to evaluate the efficiency of metal bioaccumulation in R. philippinarum. BCF and BSAF indicated that eutrophication did not significantly affect the bioaccumulation of Cr, Cu, Zn, Cd, Pb, Hg, and As in R. philippinarum. However, up to 56% of MPI variation can be related to the level of eutrophication. Therefore, further research should address the synergistic effects of eutrophication and metal pollution on coastal ecosystems.

Keywords: Eutrophication, metal pollution, Metal bioaccumulation, Bivalves, Ruditapes philippinarum

Tao Sun[ad], Shuang Wang[ad], Cheng long Ji[abc], Fei Li[ac], Huifeng Wu[abc] (a. CAS Key Laboratory of Coastal Environmental Processes and Ecological Remediation, Yantai Institute of Coastal Zone Research (YIC), Chinese Academy of Sciences (CAS); Shandong Key Laboratory of Coastal Environmental Processes, YICCAS, Yantai, 264003, PR China, b. Laboratory for Marine Fisheries Science and Food Production Processes, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266237, PR China, c. Center for Ocean Mega-Science, Chinese Academy of Sciences (CAS), Qingdao 266071, PR China, d. University of Chinese Academy of Sciences, Beijing 100049, PR China) **Microplastics aggravate the bioaccumulation and toxicity of coexisting contaminants in aquatic organisms: A synergistic health hazard, Journal of Hazardous Materials, Volume 424, Part B, 15 February 2022, 127533**

There are ongoing controversies regarding the effects of microplastics (MPs) on the bioaccumulation and toxicity of coexisting contaminants in aquatic organisms. This study aims to quantitatively evaluate this issue based on 870 endpoints from 40 publications. It was shown that the presence of MPs significantly increased the bioaccumulation of co-contaminants by 31%, with high statistical power and without obvious publication bias. The aggravated bioaccumulation was also revealed by the strongly positive correlation between bioconcentration factors in the presence and the absence of MPs. Furthermore, the subgroup/regression analyses indicated that the vector effect of MPs on other chemicals was affected by multiple factors and their interactions, such as particle size and exposure time. In addition, a relatively comprehensive biomarker profile was recompiled from included studies to assess the changes in toxicity caused by combined exposure. Results confirmed that the presence of MPs obviously exacerbated the toxicity of co-contaminants by 18%, manifested by the potentiated cytotoxicity, endocrine disruption, immunotoxicity and oxidative stress, implying a synergistic health hazard. Ultimately, the mismatches between laboratory and field conditions were discussed, and the recommendations for future research were offered.

Keywords: Microplastics, Combined exposure, Bioaccumulation, Synergistic effect, Meta-analysis

Bioremediation

Tarek A.A.Moussa, Neveen M.Khalil (Botany and Microbiology Department, Faculty of Science, Cairo University, Giza, Egypt) **Chapter 10 - Extremozymes from extremophilic microorganisms as sources of bioremediation, Microbial Extremozymes, Novel Sources and Industrial Applications 2022, Pages 135-146**

Extremophiles are a group of organisms growing in a wide range of extreme environmental conditions. The extremophilic microorganisms are diverse and are classified into psychrophiles (− 2°C to 20°C), thermophiles (55–121°C), piezophiles (> 500 atm), halophiles (2–5 M NaCl or KCl), metallophiles (high concentrations of metals, e.g., copper, zinc, lead, cadmium, and arsenic), alkaliphiles (pH > 8), and acidophiles (pH < 4) according to the extreme environmental conditions in which they grow and can tolerate. The aims of this chapter are to characterize the extremophilic microorganisms and their physiological and molecular efficiencies in bioremediation processes. Interestingly, the remarkable adaptative abilities of extremophilic microorganisms make them an attractive source of biocatalysts for bioremediation. Bioremediation is an important technology for the cleanup of environmental contaminants. Further attention has also been directed to isolation, identification, and characterization of biocatalysts from extremophilic microorganisms, most of them enzymes named extremozymes, which are well adapted to be active also at extreme conditions. Extremozymes are expected to fill the gap between biological and chemical industrial processes because of the remarkable properties of these enzymes. Even though more than 3000 different enzymes have been identified till now, and many of these were used in industrial and biotechnological applications, the enzyme toolbox at the present is still not enough to present demands. A major cause for this is the fact that many available enzymes do not withstand industrial reaction conditions.

Keywords: Bioremediation techniques, Microbial bioremediation, Extreme conditions, Extremophiles bioremediation, Extremozymes bioremediation

Valeria Ancona[a], Ida Rascio[ab], Giorgia Aimola[a], Anna Barra Caracciolo[c], Paola Grenni[c], Vito F.Uricchio[a], Domenico Borello[ad] (a. a Water Research Institute-Italian National Research Council, Bari, BA, Italy, b. b Department of Soil, Plant and Food Sciences, University of Bari, Bari , Italy, c. c Water Research Institute-Italian National Research Council, Monterotondo, RM, Italy, d. d Department of Mechanical and Aerospace Engineering, Sapienza University of Rome, RM, Italy) **Chapter 2 - Plant-assisted bioremediation: Soil recovery and energy from biomass, Assisted Phytoremediation, 2022, Pages 25-48**

Bioremediation technologies are useful and sustainable solutions for recovering pollutants from ecosystems. In particular, the plant-assisted bioremediation or phyto-assisted bioremediation (PABR) strategy, relying on the synergistic actions between plant root system and natural microorganisms (bacteria and fungi), can be effective for stabilizing, storing, and degrading contaminants of polluted soils. Plant species through release of root exudates can stimulate biodegradation activity of natural soil microorganisms in the rhizosphere. The use of organic amendments (e.g., biochar, compost) in PABR applications can also be useful for enhancing plant growth, soil quality and increase the biodegradation of some contaminants. Moreover, PABR technology produces biomass, a by-product, which can be profitably valorised for producing energy in line with a circular economy. Deeper investigations on the overall processes in order to improve PABR effectiveness and ensure its zero impact on environment are desirable.

Keywords: Root exudates, Microbial community characterization, Energy production, Biomass, Heavy metal phytoremediation, Persistent organic contaminant remediation, Organic amendments, Phyto-assisted bioremediation, Circular Economy

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As a consequence of development and industrialization, the excessive use of toxic organic and inorganic chemicals as well as heavy metals, has caused an uncontrolled accumulation of chemical waste in soil, water and air. Today, it has become a global issue since all living things suffer as a result of direct or indirect exposure to these chemicals. Bioremediation is a sustainable and economical solution to this environmental problem, where microorganisms in the ecosystem are used to convert and/or degrade and/or remove pollutants. This chapter summarizes the role of plant growth-promoting rhizbacteria as biological control agents in the biosorption of soil contaminants, including heavy metals and organic compounds. The bioremediation approaches are explained and research findings are discussed to serve as a guide for those interested in this subject.

Keywords: Bioremediation, PGPR, Soil, Biological control agents, Phytoremediation, Pollutants

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The ever-increasing demand for the necessities of the continuously growing population has led to an imbalance in the biogeochemical cycle, an important driving force of life. This has resulted in increased pollution and contamination of the environment, primarily due to heavy metals and xenobiotics. To circumvent this problem of increased concentration of heavy metals and xenobiotics in the environment, microbes, especially cyanobacteria, have gained a lot of interest. This process of bioremediation is cost-effective and nonhazardous. In this chapter, we have seen how cyanobacteria sequester heavy metals by biosorption and bioaccumulation. The primary sequestration technique is by genetic modification of the exopolysaccharides pathway in the cyanobacteria.
Similarly, we have seen in the chapter that cyanobacteria also degrade various xenobiotics to nontoxic forms, although the detailed mechanism behind this process is unknown. Owing to these properties, cyanobacteria have become a highly potential microbe for bioremediation. Further study about the mechanism involved in it can shed light on the possible manipulation that can be carried out to make the best candidates for bioremediation.

Keywords: Bioaccumulation, Biotransformation, Cyanobacteria, Heavy metal, Xenobiotics

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For decades industries have been creating waste worldwide, developing contaminated sediments and subsequent disposal in marine environments. There is a need to find effective solutions to detoxify the environment. Bioremediation is an environmentally friendly, cost-effective, and sustainable technology that uses microorganisms to decontaminate and degrade a large number of pollutants into harmless products. However, the microbes existing in the biofilm mode are more advantageous for bioremediation. This is because the biofilm-grown cells exhibit enhanced tolerance toward adverse environmental stress conditions and are capable of degrading pollutants. Biofilms are produced by bacteria, fungi, and algae. In the biofilm mode, microbes are immobilized in a self-synthesized matrix that protects them from stress, contaminants, and predatory organisms. The contaminants, such as heavy metals, petroleum, explosives, pesticides, and dyes, have been remediated through biofilms. In addition, biofilms are used in industries to produce valuable compounds like lactic acid, cellulose, table olive oil, and also for the generation of electricity. This work gives a brief overview of biofilms in bioremediation and their applications in the removal of hazardous components.

Keywords: Biofilm, Bioremediation, Pollutant

Muhammad Zubair Mohsin, Rabia Omer, Jiaofang Huang, Ali Mohsin, Meijin Guo, Jiangchao Qian, Yingping Zhuang (State Key Laboratory of Bioreactor Engineering, East China University of Science and Technology, Shanghai 200237, PR China) **Advances in engineered Bacillus subtilis biofilms and spores, and their applications in bioremediation, biocatalysis, and biomaterials, Synthetic and Systems Biotechnology Volume 6, Issue 3, September 2021, Pages 180-191**

Bacillus subtilis is a commonly used commercial specie with broad applications in the fields of bioengineering and biotechnology. B. subtilis is capable of producing both biofilms and spores. Biofilms are matrix-encased multicellular communities that comprise various components including exopolysaccharides, proteins, extracellular DNA, and poly-γ-glutamic acid. These biofilms resist environmental conditions such as oxidative stress and hence have applications in bioremediation technologies. Furthermore, biofilms and spores can be engineered through biotechnological techniques for environmentally-friendly and safe production of bio-products such as enzymes. The ability to withstand with harsh conditions and producing spores makes Bacillus a suitable candidate for surface display technology. In recent years, the spores of such specie are widely used as it is generally regarded as safe to use. Advances in synthetic biology have enabled the reprogramming of biofilms

to improve their functions and enhance the production of value-added products. Globally, there is increased interest in the production of engineered biosensors, biocatalysts, and biomaterials. The elastic modulus and gel properties of B. subtilis biofilms have been utilized to develop living materials. This review outlines the formation of B. subtilis biofilms and spores. Biotechnological engineering processes and their increasing application in bioremediation and biocatalysis, as well as the future directions of B. subtilis biofilm engineering, are discussed. Furthermore, the ability of B. subtilis biofilms and spores to fabricate functional living materials with self-regenerating, self-regulating and environmentally responsive characteristics has been summarized. This review aims to resume advances in biological engineering of B. subtilis biofilms and spores and their applications.

Keywords: Bacillus subtilis, Biofilms, Spores, Biocatalysis, Bioremediation, Biomaterials, Synthetic biology

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Co-cultures of different microorganisms are considered promising inocula for treating palm oil mill effluents (POME) and producing value-added bio-products (e.g., biofuels and fatty acid-derived materials). However, the efficiency of yeast-bacteria co-culture for microbial lipid production through bioremediation of wastewater remains a bottleneck. In this study, the performance of a co-culture for lipid accumulation through POME bioremediation was investigated using a yeast (Lipomyces starkeyi) and a bacterium (Bacillus cereus). A maximum biomass of 8.89 ± 0.33 g/L and lipid production of 2.27 ± 0.10 g/L were achieved by the co-culture inoculum, which were substantially higher than those of the monocultures. Besides, the co-culture inoculum attained a maximum chemical oxygen demand (COD) removal of 83.66 ± 1.9%, while the individual cultures of B. cereus and L. starkeyi obtained 74.35 ± 1.7% and 69.01 ± 2.3%, respectively. The bioremediation efficiency was confirmed by the seed germination index (GI) of Vigna radiata (Mung bean). It was observed that the co-culture inoculum had a higher GI compared to the untreated POME and even the monoculture-treated POME. We argue that the symbiotic association of a yeast-bacteria co-culture in POME could be an attractive approach for achieving maximum biomass as well as lipid production and simultaneous bioremediation of POME.

Keywords: Palm oil mill effluent, Lipid accumulation, Bioremediation, Co-culture, Bacillus cereus, Lipomyces starkeyi

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Dispersants with a low environmental impact are necessary for oil spill remediation. Thus, the biosurfactant produced by the bacterium Pseudomonas cepacia CCT6659 using industrial waste and formulated using a method of adding food preservative was evaluated for its toxicity against the vegetable Allium cepa and aquatic species such as the freshwater fish Poecilia vivipara and the bivalve Anomalocardia brasiliana. The biosurfactant

was also applied in the removal of hydrophobic contaminant in sand and soils, in sea stones, in the dispersion and in the bioremediation of oil in seawater. The surfactant was considered to be of low toxicity for the bioindicators evaluated. As a petroderivative removal agent, the formulated tensoactive reached 76.55 % removal in soil and 84.50 % in sea stones. The biosurfactant was able to disperse 96.00 % of oil in seawater and promoted an increase in the biodegradation of oil by 70.00 % during a bioremediation process carried out in seawater. Therefore, the formulated biosurfactant presents suitable conditions for application as a dispersing agent in the decontamination of terrestrial and aquatic environments impacted by oil spills in substitution of chemical and toxic compounds.

Keywords: Formulation, Bioremediation, Petroleum, Acute toxicity, Biosurfactant

Biotransformation

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Influence of fermentation by lactic acid bacteria and in vitro digestion on the biotransformations of blueberry juice phenolics, Food Control, Volume 133, Part A, March 2022, 108603

Enzymes secreted during fermentation by lactic acid bacteria (LAB) may induce structural changes, e.g., promote the transformation of polyphenols in fruits and vegetables and thus influence their bioavailability and antioxidant capacity. This study describes the effects of fermentation by different LAB types (Streptococcus lactis and Pediococcus pentosaceus) and simulated gastrointestinal digestion on the biotransformation and antioxidant capacity of blueberry phenolics, revealing that upon the digestion of fermented samples, antioxidant capacity increases with increasing biotransformation extent because of the concomitant formation of more potent antioxidants. Moreover, the fermentation of blueberry puree increases the bioavailability and bioacceptability of phenolics and thus promotes the survival of LAB after digestion. The best results are obtained for S. lactis, and this LAB type is therefore concluded to hold great promise for the food industry.

Keywords: Blueberry, Lactobacillus, Polyphenol, Anthocyanin, Simulated digestion in vitro, Antioxidant activity

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Chapter 6 - Polymer biosynthesis and biotransformations, Eco-friendly Functional Polymers, An Approach from Application-Targeted Green Chemistry, Advances in Geen and Sustainable Chemistry, 2021, Pages 89-104

At present, environmental concerns and the decrease in fossil fuel reserves have generated great interest in green chemistry and sustainable processes. With this background, processes mediated by living organisms have been placed as the focus of many investigations. These processes, although complex from a mechanistic point of view, are the result of many years of evolutionary and adaptive processes which have perfected the enzymatic machinery behind biotransformations and other biosynthetic processes. The raw materials for obtaining biopolymers and biopolymers have their origin in bioprocesses which can occur inside or outside living organisms. This chapter discusses the biosynthetic processes for making the biopolymers of interest for the industry, but at the same time, biotransformations for obtaining the precursors, polymers, and raw materials are included. In particular, although every living microorganism is a producer of biopolymers, mainly proteins and carbohydrates, particular emphasis is placed on the processes mediated by microorganisms and plants.

Keywords: Biodegradation, Biopolymer, Biosynthesis, Biotechnology, Biotransformation, Cellulose, Polyhydroxyalkanoate, Starch

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In this work, several immobilization strategies for Gluconobacter oxydans NBRC 14819 (Gox) were tested in the bioconversion of crude glycerol to dihydroxyacetone (DHA). Agar, agarose and polyacrylamide were evaluated as immobilization matrixes. Glutaraldehyde crosslinked versions of the agar and agarose preparations were also tested. Agar immobilized Gox proved to be the best heterogeneous biocatalyst in the bioconversion of crude glycerol reaching a quantitative production of 50 g/L glycerol into DHA solely in water. Immobilization allowed reutilization for at least eight cycles, reaching four times more DHA than the amount obtained by a single batch of free cells which cannot be reutilized. An increase in scale of 34 times had no impact on DHA productivity. The results obtained herein constitute a contribution to the microbiological production of DHA as they not only attain unprecedented productivities for the reaction with immobilized biocatalysts but also proved that it is feasible to do it in a clean background of solely water that alleviates the cost of downstream processing.

Keywords: Dihydroxyacetone, crude glycerol, Gluconobacter, biotransformation

Jonghyeok Shin[ab], Yong-Su Jin[b], Yong-Cheol Park[c], Jin-Byung Park[d], Young-Oh Lee[e], Sun-Ki Kim[e], Dae-Hyuk Kweon[a] (a. Department of Integrative Biotechnology, College of Biotechnology and Bioengineering, Sungkyunkwan University, Suwon, Gyeonggi, 16419, Republic of Korea, b. Carl R. Woese Institute for Genomic Biology, University of Illinois at Urbana-Champaign, Urbana, IL, 61801, USA, c. Department of Bio and Fermentation Convergence Technology, Kookmin University, Seoul, 02707, Republic of Korea, d. Department of Food Science and Engineering, Ewha Womans University, Seoul, 03760, Republic of Korea, e. Department of Food Science and Technology, Chung-Ang University, Anseong, Gyeonggi, 17546, Republic of Korea) Enhancing acid tolerance of Escherichia coli via viroporin-mediated export of protons and its application for efficient whole-cell biotransformation, Metabolic Engineering, Volume 67, September 2021, Pages 277-284

Escherichia coli-based whole-cell biocatalysts are widely used for the sustainable production of value-added chemicals. However, weak acids present as substrates and/or products obstruct the growth and fermentation capability of E. coli. Here, we show that a viroporin consisting of the influenza A matrix-2 (M2) protein, is activated by low pH and has proton channel activity in E. coli. The heterologous expression of the M2 protein in E. coli resulted in a significant increase in the intracellular pH and cell viability in the presence of various weak acids with different lengths of carbon chains. In addition, the feasibility of developing a robust and efficient E. coli-based whole-cell biocatalyst via introduction of the proton-selective viroporin was explored by employing (Z)-11-(heptanolyoxy)undec-9-enoic acid (ester) and 2-fucosyllactose (2′-FL) as model products, whose production is hampered by cytosolic acidification. The engineered E. coli strains containing the proton-selective viroporin exhibited approximately 80% and 230% higher concentrations of the ester and 2′-FL, respectively, than the control strains without the M2 protein. The simple and powerful strategy developed in this study can be applied to produce other valuable chemicals whose production involves substrates and/or products that cause cytosolic acidification.

Keywords: Influenza A matrix-2 protein, Acid tolerance, Whole-cell biotransformation, (Z)-11-(heptanolyoxy) undec-9-enoic acid, 2′-Fucosyllactose

Lars Weidolf[a], Anders Björkbom[a], Anders Dahlén[b], Marie Elebring[a], Peter Gennemark[a], Mikko Hölttä[c], David Janzén[a], Xue Qing Li[a], Shalini Andersson[b] (a. Drug Metabolism and Pharmacokinetics, Research and Early Development, Cardiovascular, Renal and Metabolism, BioPharmaceuticals R&D, AstraZeneca, Gothenburg, Sweden, b. Oligonucleotide Discovery, Discovery Sciences, R&D, AstraZeneca, Gothenburg, Sweden, c. Clinical Pharmacology & Quantitative Pharmacology, Clinical Pharmacology & Safety Sciences, R&D, AstraZeneca, Gothenburg, Sweden) **Distribution and biotransformation of therapeutic antisense oligonucleotides and conjugates, Drug Discovery Today, Volume 26, Issue 10, October 2021, Pages 2244-2258**

Drug properties of antisense oligonucleotides (ASOs) differ significantly from those of traditional small-molecule therapeutics. In this review, we focus on ASO disposition, mainly as characterized by distribution and biotransformation, of nonconjugated and conjugated ASOs. We introduce ASO chemistry to allow the following in-depth discussion on bioanalytical methods and determination of distribution and elimination kinetics at low concentrations over extended periods of time. The resulting quantitative data on the parent oligonucleotide, and the identification and quantification of formed metabolites define the disposition. Proper quantitative understanding of disposition is pivotal for nonclinical to clinical predictions, supports communication with health agencies, and increases the probability of delivering optimal ASO therapy to patients.

Keywords: Antisense Oligonucleotide, LCMS, Hybridization assay, Disposition, Biotransformation, Distribution

Xin-Xin Liu[1], Hong-Yun Zhang[1], Xin Song[1], Ying Yang[2], Zhi-Qiang Xiong[1], Yong-Jun Xia[1], Lian-Zhong Ai1 (1. Shanghai Engineering Research Center of Food Microbiology, School of Medical Instrument and Food Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China, 2. Institute of Food Science, Zhejiang Academy of Agricultural Sciences, Hangzhou 310021, China) **Reasons for the differences in biotransformation of conjugated linoleic acid by Lactobacillus plantarum, Journal of Dairy Science, Volume 104, Issue 11, November 2021, Pages 11466-11473**

Conjugated linoleic acid (CLA) has attracted a great deal of attention for its functions in weight loss, regulation of metabolism, and antioxidant capabilities. Many microorganisms, including rumen bacteria, propionic acid bacilli, and Lactobacillus, have CLA biotransformation ability. The CLA production capability of different species is different, as are those different strains of the same species. However, the reasons for this discrepancy remain unclear. In this study, 14 strains of Lactobacillus plantarum were found, through gas chromatography-mass spectrometry analysis, to be capable of converting linoleic acid to CLA. The transcriptional levels of CLA-related genes in the high- (AR195, WCFS1, and AR488) and low-yield strains (AR176, AR269, and AR611) were analyzed using real-time quantitative PCR. The transcriptional levels of cla-hy, cla-dh, and cla-dc in AR195 were the lowest in the exponential phase, but it had the highest CLA yield. Correlation analysis showed no correlation between CLA yield and the transcription level of these genes in the exponential phase. The results showed that a high transcriptional level in the exponential phase of cla-hy, cla-dh, and cla-dc did not necessarily lead to high CLA production. Investigation of the transcription level in different growth phases showed that the CLA biotransformation abilities of Lactobacillus plantarum strains significantly depended on the transcriptional maintenance of cla-hy, cla-dh, and cla-dc. We observed a correlation between CLA production and increased levels of cla-hy transcription, but a prerequisite is needed: the transcription of cla-dh and cla-dc should be upregulated and maintained a high transcriptional level during the platform period. This study provides a new strategy for screening high CLA-producing strains. It also lays a theoretical foundation for regulating CLA biotransformation and increasing the yield of CLA.

Keywords: conjugated linoleic acid (CLA), Lactobacillus plantarum, biotransformation, gene transcription

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& Natural Products, College of Pharmacy/Guangdong Province Key Laboratory of Pharmacodynamic Constituents of TCM and New Drugs Research, Jinan University, Guangzhou 510632, China, b. College of Traditional Chinese Materia Medica, Shenyang Pharmaceutical University, Shenyang 110016, China, c. College of Traditional Chinese Medicine, Jinan University, Guangzhou 510632, China, 4. Integrated Chinese and Western Medicine Postdoctoral Research Station, Jinan University, Guangzhou 510632, China) **Biotransformation of α-asarone by Alternaria longipes CGMCC 3.2875, Chinese Journal of Natural Medicines, Volume 19, Issue 9, September 2021, Pages 700-705**

Biotransformation of α-asarone by Alternaria longipes CGMCC 3.2875 yielded two pairs of new neolignans, (+) (7S, 8S, 7′S, 8′R) iso-magnosalicin (1a)/(–) (7R, 8R, 7′R, 8′S) iso-magnosalicin (1b) and (+) (7R, 8R, 7′S, 8’R) magnosalicin (2a)/(–) (7S, 8S, 7′R, 8’S) magnosalicin (2b), and four known metabolites, (±) acoraminol A (3), (±) acoraminol B (4), asaraldehyde (5), and 2, 4, 5-trimethoxybenzoic acid (6). Their structures, including absolute configurations, were determined by extensive analysis of NMR spectra, X-ray crystallography, and quantum chemical ECD calculations. The cytotoxic activity and Aβ42 aggregation inhibitory activity of all the compounds were evaluated. Compound 2 displayed significant anti-Aβ42 aggregation activity with an inhibitory rate of 60.81% (the positive control EGCG: 69.17%). In addition, the biotransformation pathway of α-asarone by Alternaria longipes CGMCC 3.2875 was proposed.

KEYWORDS: Biotransformation, α-Asarone, Alternaria longipes CGMCC 3.2875, Anti-Aβ42 aggregation activity

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Doxycycline (DC) is a second generation tetracycline antibiotic and its occurrence in the aquatic environment due to the discharge of municipal and agricultural wastes has called for technologies to effectively remove DC from water. The objective of the study was to characterize the synergistic benefits of adsorption and biotransformation in removing DC from water using rice straw particles (RSPs) covered with DC degrading bacteria, Brevundimonas naejangsanensis strain DD1. First, optimal experimental conditions were identified for individual processes, i.e., hydrolysis, adsorption, and biotransformation, in terms of their performance of removing DC from water. Then, synergistic effects between adsorption and biotransformation were demonstrated by adding DD1-covered RSPs (DD1-RSPs) to DC-containing solution. Results suggest that DC was quickly adsorbed onto RSPs and the adsorbed DC was subsequently biotransformed by the DD1 cells on RSPs. The adsorption of DC to DD1-RSPs can be well described using the pseudo-second-order kinetics and the Langmuir isotherm. The DD1 cells on RSPs converted DC to several biotransformation products through a series of demethylation, dehydration, decarbonylation, and deamination. This study demonstrated that adsorption and biotransformation could work synergistically to remove DC from water.

Keywords: Doxycycline, Adsorption, Biotransformation, Rice straw particles

Biomarker

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Shanghai Jiaotong University School of Medicine, Shanghai Key Laboratory of Psychotic Disorders, Shanghai 200030, PR China, b. School of Pharmacy, Brain Health Research Centre, Brain Research New Zealand, University of Otago, Dunedin, New Zealand, c. Department of Anatomy, School of Biomedical Sciences, Brain Health Research Centre, Brain Research New Zealand, University of Otago, Dunedin, New Zealand, d. CAS Center for Excellence in Brain Science and Intelligence Technology (CEBSIT), Chinese Academy of Science, Shanghai 200031, PR China, e. Institute of Psychology and Behavioral Science, Shanghai Jiao Tong University, Shanghai 200030, PR China) **Plasma metabolic alterations and potential biomarkers in individuals at clinical high risk for psychosis, Schizophrenia Research, Volume 239, January 2022, Pages 19-28**

Background: Early identification and treatment of clinical high-risk for psychosis (CHRsingle bondP) are critical to prevent the onset of psychosis, but there is no objective biomarker for CHR-P diagnosis.
Methods
Ninety medication naïve CHR-P subjects and eighty-six healthy controls (HCs) were recruited. The metabolic profiles of plasma samples were acquired using an untargeted metabolomics approach based on ultra-high-performance liquid chromatography equipped with quadrupole time-of-flight mass spectrometry. The obtained data were further mapped on the Kyoto Encyclopedia of Genes and Genomes for pathway analysis, and an ensemble learning method was applied to identify diagnostic biomarkers. Bayesian linear regression model was then used to explore predicative biomarkers of conversion to psychosis. Receiver-operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic or predicative value of potential biomarkers.
Results
A total of one hundred and four differential metabolites and forty-eight differential pathways were identified. A panel of five metabolites was found that could effectively discriminate CHR-P from HCs with area under the ROC curve of 1 in the training set (70% of the samples) and 0.997 in the testing set (30% of the samples). The biosynthesis of unsaturated fatty acids pathway perturbed most significantly in CHR-P subjects. Twenty-three CHR-P subjects converted to psychotic disorders during two-year follow-up, and increased 1-stearoyl-2-arachidonoyl-sn-glycerol in plasma was potentially associated with the higher risk of conversion to psychosis.
Conclusions: These findings demonstrate the alterations of plasma metabolic profiles in CHR-P population, which may deliver valuable biomarkers for early identification and outcome prediction of CHR-P.

Keywords: Clinical high-risk for psychosis, Diagnosis, Metabolism, Biomarkers, Metabolomics

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Background: Discrimination among patients with type 1 myocardial infarction (T1MI), type 2 myocardial infarction (T2MI), and myocardial injury is difficult.
Objectives: The aim of this study was to investigate the discriminative value of a 29-biomarker panel in an emergency department setting.
Methods: Patients presenting with suspected myocardial infarction (MI) were recruited. The final diagnosis in all patients was adjudicated on the basis of the fourth universal definition of MI. A panel of 29 biomarkers was measured, and multivariable logistic regression analysis was used to evaluate the associations of these biomarkers with the diagnosis of MI or myocardial injury. Biomarkers were chosen using backward selection. The model was internally validated using bootstrapping.

Results: Overall, 748 patients were recruited (median age 64 years), of whom 138 had MI (107 T1MI and 31 T2MI) and 221 had myocardial injury. In the multivariable model, 4 biomarkers (apolipoprotein A-II, N-terminal prohormone of brain natriuretic peptide, copeptin, and high-sensitivity cardiac troponin I) remained significant discriminators between T1MI and T2MI. Internal validation of the model showed an area under the curve of 0.82. For discrimination between MI and myocardial injury, 6 biomarkers (adiponectin, N-terminal prohormone of brain natriuretic peptide, pulmonary and activation-regulated chemokine, transthyretin, copeptin, and high-sensitivity troponin I) were selected. Internal validation showed an area under the curve of 0.84.
Conclusions: Among 29 biomarkers, 7 were identified to be the most relevant discriminators between subtypes of MI or myocardial injury. Regression models based on these biomarkers allowed good discrimination. (Biomarkers in Acute Cardiac Care [BACC]; NCT02355457)

Keywords: acute coronary syndrome, biomarker, copeptin, myocardial infarction, myocardial injury, NT-proBNP, troponin, type 1, type 2

YanZhang, Da-Hai He, Shun-Ning Jiang, Hua-Li Wang, Xiao-Hua Xu, Li-Rui Kong (Department of Clinical Laboratory, Traditional Chinese Medicine Hospital of Pidu District, Chengdu, China) **Biological variation of thyroid function biomarkers over 24 hours, Clinica Chimica Acta, Volume 523, December 2021, Pages 519-524**

Background: Thyroid-stimulating hormone (TSH), triiodothyronine (T3), thyroxine (T4), free T3 (FT3), and free T4 (FT4) are used to diagnose thyroid diseases and monitor treatment effects. Reliable biological variation (BV) data is required to ensure accurate clinical decisions.
Methods: Blood samples were collected from 31 healthy subjects at 00:00, 04:00, 08:00, 12:00, 16:00, and 20:00; each sample was analyzed twice for TSH, T3, T4, FT3, and FT4. After outlier exclusion, normality assessment, and variance homogeneity, sex-stratified BV, including within-subject (CVI) and between-subject (CVG), was defined using nested ANOVA.
Results: Concentrations of five biomarkers were significantly different between sexes. The CVI and CVG estimates were 34.54% and 34.43% for TSH, 5.89% and 14.18% for T3, 4.48% and 14.96% for T4, 5.37% and 11.23% for FT3, and 3.57% and 8.03% for FT4, respectively. The individual indexes (IIs) of all the biomarkers (except TSH) were ≤ 0.63. Males had lower CVIs and IIs than females.
Conclusion: CVI estimates of all hormones, except TSH, were lower than those reported on the BV website, showing low IIs and differences between sexes. We provide updated data on the short-term BV of thyroid function biomarkers according to sex and complement BV data of thyroid function biomarkers.

Keywords: Thyroid disease, Biomarker, Biological variation, Within-subject variation, Between-subject variation

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COPD is lagging in the precision medicine race. The term COPD was designed to be an umbrella term, which is intentionally heterogeneous. To help understand the physiology of COPD and better treat our patients, researchers have evaluated many biomarkers in COPD. There are now robust validated biomarkers such as the blood eosinophil count, blood C-reactive protein, plasma fibrinogen, sputum purulence and hypercapnia. However, there is no one biomarker for the various aspects of COPD. Instead, the focus should be on repeatability, evaluation circumstances and validity of candidate biomarkers.

Keywords: Biomarkers, Eosinophils, Exhaled breath condensate, Fibrinogen, Serum biomarkers, Sputum biomarkers

T.Y.Wong, Ruth C.Travis, Tammy Y.N.Tong (Cancer Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, Oxford OX3 7LF, UK) Blood biomarker levels by total sleep duration: cross-sectional analyses in UK Biobank, Sleep Medicine, Volume 88, December 2021, Pages 256-261

Background: Short or long sleep duration has been associated with some major chronic diseases, but whether disease-related blood biomarkers vary according to habitual sleep duration is unclear. This cross-sectional study aimed to assess blood biomarker levels in relation to total sleep duration.
Methods: The analysis includes 459,796 white British adults aged 40–69 during 2006–2010 in UK Biobank. At recruitment, blood samples and self-reported information on total sleep duration were collected from participants. A panel of blood biomarkers was measured. Using linear regression, we estimated geometric mean concentrations of blood biomarkers and mean ratio of ApoB/ApoA1 by sleep duration adjusted for sex, age at data collection, time of blood collection, and lifestyle covariates.
Results: Percentage differences in the concentrations of most biomarkers by sleep duration were modest. The largest differences were for C-reactive protein (CRP, an inflammatory biomarker) and gamma glutamyltransferase (GGT, a liver function biomarker), and the differences were markedly attenuated after multivariable-adjustment. The multivariable-adjusted geometric means of CRP and of GGT were 14% and 14% higher in <6 h vs 7–8 h of sleep; and 22% and 12% higher in >9 h vs 7–8 h of sleep, respectively.
Conclusion: In white British adults, most blood biomarker levels varied only modestly with sleep duration and the remaining associations may be due to residual confounding.

Keywords: Sleep duration, Blood biomarkers, C-reactive protein, Gamma glutamyltransferase, UK Biobank

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SLE (lupus) is a chronic autoimmune disease with substantial personal and public health impact. Lupus nephritis (LN) remains the most severe complication of SLE, accounting for sizable morbidity, mortality, and end-stage renal disease (ESRD).1 SLE with onset in adolescence or younger is termed cSLE.2 The incidence and prevalence of SLE varies widely between populations, with higher disease prevalence observed among African American and Asian populations.3,4 An estimated 20% of SLE cases commence during childhood, and renal involvement occurs in 50% to 70% of patients with cSLE, hence more common than in adult-onset SLE.3,5 Notably, about 10% of children with proliferative LN progress to ESRD within 5 years of diagnosis.3 Patients with cSLE tend to have more severe disease courses compared with adult-onset SLE, and this results in higher accumulation of disease- and therapy-related damage, especially chronic corticosteroid use.3 The new 2019 American College of Rheumatology/European League against Rheumatism Classification Criteria for SLE can be applied

Keywords: Biomarkers, Pediatric, Lupus, SLE, Childhood-onset SLE

Catherine Dunn[a], Lucy Gately[a], Peter Gibbs[ab] (a. Personalised Medicine Division, Walter and Eliza Hall, Melbourne, VIC, Australia, b. University of Melbourne, Department of Medicine, Melbourne, VIC, Australia) Drinking from the firehose – A clinician's perspective on the challenges of delivering biomarker-driven care in routine practice, European Journal of Cancer, Volume 157, November 2021, Pages 301-305

Countless biomarkers continue to be identified and analysed in the modern era of omics focused research, with innumerable articles purporting clinical utility and bolstering optimism for truly personalised cancer care. While many commentaries have expounded on the complexities of biomarker development, validation and reporting, the monumental challenge of integrating this research into clinical practice has to date received little attention. The challenges are multitude; variable and sometimes contradictory findings across studies for individual biomarkers, a rapidly evolving landscape with new biomarkers continually being presented and tendency to examine each biomarker in isolation. Here, using examples from colorectal cancer, we explore the difficulties for the practicing clinician in interpreting and integrating novel biomarkers. Here, we present the '4Cs' to interrogate the biomarker literature, including analysis of the credibility, consistency, completeness and context of the biomarker research, and suggest a framework to frame the literature moving forward.

Keywords: Biomarkers, Clinical utility, colorectal cancer

Megan E.Huibregtse[a], Jeffrey J.Bazarian[b], Sandy R.Shultz[cd], Keisuke Kawata[ae] (a. Department of Kinesiology, School of Public Health, Indiana University, 1025 E 7th St, Suite 112, Bloomington, IN 47405, USA, b, Department of Emergency Medicine, University of Rochester Medical Center, 200 E River Rd, Rochester, NY 14623, USA, c. Department of Neuroscience, Monash University, The Alfred Centre, Level 6, 99 Commercial Road, Melbourne, VIC 3004, Australia, d. Department of Medicine, University of Melbourne, Clinical Sciences Building, 4th Floor, 300 Grattan St, Parkville, VIC 3050, Australia, e. Program in Neuroscience, College of Arts and Sciences, Indiana University, 1101 E 10th St, Bloomington, IN 47405, USA) **The biological significance and clinical utility of emerging blood biomarkers for traumatic brain injury, Neuroscience & Biobehavioral Reviews, Volume 130, November 2021, Pages 433-447**

HUIBREGTSE, M.E, Bazarian, J.J., Shultz, S.R., and Kawata K. The biological significance and clinical utility of emerging blood biomarkers for traumatic brain injury. NEUROSCI BIOBEHAV REV XX (130) 433–447, 2021.- Blood biomarkers can serve as objective measures to gauge traumatic brain injury (TBI) severity, identify patients at risk for adverse outcomes, and predict recovery duration, yet the clinical use of blood biomarkers for TBI is limited to a select few and only to rule out the need for CT scanning. The biomarkers often examined in neurotrauma research are proteomic markers, which can reflect a range of pathological processes such as cellular damage, astrogliosis, or neuroinflammation. However, proteomic blood biomarkers are vulnerable to degradation, resulting in short half-lives. Emerging biomarkers for TBI may reflect the complex genetic and neurometabolic alterations that occur following TBI that are not captured by proteomics, are less vulnerable to degradation, and are comprised of microRNA, extracellular vesicles, and neurometabolites. Therefore, this review aims to summarize our understanding of how biomarkers for brain injury escape the brain parenchymal space and appear in the bloodstream, update recent research findings in several proteomic biomarkers, and characterize biological significance and examine clinical utility of microRNA, extracellular vesicles, and neurometabolites.

Keywords: Blood biomarkers, Traumatic brain injury, Proteomics, Metabolomics, microRNA, Extracellular vesicles

Biofertilizer

Md Shawon Mahmud, Khim Phin Chong (Biotechnology Programme, Faculty of Science and Natural Resources, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia) **Formulation of biofertilizers from oil palm empty fruit bunches and plant growth-promoting microbes: A comprehensive and novel approach towards plant health, Journal of King Saud University – Science, Volume 33, Issue 8, December 2021, 101647**

Our heavy reliance on chemical fertilizers for agricultural practices has fostered the development of a vast industry that is producing chemicals that are toxic not only for humans but also for the environment. Biofertilizers are microbial formulations containing native plant growth-promoting microorganisms (PGPM) which have the potential to enhance plant growth either directly or indirectly by producing different types of phytohormones, iron-binding metabolites (siderophores), and solubilizing soil nutrients and minerals. The positive impacts on crop growth and development were documented by many researchers while using biofertilizers. Thus, biofertilizers offer enormous promise for sustainable agriculture, particularly in the face of climate change. Despite the growing interest in this technology, its entire potential remains untapped. This review collectively describes the potential use of empty fruit bunches (EFB) biomass as a biofertilizer for sustainable agricultural practices and the roles of plant growth-promoting microbes (PGPM) in plant growth and development. Attempts were also made to give insights into the oil palm industry in Malaysia and the nutrient profile of EFB biomass. We concluded that more research, fund and development activities are needed to improve traits of beneficial microbes that will potentially enhance the biological pathway of different biocompounds production and find solutions for the current issues related to converting EFB biomass into biofertilizers.

Keywords: Biofertilizer, Malaysian oil palm industry, Empty fruit bunches, Sustainability, Plant nutrients, Plant growth-promoting microbes

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Ammonia volatilization from the farmland caused by the application of synthetic nitrogen fertilizer is the most important source of anthropogenic ammonia emissions. Biofertilizer application has been considered as an alternative option for agriculture sustainability and soil improvement. In this study, field trials were carried out to investigate the efficiency of Bacillus amyloliquefaciens (BA) biofertilizer on alleviating ammonia volatilization in alkaline farmland soil and increasing crop yield and nitrogen utilization. Potential response mechanisms were investigated from soil enzyme, nitrogen cycle function genes and microbial community levels. Compared with conventional fertilization, BA biofertilizer application reduced the ammonia volatilization by 68%, increased the crop yield and nitrogen recovery by 19% and 19%, respectively. Soil enzyme activity analysis showed that BA biofertilizer inhibited the urease activity and enhanced the potential ammonia oxidation (PAO). In addition, BA biofertilizer application also increased the bacterial amoA gene abundance, while decreased the ureC gene abundance. BA biofertilizer also significantly altered the community structure and composition, and especially raised the abundance of ammonia oxidation bacteria (AOB), while no changes were observed in abundance of nitrite oxidation bacteria (NOB). Briefly, BA biofertilizer was approved to reduce the transformation of fertilizer nitrogen to NH4+-N, simultaneously accelerating NH4+-N into the nitrification process, thus decreasing the NH4+-N content remained in alkaline soil and consequently alleviating the ammonia volatilization. Thus, these results suggested that the application of BA biofertilizer is a feasible strategy to improve crop yields and reduce agricultural ammonia emissions.

Keywords: Bacillus amyloliquefaciens, Biofertilizer, Ammonia volatilization, Nitrogen cycle functional genes, Microbial community

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Science and Technology, Enugu State, Nigeria) Biofertilizer production via composting of digestate obtained from anaerobic digestion of post biocoagulation sludge blended with saw dust: Physiochemical characterization and kinetic study, Environmental Challenges, Volume 5, December 2021, 100288

A study on biofertilizer production via oxidation of heterogeneous mass and microbial decomposition of organic matter in the digestate obtained after anaerobic digestion of post biocoagulation sludge was undertaken. The digestate was characterized. Effect of process variables on composting was investigated. The kinetics of composting was studied. The characterization results show that digestate and saw dust contains macro (nitrogen-N, phosphorus-P, magnesium-Mg, sodium-Na, Calcium-Ca and potassium-K) and micro (manganese-Mn, zinc-Zn, Fe-iron and Cu-copper) nutrients that when composted can be used as biofertilizer/soil improver. Also, the final compost (biofertilizer) contains Zn, Cr, Cu, Cd and Pb that lay within the recommended limits for agricultural use. The kinetic data fitted very well to the second order model with of 0.9675 and activation energy of 1442.15 . Composting kinetic analysis showed that temperature dependence of rates reaction clearly followed the Arrhenius equation. Also, the kinetics results revealed that the degradation of organic waste could be quantitatively predicted using the second order reaction model. It can be concluded that the composting of digestate with saw dust resulted in biofertilizer production; thus, converting waste to wealth.

Keywords: Digestate, Saw dust, Composting, Characterization, Biofertilizer

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Low and erratic rainfall can cause a significant reduction in crop yields in agriculture systems that rely exclusively on rain water. Some plant growth promoting rhizobacteria (PGPR) capable of producing 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase can mitigate the negative impact of water stress on plant in rainfed agriculture through modulation of plant stress hormone ethylene. The present study was conducted in rainfed areas to demonstrate the potential of PGPR with ACC-deaminase activity to enhance the growth and yield of wheat (Triticum aestivum L.) under field conditions. Previously isolated bacterial strains (Serratia odorifera CC7, Aerococcus viridans CK3 and Serratia proteamaculans R20) having in-vitro ACC deaminase activity were used for inoculation. Peat, compost and biochar were used as carrier material for the formulation of biofertilizer. Our results show that application of the compost biofertilizer increased plant biomass up to 27% and grain yield up to 33.3% compared with uninoculated control. Maximum N and P content in grain was observed 24.7 % and 25.8% respectively. Maximum ACC-deaminase activity of 821 nmol g^{-1} biomass h^{-1} was observed with strain CC7, while root colonization activity was also highest in case of strain CC7 i.e 6.2 106 compared to other strains. All the strains showed positive response to phosphate solubilization activity as well. Furthermore, ACC deaminase gene isolated from CC7 strain showed 79.1% homology to the ACC deaminase gene of Achromobacter, 83.9% homology to the ACC deaminase gene of Pseudomonas. These findings indicate that PGPR isolated from rainfed area can be used for biofertilizer formulation which could be very effective to increase the production of wheat in rainfed agriculture system.

Keywords: Biofertilizer, Rainfed farming system, ACC deaminase, Wheat, PGPR

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India, d. Post Graduate Department of Botany, Utkal University, Bhubaneswar 751004, Odisha, India) Biofertilizers and nanofertilizers for sustainable agriculture: Phycoprospects and challenges, Science of The Total Environment, Volume 803, 10 January 2022, 149990

Increased food demands and ceasing nutrient deposits have resulted in a great shortfall between the food supply and demand and would be worse in the years to come. Higher inputs of synthetic fertilizers on lands have resulted in environmental pollution, persistent changes in the soil ecology, and physicochemical conditions. This has greatly decreased the natural soil fertility thereby hindering agricultural productivity, human health, and hygiene. Bio-based resilient nutrient sources as wastewater-derived algae are promising as a complete nutrient for agriculture and have the potential to be used in soilless cultivations. Innovations in nano-fortification and nano-sizing of minerals and algae have the potential to facilitate nutrients bioavailability and efficacy for a multifold increase in productivity. In this context, various options on minerals nanofertilizer application in agricultural food production besides efficient biofertilizer have been investigated. Algal biofertilizer with the nanoscale application has huge prospects for further agriculture productivities and fosters suitable development.

Keywords: Algae, Nanofertilizer, Biofertilizer, Agriculture, Wastewater, Algaponics

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The injudicious use of agrochemicals (pesticides and fertilizers) has changed the soil properties (physical, chemical and biological), leading to the reduction in the native beneficial microorganisms in rhizosphere and stagnation/reduction in crop yields with grave implications on the ecosystem, human health and ground water. Looking to problem, organic farming is getting priority worldwide with the objective of safe, healthy and residue free food and long-term sustainability. To minimize the harmful effect of indiscriminate use of pesticides, chemical fertilizers (agrochemicals) and other associated environmental problems to it, enhances the application of biofertilizers and biopesticides in organic farming. Biofertilizers and biopesticides have appeared as a potential eco-friendly inputs that are supplement for crop development and plant protection in organic farming. They are an alternative of agrochemicals (Chemical fertilizers and pesticides) to improve soil fertility and control various insect, pests and disease in almost all agricultural crops. They can be used in integrated nutrient and pest management techniques. They are the living organisms that can colonize roots, increased root branching, root number and enhanced growth through direct and indirect mechanisms like phytohormones, siderophores, HCN, nitrogen fixation and macro and micronutrients solubilization mechanisms. Various microbial formulations are used to enhance certain microbial process to increase the availability of nutrients in a form which can be assimilated by plant. Adequate use of Bio-inputs (biofertilizers, biopesticides, FYM, vermicompost, etc.) is a cost effective way to enhance soil health, crop yield along with manage balance environment. This chapter reviews about biofertilizers and biopesticides, their potential role in organic farming, challenges and strategies for promotion and commercialization of biofertilizer and biopesticides.

Keywords: Organic farming, Biofertilizers, Biopesticides, Crop growth and protection, Soil health

Salem.M.Al-Amri (Department of Biological Sciences, College of Science and Humanities, Shaqra University, Saudi Arabia) Response of growth, essential oil composition, endogenous hormones and microbial activity of Mentha piperita to some organic and biofertilizers agents, Saudi Journal of Biological Sciences, Volume 28, Issue 10, October 2021, Pages 5435-5441

The effect of organic (poultry and cattle manures) and biological (effective microorganisms, EM) fertilizers on growth, essential oil yield and its compositions, endogenous phytohormones content and antibacterial activity of peppermint plants grown in pot over 12 weeks was studied. Application of organo- and bio-fertilizers greatly affected on growth, essential oil production and other estimated parameters of peppermint plants. Slight stimulation effect was happened due to soil application of organic manures. Soil application of EM alone or in combination with organic fertilizers significantly increased growth, yield and components of essential oils, endogenous hormones of peppermint as compared to other treatments. Using disc diffusion method, the extracted oil of peppermint plants amended with organic and biofertilizers recorded the highest antibacterial activity against tested pathogenic bacteria like Klebsiella pneuumoniae and Staphylococcus aureus.

Keywords: Organic manures, Effective microorganism, Essential oils, Peppermint, Antibacterial activity, Hormones

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Conventional agriculture adds significant contribution towards meeting the food needs of the growing population. Subsequent usage of chemical fertilizers and pesticides to enhance the soil fertility and control insects and pests has increased the global food production. However, excessive use has resulted in environmental pollution and affecting human health. Considering such negative influence of these inorganic fertilizers and pesticides, environmental friendly approach such as use of biofertilizers and biocontrols can be appropriate alternative. Termite gut hosts a large amount of bacteria which has lignocellulytic functions. In this study, termite gut microbiome DNA has been extracted and subsequent 454 pyrosequencing has been done to unveil the phylogenetic distribution of the microflora in the microbiome. Results indicate predominance of Rhizobium leguminosarum and Rhizobium etli in the microbiome which are suitable for biofertilizer function.

Keywords: Biofertilizer, 454 pyrosequencing, Termite gut, Rhizobium leguminosarum

Biocomposting

Yuan-yuan XIN[a], Anisur RAHMAN[a], Hui-xiu LI[a], Ting XU[ab], Guo-chun DING[ab], Ji LI[ab] (a. College of Resources and Environmental Sciences, China Agricultural University, Beijing 100193, P.R.China, b. Organic Recycling Institute (Suzhou), China Agricultural University, Suzhou 215128, P.R.China) **Modification of total and phosphorus mineralizing bacterial communities associated with Zea mays L. through plant development and fertilization regimes, Journal of Integrative Agriculture, Volume 20, Issue 11, November 2021, Pages 3026-3038**

Harnessing the rhizospheric microbiome, including phosphorus mineralizing bacteria (PMB), is a promising technique for maintaining sustainability and productivity in intensive agricultural systems. However, it is unclear as to which beneficial taxonomic group populations in the rhizosphere are potentially associated with the changes in soil microbiomes shifted by fertilization regimes. Herein, we analyzed the diversity and community structure of total bacteria and PMB in the rhizosphere of maize (Zea mays L.) grown in soils under 25 years of four fertilization regimes (compost, biocompost, chemical, or non-fertilized) via selective culture and Illumina sequencing of the 16S rRNA genes. Plant development explained more variations (29 and 13%, respectively) in

the composition of total bacteria and PMB in the rhizosphere of maize than the different fertilization regimes. Among those genera enriched in the rhizosphere of maize, the relative abundances of Oceanobacillus, Bacillus, Achromobacter, Ensifer, Paracoccus, Ramlibacter, and Luteimonas were positively correlated with those in the bulk soil. The relative abundance of Paracoccus was significantly higher in soils fertilized by compost or biocompost than the other soils. Similar results were also observed for PMB affiliated with Ensifer, Bacillus, and Streptomyces. Although plant development was the major factor in shaping the rhizospheric microbiome of maize, fertilization regimes might have modified beneficial rhizospheric microbial taxa such as Bacillus and Ensifer.

Keywords: organic fertilization, bacterial diversity, phosphorus mineralizing bacteria (PMB), Zea mays L., rhizosphere

Biopesticide

Arnau Sala, Raquel Barrena, Antoni Sánchez, Adriana Artola (Department of Chemical, Biological and Environmental Engineering, Universitat Autònoma de Barcelona, Edifici Q, Campus de Bellaterra, 08193 Cerdanyola del Vallès, Spain) Fungal biopesticide production: Process scale-up and sequential batch mode operation with Trichoderma harzianum using agro-industrial solid wastes of different biodegradability, Chemical Engineering Journal, Volume 425, 1 December 2021, 131620

This work presents a sequential batch operational strategy (SBR) for fungal conidia production in solid-state fermentation (SSF) to improve the traditional batch operation, while also aiming to present a robust and scalable process. Trichoderma harzianum was fermented using two substrates with different biodegradability (rice husk and beer draff), scaling from 1.5 L to 22 L bioreactors. Before the SBR operation, the optimum time to get inoculum from each SBR batch was determined as 4 days. While single batch process scale-up was successful with both substrates, SBR strategy was only feasible using beer draff as substrate: conidia production was sustained during 3 consecutive batches in 1.5 L bioreactors and for 5 batches at 22 L. At both scales conidia production was around 2.0x109 conidia g-1dm, achieving maximum specific oxygen consumption rate (sOUR) values close to 4 g O2 kg-1dm h-1 in most reactors. Air filled porosity was found as a key parameter regarding process scale-up, with a minimum value of 80% as necessary to proper scaling up to 22 L. Process robustness was statistically demonstrated as no significant differences in conidia production, moisture and pH were found at different reactor heights using both substrates in most 22 L reactors tests. Consequently, SBR operation has been presented as a reproducible method to overcome traditional packed-bed drawbacks while also improving SSF performance in comparison to traditional industrial SSF processes.

Keywords: Solid-state fermentation, Sequential-batch reactor, Fungal conidia, Packed bed reactor, Substrate biodegradability

Felipe Chagas Rocha Almeida[a], Diego Martins Magalhães[a], Arodí Prado Favaris[a], Jonathan Rodríguez[b], Kamila Emmanuella Xavier Azevedoa, José Maurício Simões Bento[a], Denise Araujo Alves[a] (a. Laboratory of Chemical Ecology and Insect Behaviour, Department of Entomology and Acarology, Luiz de Queiroz College of Agriculture, University of São Paulo, Piracicaba, Brazil, b. Laboratory of Pathology and Microbial Control, Department of Entomology and Acarology, Luiz de Queiroz College of Agriculture, University of São Paulo, Piracicaba, Brazil) Side effects of a fungus-based biopesticide on stingless bee guarding behaviour, Chemosphere, Volume 287, Part 2, January 2022, 132147

Pathogenic fungi have been used worldwide to control crop pests and are assumed to pose negligible threats to the survival of pollinators. Although eusocial stingless bees provide essential pollination services and might be exposed to these biopesticides in tropical agroecosystems, there is a substantial knowledge gap regarding the side effects of fungal pathogens on behavioural traits that are crucial for colony functioning, such as guarding

behaviour. Here, we evaluated the effect of Beauveria bassiana on the sophisticated kin recognition system of Tetragonisca angustula, a bee with morphologically specialized entrance guards. By combining behavioural assays and chemical analyses, we show that guards detect pathogen-exposed nestmates, preventing them from accessing nests. Furthermore, cuticular profiles of pathogen-exposed foragers contained significantly lower amounts of linear alkanes than the unexposed ones. Such chemical cues associated with fungal conidia may potentially trigger aggression towards pathogen-exposed bees, preventing pathogen spread into and among colonies. This is the first demonstration that this highly abundant native bee seems to respond in a much more adaptive way to a potentially infectious threat, outweighing the costs of losing foraging workforce when reducing the chances of fungal pathogen outbreaks within their colonies, than honeybees do.

Keywords: Entomopathogenic fungus, Nestmate recognition, Cuticular hydrocarbons, Social insects, Tetragonisca angustula, Beauveria bassiana

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The use of chemical pesticides in agriculture has been of great concern due to their adverse effects on health and the environment; hence the need to come up with alternative ways of controlling plant pests and diseases. Biopesticides are one of the means to achieve healthy agricultural practices while being environmentally friendly without compromising productivity. Entomopathogenic fungi (EPF) have been used to effectively control insect pests for so long and therefore promise a paradigm shift in the pesticide industry. Therefore, there is an increasing demand for the development of EPF formulations that have already been characterized to ensure an adequate supply of biopesticides. Beauveria bassiana and Metarhizium anisopliae have been used for decades for insect pest management. Notably, several steps are involved in the identification, formulation, and use of different EPF as biopesticides, and there is growing molecular research on how to improve the effectiveness of these fungi. This chapter explores the current status of EPF-based biopesticides and their future in insect pest control.

Keywords: Beauveria bassiana, Biopesticides, Entomopathogenic fungi (EPF), Metarhizium anisopliae, Synthetic pesticides

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This study aims to investigate phenolic compounds recovery from pistachio hull using cleaner production technology. The effects of solvent type (acetone, n-hexane, ethanol, methanol, and deionized water), solvent temperature (25, 50, 75 °C), and extraction time (0.5, 1, 2, 4, 8, 24 h) were optimized for maximum phenolic compounds extraction from the hull. The maximum phenolic compounds extraction (30.8 mg/g) was obtained for water at 75 °C temperature and 4 h extraction time. The pressure-driven membrane process was used to

concentrate phenolic compounds from water used as a solvent. UP150, UP005, NF270, and NF90 membranes were used to concentrate the phenolic compounds. The contents of phenolic compounds in permeate and concentrate streams were determined by LC-MSMS. Moreover, the biopesticide properties of the recovered phenolic compounds were also investigated, which are carried out by researching their bactericidal and fungicidal properties. The extracted phenolic compounds, UP150 permeate, UP150 concentrate, NF270 permeate, and NF270 concentrate showed excellent antioxidant activity. DPPH (2,2-diphenyl-1-picryl-hydrazyl-hydrate) scavenging activity, ferrous chelating activity, antimicrobial activity, bacterial viability inhibition test, and biofilm inhibition activity were tested to investigate the biopesticide properties of the recovered phenolic compounds which displayed moderate antimicrobial activity. UP150 concentrate and NF270 concentrate inhibited 29% and 33% biofilm formation of P. aeruginosa and S. aureus, respectively.

Keywords: Pistachio hull, Phenolic compounds extraction, Membrane process, Antioxidant, Biofilm, Antimicrobial, Cell viability

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Cotton is a major fibre crop grown in South Africa; and is subjected to pest attacks, which reduce its yield and profitability for farmers. Field trials were conducted in 2017 and 2018 to evaluate three biopesticides, namely, Eco-Bb®, Bb endophyte, and Metarhizium rileyi in comparison with the insecticides Chlorpyrifos® 480 EC, Karate® EC, and Bandit® 350 SC. The objective was to determine their efficacy against sucking pests, leafhoppers Jacobiella facialis, aphids Aphis gossypii, thrips Thrips tabaci, whiteflies Bemisia tabaci, red spider mite Tetranychus urticae, and cotton stainers Dysdercus spp. Karate® significantly reduced the leafhopper population and outperformed all the other treatments. Eco-Bb® and Bb endophyte did not control the aphids in 2017. However, in 2018 the best aphid control resulted from the biopesticides used. In 2017 plots treated with Eco-Bb® had the lowest number of thrips, while in 2018 plots treated with Bandit® had the least thrips, followed by treatments with M. rileyi and Karate®. There were no significant differences in the populations of whiteflies, however, insecticides were more effective than the biopesticides. All the treatments, except for Bandit®, significantly reduced the number of spider mites compared in 2017.

Applications of Eco-Bb® and Bb endophyte significantly reduced spider mites in 2017, while in 2018 plots treated with Karate®, followed by M. rileyi, resulted in the lowest number of spider mites. Application of Bb endophyte, Chlorpyrifos®, and Karate® resulted in the lowest number of cotton stainers. The highest mean cottonseed yields of 6395 kg ha−1, 6295 kg ha−1, and 6141 kg ha−1 were recorded in plots sprayed with Bandit®, Bb endophyte, and Eco-Bb®, respectively. Biopesticides and chemical insecticides can be combined or alternated for future IPM programmes to control cotton pests.

Keywords: Cotton, Biopesticides, Insecticides, Leafhopper

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Developing biopesticide-based programmes for managing powdery mildew in protected strawberries in the UK, Crop Protection, Volume 149, November 2021, 105766

Powdery mildew, caused by Podosphaera aphanis, is an important disease of strawberries and currently its control in the UK is very dependent on conventional fungicides. A series of experiments were carried out to integrate conventional fungicides with biopesticides and biostimulants for mildew control. In 2015–2016, the biopesticides Sonata (Bacillus pumilis) and AQ10 (Ampelomyces quisqualis) achieved at least as good as or better mildew control where they were applied alone rather than alternated with or tanked mixed with conventional fungicides. Three mildew management programmes were evaluated in 2017 on an ever-bearer cultivar. In the B. pumilis based programme, the need for treatment and the choice of products were partially

determined by predicted mildew risks. The incidence of mildew on leaves was very low in untreated plots with virtually no mildew observed in the other treated plots. By contrast, mildew on the fruit rose rapidly from 2 % in late July to >90 % in late August in untreated plots. In treated plots, the percentage of fruit with mildew did not rise above 3 % with the three managed programmes based on B. pumilis. There were no significant differences in total yield and marketable yield between the managed programmes and the routine fungicide programme, but all were significantly greater than the untreated control. Most of the unmarketable fruit in the untreated control was due to infection with powdery mildew. The results suggested that strawberry powdery mildew can be effectively managed by the integrated use of biopesticides, biostimulants and conventional fungicides.

Keywords: Biopesticide, Biostimulant, Fungicide, Plant extract, Podosphaera aphanis

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Bacillus thuringiensis (Bt) is a ubiquitous bacterium that produces several proteins that are toxic to different invertebrates such as insects, nematodes, mites, and also some protozoans. Among these, Cry and Cyt proteins are most explored as biopesticides for their action against agricultural pests and vectors of human diseases. In 2000, a group of researchers from Japan isolated parasporal inclusion proteins from B. thuringiensis, and reported their cytotoxic action against human leukemia. Later, other proteins with similar antitumor properties were also isolated from this bacterium and these cytotoxic proteins with specific activity against human cancer cells were named parasporins. At present, nineteen different parasporins are registered and classified in six families. These parasporins have been described to have specific in vitro antitumor activity against several cancer cell lines. The antitumor activity makes parasporins possible candidates as anticancer agents. Various research groups around the world are involved in isolating and characterizing in vitro antitumor activity of these proteins and many articles reporting such activities in detail have been published. However, there are virtually no data regarding the antitumor activity of parasporins in vivo. This review summarizes the properties of these potentially useful antitumor agents of natural origin, focusing on their in vivo activity thus also highlighting the importance of testing these proteins in animal models for a possible application in clinical oncology.

Keywords: Toxicity, Bacterial proteins, Parasporin, Antitumor activity, In vivo analysis

Martha L.Chaparro, Poldy J.Sanabria, Ana M.Jiménez, Martha I.Gómez, Eddy J.Bautista, Leyanis Mesa (Bioproducts Department, Tibaitatá, Corporación Colombiana de Investigación Agropecuaria (Agrosavia), Km 14 Mosquera, Bogotá, Cundinamarca, Colombia) **A circular economy approach for producing a fungal-based biopesticide employing pearl millet as a substrate and its economic evaluation, Bioresource Technology Reports, Volume 16, December 2021, 100869**

This study aims to present a circular economy approach as regards developing a culture medium based on pearl millet as a substrate to produce Akanthomyces lecanii conidia for purposes of biopesticides employing solid-state fermentation (SSF) in polypropylene bags. The study was developed with two main focuses. First, on the evaluation of a culture medium based on pearl millet and a separation step. Second, a techno-economic analysis

was carried out to evaluate the production costs of alternative processes. The best medium for biomass yield and enzymatic activities was the one with recycled pearl millet with 0.6% sugarcane molasses. The unitary production cost is reduced 32% when recycled pearl millet and sugarcane molasses are used as production mediums at highest production volume. These results show the economic advantages of introducing the concepts linked to a circular economy, such as recycle and recovery in biopesticide obtention from A. lecanii conidia.

Keywords: Pearl millet, Fungal biopesticide, Multi-systems approach, Circular economy

Biodegradation

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Based on the available literature, biodegradation and biodeterioration at the nanoscale aim to explore two critical issues, among others: (1) exploitation of catalytic cues or adsorbents, which are engineered at the nanoscale, for highly effective and sustainable biodegradation and biodeterioration of thousands of toxic and hazardous chemical compounds of so-called pollutants of serious concern; (2) effects/roles of engineered nanoscale materials in the biodegradation/biodeterioration processes. Regarding the environmental impacts, the biodegradation of polymers, plastics, and environmentally related pollutants of concern has a positive impact. In contrast, biodeterioration/biocorrosion of metals or alloys has a negative impact. In fact, nanoparticles can accelerate or inhibit the biodegradation process, depending on the nature of bacteria, fungi, algae, enzymes, nanomaterials, or bulk materials, especially in the soil environment. In general, biodegradation refers mostly to the microbial-induced degradation of polymers, plastics, and environmentally related pollutants of concern. In this direction, the incorporation of nanomaterials in an organic matrix (nanocomposites) might affect its degradation due to of their nanotoxicity. In the case of metals and their alloys, their biodeterioration/biocorrosion due to microbial biofilms' presence could be reduced by the introduction of nanocrystals/nanophases into the metal matrix (nanoalloys).

Keywords: Nanotechnology, bioremediation, environmental pollution, nano-sensing, bio-catalysis, mitigation, safe environment

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Environmental pollution has become a huge concern and threat in the last decades. This fact is due to hazardous effects of the different pollutants on the environment and human. In this regard, removal and treatment of pollutants from the environment is vital. Between different treatment approaches, biodegradation process is a versatile method for removal of contaminations, which is due to the amazing properties of this method. The biodegradation process does not need a high consumption of energy; it can save nonrenewable sources of energy, and it is considered a green and ecofriendly approach. Among the various biodegradation processes, the biodegradation methods that are based on the application of nanomaterials and especially nanoparticles are in the

hotspot. Nanoparticles with unique properties in terms of high chemical and physical stability, high surface area, high adsorption capacity, high-loading capacity, and so on can improve the performance of biodegradation processes. To this end, this chapter focuses on the recent development in roles and application of nanomaterials in biodegradation. To this end, at first, nanomaterials and their unique physical and chemical features will be introduced. Then, the roles of nanoparticles in biodegradation will be discussed. And finally, recent developments and progress of biodegradation processes, which are based on the application of nanoparticles, will be investigated. This chapter can open a new window toward researchers who are interested in biodegradation processes and nanoparticles. We hope that this chapter can help researchers understand the roles of nanoparticles in biodegradation processes for removal of different pollutants from the environment.

Keywords: Biodegradation process, nanoparticles, pollutants, removal, treatment

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Plastics have wide applications industrially and domestically, so there is always an increasing trend toward its production around the globe. Several studies have been carried out on plastics biodegradation to overcome the environmental issues linked with synthetic plastics. The production of biodegradable plastics has become vital in the last few decades because of its origination from renewable sources. Interest in plastic biodegradation revolves around ecofriendly methods as through microbes, which provide CO2 and H2O end products resulting in no pollution. Shortcomings of biodegradable polymers can be overcome by nanoparticle incorporation into polymer framework or by developing nanocomposites. The rate of biodegradation can also be tuned by nanoparticle incorporation according to the required efficiency. This chapter focuses on broad spectrums of biodegradable polymers, types, and mechanisms of biodegradation, the impact of nanoparticle, and nanofillers on biodegradation.

Keywords: Bioplastics, nanoparticles, microbial degradation, nanobiodegradation, nanoclays

Emily R.Byrne, Kayley M.Roche, Laura G.Schaerer, Stephen M.Techtmann (Department of Biological Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI, USA) **Temporal variation of crude and refined oil biodegradation rates and microbial community composition in freshwater systems, Journal of Great Lakes Research, Volume 47, Issue 5, October 2021, Pages 1376-1385**

Freshwater systems are vulnerable to contamination by oil extraction and transportation. Thus, it is critical to understand how large freshwater ecosystems such as the Great Lakes will respond to released oil. In this study, we investigated differences in the microbial response to oil in the Straits of Mackinac at different times throughout the year and if crude (Bakken) and refined (non-highway diesel) oil exposure differentially altered the microbial community composition and hydrocarbon biodegradation rates. We also investigated the impact of temperature on the microbial response to oil by incubating samples collected in October of 2018 at 23 °C and at 4 °C. Ambient microbial communities differed between sample collection times, with significantly enriched microbial groups present between most sample types. We found significantly different microbial communities between control and oil-amended samples, but no significant differences between either oil type. We found that the bacterial family Solimonadaceae were significantly enriched in all oil-amended microcosms compared to the control microcosms across sampling times. We assessed oil biodegradation using CO2 production as a proxy for hydrocarbon metabolism. We observed a general trend of increased respiration rates with oil amendment compared to the control. No statistically significant differences in daily CO2 production rates existed between the two oil types. These findings suggest that microbial community in the Straits of Mackinac shifts over time even without oil amendment, and that the microbial communities in the Straits of Mackinac are compositionally and metabolically responsive to the presence of varying oil types throughout the year.

Keywords: Bioremediation, Biodegradation rates, Microbial communities, Crude oil, Season

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Two morphologies of laccase-mineral hybrid complexes, i.e., laccase-mineral hybrid nanoflowers (La-HNF) and nanopetals (La-HNP), were synthesized via biomineralization using Cu3 (PO4)2·3H2O as the mineral for Evans Blue (EB) dye biodegradation. XRD patterns and FT-IR spectra results revealed the successful immobilization of laccase via in-situ formed Cu3(PO4)2·3H2O crystals. Compared with free laccase, laccase-mineral hybrid complexes showed higher enzymatic activity due to the activation effect induced by copper ions of Cu3(PO4)2·3H2O, further, the improved kinetic parameters of laccase-mineral hybrid complexes could be ascribed to nanoscale-dispersed laccase molecules within hybrid complexes. For EB dye biodegradation, the reason why the biodegradation efficiency (94.9%) of La-HNF was higher than that (86.8%) of La-HNP could be synergistic effect of immobilized laccase within 3D hierarchical structure of La-HNF. In addition, the optimized biodegradation conditions (pH 4.6 and 40 °C) of La-HNF were obtained, moreover, 93.2% and 48.1% of EB dye were biodegraded by La-HNF after stored for 30 days and reused for 10 cycles, respectively, demonstrating La-HNF have good practicability.

Keywords: Biomineralization, Laccase, Biodegradation

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Fifteen azo dyes were subjected to microbial degradation by four fungal strains and their mixtures as well as five bacterial strains and their mixtures. The biodegradation efficiency was determined by LC/MS/MS analysis. The most active bacterial strain was B. subtilis, where it showed the highest biodegradation capacity (71.8% to 100%) of eight azo dyes. Bacterial strain B. brevis came next to it. However, the consortium of the five bacterial strains gave lower degradation percentages. On the other hand, the fungal strains and their consortium were more potent in biodegradation of all tested azo dyes, where ten azo dyes were completely (100%) degraded by the consortium. Two of widely used azo dyes, direct violet and methyl red, were further studied in relation to the intermediate biodegradation products by each of the tested fungi and bacteria as well as the bacterial and fungal consortia using GC/MS/MS. The major biodegradation product of methyl red was 2-amino benzoic acid by all of the tested bacterial strains and A. niger, while the major biodegradation products of direct violet by both bacteria and fungi were ethanol, 2(2-butyxyethoxy), followed by 4- methyl benzoic acid and phenol, 2,4-bis (1,1-dimethyl ethyl). The results of this study suggest the successful use of the four fungal consortium for the biodegradation of the azo dyes. These findings are important to design bioremediation technology for treating the azo dye residues.

Keywords: Azo dyes, Biodegradation, Bacterial consortium, Fungal consortium

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Nicolaus Copernicus University, Lwowska 1, 87-100 Toruń, Poland, b. Department of Microbiology, Faculty of Biological and Veterinary Sciences, Nicolaus Copernicus University, Lwowska 1, 87-100 Toruń, Poland) **Potential of Serratia plymuthica IV-11-34 strain for biodegradation of polylactide and poly(ethylene terephthalate) International Journal of Biological Macromolecules, Volume 193, Part A, 15 December 2021, Pages 145-153**

Serratia plymuthica strain IV-11-34 belongs to the plant growth promoting bacteria (PGPR). In the sequenced genome of S. plymuthica IV-11-34, we have identified the genes involved in biodegradation and metabolisms of xenobiotics. The potential of S. plymuthica IV-11-34 for the degradation of biodegradable aliphatic polyester polylactide (PLA) and resistant to biodegradation – poly(ethylene terephthalate) (PET) was assessed by biochemical oxygen consumption (BOD) and carbon dioxide methods. After seven days of growth, the bacteria strain showed more than 80% and 60% increase in respiratory activity in the presence of PLA and PET, respectively. We assume that during biodegradation, S. plymuthica IV-11-34 colonise the surface of PLA and PET, since the formation of a biofilm on the surface of polymers was shown by the LIVE/DEAD method. We have demonstrated for the relA gene, which is an alarmone synthetase, a 1.2-fold increase in expression in the presence of PLA, and a 4-fold decrease in expression in the presence of PET for the spoT gene, which is a hydrolase of alarmones. Research has shown that the bacterium has the ability to biodegrade PLA and PET, and the first stage of this process involves bacterial stringent response genes responsible for survival under extreme conditions.

Keywords: Bacterial stringent response, Polylactide, Poly(ethylene terephthalate), Biodegradation

Zhimao Mai[ab], Lin Wang[ab], Qiqi Li[a], Yingting Sun[a], Si Zhang[ab] (a. State Key Laboratory of Tropical Oceanography and CAS Key Laboratory of Tropical Marine Bio-resources and Ecology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China, b. Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou), Guangzhou, 511458, China) **Biodegradation and metabolic pathway of phenanthrene by a newly isolated bacterium Gordonia sp. SCSIO19801, Biochemical and Biophysical Research Communications, Volume 585, 31 December 2021, Pages 42-47**

The bacterium Gordonia sp. SCSIO19801, which could effectively utilize phenanthrene as the sole carbon source, was isolated from the seawater of the South China Sea. Its biodegradation characteristics, whole genome sequence, and biodegradation pathway were investigated. The phenanthrene biodegradation process of Gordonia sp. SCSIO19801 was estimated to be a first-order kinetic model with a k value of 0.26/day. Based on the identification of metabolites, utilization of probable intermediates, and genomics analysis of related genes, the degradation of phenanthrene by Gordonia sp. SCSIO19801 was proposed to occur via the salicylate metabolic pathway. This is the first report of a phenanthrene degradation pathway in Gordonia species. In addition, the Gordonia sp. SCSIO19801 could use other aromatic compounds as the sole source of carbon and energy. These characteristics indicate that Gordonia sp. SCSIO19801 can be utilized for developing effective methods for the biodegradation of petroleum hydrocarbons in marine environments.

Keywords: Gordonia sp., Biodegradation, Polycyclic aromatic hydrocarbons, Phenanthrene, Metabolic pathway

Biosensor

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Universiti Malaysia Perlis, Arau, Perlis 02600, Malaysia., e. Centre for Artificial Intelligence and Robotics, Universiti Teknologi Malaysia, Jalan Sultan Yahya Petra, Kuala Lumpur 54100, Malaysia, f. School of Biological Sciences, Universiti Sains Malaysia (USM), George Town, Penang 11800 , Malaysia) **Essential semiconductor films in micro-/nano-biosensors: Current scenarios, Journal of the Taiwan Institute of Chemical Engineers, Volume 127, October 2021, Pages 302-311**

Background:Engineering nanoscale matter in a controlled functional system has expanded the area of science in the state-of-art of nanotechnology. The urgency in introducing real-time health monitoring sensors and rapid diagnostic tools in medical health is indeed high and crucial to date. The efforts are accompanied by nanotechnology to improve the sensors performances. In this line, semiconductor materials (Silicon/Silica) have been in well-focus to develop micro-/nano-sensors.
Methods: Further, additional layering such as metal oxide and graphene material have elevated the current scenario in biosensor developments. Among these, two-dimensional graphene nanomaterial owns its remarkable mechanical, electronic, electrochemical, and optical properties, has excited the medical field to develop graphene-based biosensors for human health diagnosis and monitoring. The oxygen rich graphene materials enhance the bio-functionalization of recognition bio-elements for excellent graphene-based biosensor development.
Significance: This review encloses the excellence of semiconductor materials in conjunction with biosensors for monitoring health and diagnosis. The advances and challenges encountered with developing semiconductors for nanobiosensors from laboratory set-up to the novel hand-held device for rapid and accurate human health care are outlined.

Keywords: Nanomaterial, Semiconductor industry, Nanobiosensor, Signal transduction

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l-lysine being one of the essential amino acids is not produced by the body, but is obtained through diet. l-lysine determination is important in the food and pharmaceutical industries as well as have medical and diagnostic applications. The normal l-lysine levels in a healthy human serum sample is 150 to 250 μmol/l. There is imbalance in l-lysine levels in certain diseased conditions. So, it could be a biomarker for diagnosis. Various basic methods are available for the determination of l-lysine such as colorimetric, radioisotope dilution, chromatographic, fluorometric and voltammetric methods. These methods have certain disadvantages like sample pretreatment, costly, time consuming and requirement of skilled personnel. These drawbacks are overcome by the use of biosensors due to their high sensitivity, stability and specificity. The present review article discusses about the principles, merits and demerits of the various analytic methods for determination of l-lysine with special emphasis on biosensors. l-lysine biosensors work ideally under the optimum pH 5 to 10, potential range −0.05 to 1.5 V, temperature 25 to 40 °C, with linear range 0.01 to 5500 μM, detection limit 0.000004 to 650 μM and response time 2 to 300 s. The sensor had storage stability between 14 and 200 days.

Keywords: l-lysine, l-lysine biosensor, Amperometric

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Apoptosis is a type of cell death caused by the occurrence of both pathological and physiological conditions triggered by ligation of death receptors outside the cell or triggered by DNA damage and/or cytoskeleton disruption. Timely monitoring of apoptosis can effectively help early diagnosis of related diseases and continuous assessment of the effectiveness of drugs. Detecting caspases, a protease family closely related to cellular apoptosis, and its identification as markers of apoptosis is a popular procedure. Biosensors are used for early diagnosis and play a very important role in preventing disease progression in various body sections. Recently, there has been a widespread increase in the desire to use materials made of paper (e.g. nitrocellulose membrane) for Point-of-Care (POC) testing systems since paper and paper-like materials are cheap, abundant and degradable. Microfluidic paper-based analytical devices (μPADs) are highly promising as they are cost-effective, easy to use, fast, precise and sustainable over time and under different environmental conditions. In this review, we focused our efforts on compiling the different approaches on identifying apoptosis pathway while giving brief information about apoptosis and biosensors. This review includes recent advantages in biosensing techniques to simply determine what happened in the cell life and which direction it would continue. As a conclusion, we believed that the review may help to researchers to compare/update the knowledge about diagnosis of the apoptosis pathway while reminding the basic definitions about the apoptosis and biosensor technologies.

Keywords: Apoptosis, Caspases, Biosensors, Bioreceptors, Paper-based biosensors

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Current arsenic analysis methods in groundwater samples rely on expensive apparatus, complicated procedures, and dangerous chemical reagents. Also, delays in detecting arsenic harm to public health, the environment, agriculture and food sectors. Therefore, in this study, a bioluminescent biosensor has been optimized and used to detect and measure arsenic concentration in groundwater. Optimum conditions for the appropriate performance of E. coli DH5α (pJAMA-arsR) were determined and the luminescent calibration curve was drawn. The optimization results showed that maximum luminescent light output could occur at the end of the logarithmic phase or the beginning of the stationary phase, the temperature of 37 °C, and pH between 5.5 and 7 upon adding 10 μl n-decanal (18 mM). Increasing the duration of bacterial induction by arsenic leads to elevation of biosensor luminescent light yield. Functional stability of the biosensor with 20 % glycerol (V/V) at −20 °C was verified for at least six months. Luminescence reaction of the bacterial biosensor cells to arsenic concentration in the range of 0–90 ppb was promising (R2 = 0.948 by linear regression), but higher arsenic concentration had poisonous effect on biosensor cells. The modified Gompertz model derived here could successfully predict the bacterial biosensor growth under the optimum condition compared with experimental data. In this study critical challenges, such as technical and appropriate performance, are defined to interpret the bacterial biosensor's true perspective to promote its broad adoption and usage. The work is concluded with closing remarks and potential perspectives to emphasize the importance of the bacterial biosensor, which could detect arsenic from a wide scope in real-time, quickly, and environmentally friendly signaling tool with high sensitivity and selectivity.

Keywords: Biosensor, Arsenic, Gompertz model, Growth kinetics, E. coli DH5α (pJAMA8-arsR)

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University of Light Industry, Zhengzhou, 450001, China) Metal–organic frameworks (MOFs) based chemosensors/biosensors for analysis of food contaminants, Trends in Food Science & Technology, Volume 118, Part A, December 2021, Pages 569-588

Background: As a critical topic of international concern, food safety has received great attention in recent years. The hazardous substances (such as antibiotics, heavy metal ions, food additives, and foodborne bacteria) in foodstuffs would cause threat to human health and economic losses in food industry. Despite of high sensitivity, accuracy, and reliability of conventional techniques for analysis of food contaminants, they often require complicated apparatus, well-trained personalized operation, and laborious and time-consuming procedure. In this regard, new sensing strategies for convenient, fast, and sensitive detection of food contaminants should be developed for food safety.
Scope and approach: Metal–organic frameworks (MOFs), as a large category of porous crystalline materials, could be used as efficient platforms for constructing diverse chemosensors and biosensors, for their high porosity, adjustable compositions or structures, and good stability. A variety of MOFs, MOFs-based composites, and MOFs-based derivatives show excellent fluorescence (FL), chemical functionality, and strong bioaffinity toward probes (DNA, aptamers, or antibodies), exhibiting great potentials as FL emitters, electrode materials, or platforms of biosensors for selective and sensitive detection of hazard analytes in foodstuffs. By coupling with different determination techniques such as FL, electrochemical (EC), photoelectrochemical (PEC) or surface-enhanced Raman spectroscopy methods, MOFs-based materials have shown promising applications for detecting diverse analytes. Furthermore, the current challenges and future developments of MOFs-based materials for analysis of food contaminants have been discussed.
Key findings and conclusions: Although some reviews on the applications of MOFs in food packing and food safety have been documented, this comprehensive review will provide new insights to the construction of chemosensors and biosensors with MOFs-based materials for determination of food contaminants toward food safety monitoring.

Keywords: Metal–organic frameworks (MOFs), Biosensors, Chemosensors, Food safety, Analysis of food contaminants

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Biosensor-based growth-coupling and spatial separation as an evolution strategy to improve small molecule production of Corynebacterium glutamicum, Metabolic Engineering, Volume 68, November 2021, Pages 162-173

Evolutionary engineering is a powerful method to improve the performance of microbial cell factories, but can typically not be applied to enhance the production of chemicals due to the lack of an appropriate selection regime. We report here on a new strategy based on transcription factor-based biosensors, which directly couple production to growth. The growth of Corynebacterium glutamicum was coupled to the intracellular concentration of branched-chain amino acids, by integrating a synthetic circuit based on the Lrp biosensor upstream of two growth-regulating genes, pfkA and hisD. Modelling and experimental data highlight spatial separation as key strategy to limit the selection of 'cheater' strains that escaped the evolutionary pressure. This approach facilitated the isolation of strains featuring specific causal mutations enhancing amino acid production. We envision that this strategy can be applied with the plethora of known biosensors in various microbes, unlocking evolution as a feasible strategy to improve production of chemicals.

Keywords: Transcription factor-based biosensors, Growth-coupling, Adaptive evolution, Amino acid production

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During the last years, the use of biosensors in food analysis has gained considerable interest. These analytical devices provide highly selective, sensitive and cost-effective detection of cells, chemical or biochemical compounds that are relevant for food industry. In special, such sensors can be employed to control and monitoring biotechnological processes for food production and transformation. This review provides an overview on the state-of-the-art of electrochemical biosensors with potential use in food bioprocess technology, focusing on those with potential application in fermentation productions.

Keywords: Biosensor

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Glycolysis is the primary metabolic pathway in all living organisms. Maintaining the balance of glycolysis flux and biosynthetic pathways is the crucial matter involved in the microbial cell factory. Few regulation systems can address the issue of metabolic flux imbalance in glycolysis. Here, we designed and constructed a bifunctional glycolysis flux biosensor that can dynamically regulate glycolysis flux for overproduction of desired biochemicals. A series of positive-and negative-response biosensors were created and modified for varied thresholds and dynamic ranges. These engineered glycolysis flux biosensors were verified to be able to characterize in vivo fructose-1,6-diphosphate concentration. Subsequently, the biosensors were applied for fine-tuning glycolysis flux to effectively balance the biosynthesis of two chemicals: mevalonate and N-acetylglucosamine. A glycolysis flux-dynamically controlled Escherichia coli strain achieved a 111.3 g/L mevalonate titer in a 1L fermenter.

Keywords: Glycolysis flux, Fructose-1,6-diphosphate, Bifunctional biosensor, Dynamic control, Mevalonate

Bioengineering

M.E.Ali[1], M.M.Rahman[1], T.S.Dhahi[2], M.Kashif[3], M.S.Sarkar[4], W.J.Basirun[5], S.B.A.Hamid[5], S.K.Bhargava[6], Mohamad Ramadan[7] (1. University of Malaya, Kuala Lumpur, Malaysia, 2. Basra University, Basra, Iraq, 3. University of Malaysia Sarawak, Sarawak, Malaysia, 4. University of Malaysia, Pahang, Kuantan, Malaysia, 5. University of Malaya, Kuala Lumpur, Malaysia, 6. RMIT University, Melbourne, VIC, Australia, 7. International University of Beirut, Beirut, Lebanon, Associate member at FCLAB, University Bourgogne Franche-Comte, Belfort cedex, France, Lebanese International University, Beirut, Lebanon) **Nanostructured Materials: Bioengineering Platforms for Sensing Nucleic Acids, Encyclopedia of Smart Materials, Volume 3, 2022, Pages 325-351**

Detection of specific nucleic acid targets is of enormous and increasing interest in molecular biodiagnostics, food analysis, forensic investigation, and environmental monitoring. The advancement of nanotechnology with a

myriad of novel and engineered nanomaterials and their hybrids with attractive physiochemical properties has raised hopes for the development of DNA sensors capable of identifying specific nucleic acid sequences with single molecule precision, avoiding the need of skilled personnel or sophisticated machineries. Compared to the traditional sensing platforms, DNA–nanomaterial hybrids provide better sensitivity and multiplexing facility, reducing analysis cost and increasing detection precision by several orders of magnitudes. The biofusion of DNA with nanostructured gold, nanostructured silica, nanogap semiconductors, carbon nanotubes, graphenes, and quantum dots has shown great possibilities to fabricate specialized nanostructured configurations capable of enhancing DNA detection several-fold. Miniaturized devices with embedded DNA of thousands of fingerprints in lab-on-a-chip are no longer a surprise. Here, we describe potential candidate nanomaterials and their molecular binding patterns with DNA to constitute a sensing platform for nucleic acid targets. The future perspectives and challenges of nanotechnology strategies are also outlined.

Keywords: Nanobiofusion, Nanostructured materials, Nucleic acid sensors, Quantum dots, Sensing platforms

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T cell based immunotherapies can be applicable to acute myeloid leukemia (AML). Therefore, the selection of optimal T cells, cell manufacturing, and therapeutic T cell engineering are essential for the development of effective adoptive T cell therapies for AML. Autologous tumor-infiltrating lymphocytes (TILs) have been in clinical trials to treat solid malignancies. Herein, we assessed whether TILs can be isolated from the bone marrow (BM) of AML patients, expanded ex vivo and utilized as a novel therapeutic strategy for AML. To this end, firstly we analyzed the immunophenotypes of a series of primary BM samples from AML patients (N = 10) by flow cytometry. We observed a variable amount of CD3+ TILs (range ~2.3–~32.6% of mononuclear cells) among BM samples. We then developed a novel protocol that produced a three-log ex vivo expansion of TILs isolated from AML patient BM (N = 10) and peripheral blood (PB) (N = 10), including from patients with a low number of CD3+ T cells, within 3, 4 weeks. Further, we identified previously described naïve T cells (CCR7+CD95-/or CD62L+CD45RA+) in AML BM and PB samples, which seemed to be required for a successful TILs ex vivo expansion. Finally, we showed that the expanded TILs could: (1) cause cytotoxicity to autologous AML blasts ex vivo (90.6% in control without T cell treatment vs. 1.89% in experimental groups with PB derived T cells and 1.77% in experimental groups with BM derived TILs, $p < 0.01$), (2) be genetically engineered to express CYP27B1 gene, and (3) infiltrate the BM and reside in close proximity to pre-injected autologous AML blasts of engrafted immunodeficiency mice. Altogether, these results provide a rationale for further studies of the therapeutic use of TILs in AML.

Keywords: Acute myeloid leukemia, Tumor-Infiltrating Lymphocytes, Immunotherapy, Naïve T, CCR7, CD95, CD62L, CD45RA, Bone marrow, Adoptive cell therapy, Interleukin, Programmed cell death protein 1, PD-1, CAR-T

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Bengal, 741246, India, b. Department of Pathobiology, Ontario Veterinary College, University of Guelph, Guelph, ON, N1G 2W1, Canada) **Pre-treatment with chicken IL-17A secreted by bioengineered LAB vector protects chicken embryo fibroblasts against Influenza Type A Virus (IAV) infection, Molecular Immunology, Volume 140, December 2021, Pages 106-119**

The recent advances in our understanding of the host factors in orchestrating qualitatively different immune responses against influenza Type A virus (IAV) have changed the perception of conventional approaches for controlling avian influenza virus (AIV) infection in chickens. Given that infection-induced pathogenicity and replication of influenza virus largely rely on regulating host immune responses, immunoregulatory cytokine profiles often determine the disease outcomes. However, in contrast to the function of other inflammatory cytokines, interleukin-17A (IL-17A) has been described as a 'double-edged sword', indicating that in addition to antiviral host responses, IL-17A has a distinct role in promoting viral infection. Therefore, in the present study, we investigated the chicken IL-17A mediated antiviral immune effects on IAVs infection in primary chicken embryo fibroblasts cells (CEFs). To this end, we first bioengineered a food-grade Lactic Acid Producing Bacteria (LAB), Lactococcus lactis (L. lactis), secreting bioactive recombinant chicken IL-17A (sChIL-17A). Next, the functionality of sChIL-17A was confirmed by transcriptional upregulation of several genes associated with antiviral host responses, including granulocyte-monocyte colony-stimulating factor (GM-CSF) (CSF3 in the chickens), interleukin-6 (IL-6), interferon-α (IFN-α), -β and -γ genes in primary CEFs cells. Consistent with our hypothesis that such a pro-inflammatory state may translate to immunoprotection against IAVs infection, we observed that sChIL-17A pre-treatment could significantly limit the viral replication and protect the primary CEFs cells against two heterotypic IAVs such as A/turkey/Wisconsin/1/1966(H9N2) and A/PR/8/1934(H1N1). Together, the data presented in this work suggest that exogenous application of sChIL-17A secreted by modified LAB vector may represent an alternative strategy for improving antiviral immunity against avian influenza virus infection in chickens.

Keywords: Chicken interleukin 17A, Lactococcus lactis, Influenza Type A virus, Primary chicken embryo fibroblasts cells

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Among the issues faced by humans, the availability of land for usage is becoming a critical and primary concern, which affects a large population. Land degradation converts useful, productive land into non-cultivable and unproductive land. It degrades land in terms of reduction in productivity and usage, which occurs due to several factors, including climate change and poor land management. In this process, two interlocking complex systems are involved: the natural environment and the social system of humans, which alter the biophysical, natural environment, and socioeconomic factors in the area through this deterioration mechanism. Focusing on enhancing land usability, numerous efforts and techniques are being studied and used by researchers and practitioners worldwide. In this work, we introduced one such method called soil bioengineering, which is a process of promoting strength in slopes that are vulnerable to soil erosion and slope failure, and it is used for riverbank protection and, embankment strength enhancement. This method has gained worldwide popularity in the recent decade owing to its simplicity, ecosystem services, and economic viability of the process. Its particularity resides in the technological application of vegetation and is often mixed with other products. The sources and content of soil bioengineering have not been thoroughly explored, and there is still the possibility for other aspects to be examined. Many countries have already started implementing procedures and formed

frameworks for using plant wealth not only to protect slopes but also to eradicate land degradation, which is important for ecosystem protection.

Keywords: Plants, Grasses, Soil bioengineering, Land degradation

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Extracellular matrix (ECM) hydrogels obtained from decellularized tissues are promising biocompatible materials for tissue regeneration. These biomaterials may provide important options for endometrial pathologies such as Asherman's syndrome and endometrial atrophy, which lack effective therapies thus far. First, we performed a proteomic analysis of a decellularized endometrial porcine hydrogel (EndoECM) to describe the specific role of ECM proteins related to regenerative processes. Furthermore, we investigated the ability of a bioengineered system—EndoECM alone or supplemented with growth factors (GFs)—to repair the endometrium in a murine model of endometrial damage. For this model, the uterine horns of female C57BL/6 mice were first injected with 70% ethanol, then four days later, they were treated with: saline (negative control); biotin-labeled EndoECM; or biotin-labeled EndoECM plus platelet-derived GF, basic fibroblast GF, and insulin-like GF 1 (EndoECM+GF). Endometrial regeneration and fertility restoration were evaluated by assessing the number of glands, endometrial area, cell proliferation, neaoangiogenesis, reduction of collagen deposition, and fertility restoration. Interestingly, regenerative effects such as an increased number of endometrial glands, increased area, high cell proliferative index, development of new blood vessels, reduction of collagen deposition, and higher pregnancy rate occurred in mice treated with EndoECM+GF. Thus, a bioengineered system based on EndoECM hydrogel supplemented with GFs may be promising for the clinical treatment of endometrial conditions such as Asherman's syndrome and endometrial atrophy.
Statement of significance: In the last years, the bioengineering field has developed new and promising approaches to regenerate tissues or replace damaged and diseased tissues. Bioengineered hydrogels offer an ideal option because these materials can be used not only as treatments but also as carriers of drugs and other therapeutics. The present work demonstrates for the first time how hydrogels derived from pig endometrium loaded with growth factors could treat uterine pathologies in a mouse model of endometrial damage. These findings provide scientific evidence about bioengineered hydrogels based on tissue-specific extracellular matrix offering new options to treat human infertility from endometrial causes such as Asherman's syndrome or endometrial atrophy.

Keywords: Extracellular matrix hydrogels, Decellularized tissue engineering, Endometrium, Growth factors, Murine model

Jeffery Young[a], Maria Spichkova[b], Milan Simic[a] (a. School of Engineering, RMIT University, Melbourne, Australia, b. School of Computing Technologies, RMIT University, Melbourne, Australia) **Project-based learning within eHealth, bioengineering and biomedical engineering application areas, Procedia Computer Science, Volume 192, 2021, Pages 4952-4961**

This paper presents a short overview of projects conducted at RMIT University in Melbourne, Australia, as a part of the learning and teaching activities in the Science, Technology, Engineering and Mathematics (STEM) College. The focus is on eHealth, bioengineering, biomedical engineering and related application areas. We introduce how these research areas are embedded into the curriculum, as well as, present a number of recent and current projects conducted by our students in collaboration with industrial partners, other academic institutions and medical practitioners.

Keywords: project-based learning, bioengineering, biomedical engineering, eHealth, software engineering

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Current textile production and processing practices provide materials with desirable performance properties, such as stretch and moisture management, but these processes are leading contributors to global greenhouse gas emissions, microplastic pollution, and toxic wastewater. Fortunately, green alternatives to current textile fibers that support a transition to a sustainable, circular materials economy are within reach. Bioengineering of fibers at the nano-, micro-, and macroscale provides several avenues to improve both the environmental impacts and technical performance of textile materials. Herein, we provide an overview of recent efforts to bioengineer fibers and textiles from the biopolymer components to biofabrication schemes. These include the genetic engineering of microorganisms for biofabrication, green chemistry processing of raw materials, and green manufacturing techniques. This overview informs a discussion on the future outlook of sustainable biotextile production, with a focus on utilization of waste streams to both improve the circularity and commercial viability of the processes.

Keywords: biofabrication, biomaterials, synthetic biology, microbial biosynthesis, green chemistry, textiles, climate impacts

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Chronic and acute lung diseases are the third and fourth leading causes of global mortality. Distal lung tissue is severely damaged in many lung diseases, causing respiratory insufficiency from loss of surface area available for gas exchange. Current therapies aim at relieving symptoms and are unable to reverse disease. Lung transplantation remains the only potential curative option at end-stage disease but is severely limited by a lack of suitable donor lungs and low long-term survival. Bioengineering lung tissue or bioengineering cells with biomaterials for transplantation is an exciting new approach to (re)generate tissue to close this large unmet clinical need.

Keywords: 3D bioprinting, Alveolar, Bioengineering, Bioreactor, Chronic lung disease, Chronic obstructive pulmonary disease, Decellularization, Extracellular matrix, Pulmonary fibrosis, Pulmonary hypertension, Scaffold, Small airways, Synthetic scaffold

Pollen Biotechnology

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Departamento de Ecosistemas Agroforestales, Universitat Politècnica de València, 46022, Valencia, Spain, c. Instituto Cavanilles de Biodiversidad y Biología Evolutiva, Universidad de Valencia, 46010, Valencia, Spain, d. Instituto de Conservación y Mejora de la Agrobiodiversidad Valenciana/Departamento de Química, Universitat Politècnica de València, 46022, Valencia, Spain, e. S.A. Explotaciones Agrícolas Serrano (SAEAS). C/ En Sanz 5-1. 46001. Valencia, Spain) **Agronomic treatments to avoid seed presence in 'Nadorcott' mandarin I. Effect on in vivo pollen tube growth, Scientia Horticulturae, Available online 23 November 2021, 110760**

Fresh market demands high quality fruit and, therefore, citrus growers and researchers are constantly looking for solutions to avoid seed presence. Current horticultural techniques have low effectiveness or high cost. The objective of this study is to evaluate the inhibition effect of seven products on the in vivo pollen tube growth in Nadorcott mandarin, which is a high-value seedy variety. To achieve this main objective, three inorganic fertilizers (ammonium nitrate, potassium nitrate, sulfur), and four saccharides (saccharose, methyl cellulose, callose, chitosan) were applied to Nadorcott stigmas 24 h before and after hand pollination. Pollen tubes were counted 1, 3, and 5 days after treatment in longitudinal blue violet autofluorescence-stained sections. Of the seven evaluated products, only sulfur had a strong inhibitory effect. Elemental sulfur (S8) inhibited pollen tube growth by 94-100%. This strong effect was observed regardless of sulfur being applied 24 h before or after pollination, and on fixed flowers 1, 3 or 5 days after applications. Saccharose treatment seemed to have the opposite effect: stimulated pollen tube growth, but the difference with the positive control was small and non-significant. The sulfur effect could be useful for designing agronomic applications capable of preventing seed presence in Nadorcott mandarin.

Keywords: Citrus, Mandarin, Nadorcott, Seedless, Pollen tube, Sulfur, Saccharose, Inhibition

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

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

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In plants, non-green plastids in heterotrophic tissues are sites for starch and fatty acids biosynthesis, which are essential for plant development and reproduction. Distinct from chloroplasts, the metabolites for these processes in non-green plastids have to be imported through specific transporters. Glucose 6-Phosphate/Phosphate Translocator 1 is required for the uptake of cytosolic Glucose 6-Phosphate into non-green plastids. In Arabidopsis, GPT1 has been demonstrated to play essential roles in male, female gametophyte and embryo development. However, the roles of GPTs in other species are yet largely unknown. Here, we reported that rice OsGPT1 is indispensable for normal tapetal degeneration and pollen exine formation during anther and pollen development. OsGPT1 is localized in the plastid and distributed in the anther wall layers and late-stage pollen grains. Different from the gametic defects caused by mutation in AtGPT1, disruption of OsGPT1 does not affect male and female gamete transmission as well as embryo development. On the contrary, osgpt1 mutant exhibits delayed tapetum degeneration, decreased Ubisch bodies formation and thinner pollen exine, leading to pollen abortion at the mature stage. Furthermore, the expression of several genes involved in tapetal programmed cell death (PCD) and sporopollenin formation is decreased in osgpt1. Our study suggests that OsGPT1 coordinates the development of anther sporophytic tissues and the male gametophyte by integrating carbohydrate and fatty acid metabolism in the plastid.

Keywords: Glucose-6-Phosphate/Phosphate Translocator, Heterotrophic plastids, Male fertility, Tapetal PCD, Pollen exine formation

Xuetong Yang, Yaning Bu, Fuqiang Niu, Yujie Cun, Lingli Zhang, Xiyue Song (College of Agronomy, Northwest A&F University, Yangling, 712100, Shaanxi, China) Comprehensive analysis of LIM gene family in wheat reveals the involvement of TaLIM2 in pollen development, Plant Science, Available online 23 October 2021, 111101

LIM domain proteins were involved in organizing the cytoskeleton, adjusting the metabolism and gene expression, some of them were specific express in pollen. LIM gene family in plants were studied in sunflower, tobacco, foxtail millet, rape, rice and Arabidopsis thaliana, however, it has not been investigated in wheat to date. In the present study, we totally characterized 29 TaLIM genes through genome-wide analysis, which were divided into two categories and five subclasses according to phylogenetic analysis. RNA-Seq analysis indicated the expression patterns of TaLIM genes have specific temporal and spatial characteristics, especially TaLIM2 was highly expressed in fertility anthers. Phenotypic and cytological of BSMV: TaLIM2 showed that it had defects in the later stage of pollen development and germination, which further testified that TaLIM2 was closely related to fertility conversion. These findings will be useful for functional analysis of LIM genes in wheat fertility and contribute to hybrid wheat breeding.

Keywords: Genome-wide analysis, LIM genes, Wheat, Male sterility, Pollen development

Shan Li, Saimijiang Yaermaimaiti, Xiao-Meng Tian, Zi-Wen Wang, Wen-Jun Xu, Jun Luo, Ling-Yi Kong (State Key Laboratory of Natural Medicines and Jiangsu Key of Bioactive Natural Product Research, School of Traditional Chinese Pharmacy, China Pharmaceutical University, Nanjing 210009, People's Republic of China) Dynamic metabolic and transcriptomic profiling reveals the biosynthetic

characteristics of hydroxycinnamic acid amides (HCAAs) in sunflower pollen, Food Research International, Volume 149, November 2021, 110678

Sunflower pollen is a natural nutritious food with a long history and multiple functions, however, the main chemical components apart from flavonoids and their biosynthesis processes have not been thoroughly investigated. In this study, seven hydroxycinnamic acid amides (HCAAs) (1–7) abundant in sunflower pollen were isolated and identified as one type of the pollen's main chemicals. For a comprehensive understanding of HCAA biosynthesis in Helianthus annuus flowers, RNA-seq, metabolomics, and key genes related to biosynthesis in the sunflower were studied. A large number of compounds at different sunflower growth stages (the 7th, 14th, 21st, and 28th days) and high expression levels of related genes in the transcriptome were detected. A molecular network was constructed to clarify the synthetic pathway of HCAAs, which revealed high transcriptional levels of spermidine hydroxycinnamoyl transferase genes (HaSHT2795 and HaSHT2436) in 14–21-days-old flowers. HaSHT2795 enzymes catalyze tri-coumaroylspermidine formation, and virus-induced gene silencing to inhibit HaSHT2795 and HaSHT2436 could significantly reduce the synthesis of hydroxycinnamic acid amides in sunflower pollen. HCAAs were inferred to be related to the formation of pollen walls and the health effects of pollen. Analyzing HCAA biosynthesis and accumulation in H. annuus pollen will be helpful to understand the functions of HCAAs in the development of pollen and its nutritional value.

Keywords: Sunflower pollen, ·Hydroxycinnamic acid amides, Biosynthesis, Spermidine hydroxycinnamoyl transferase, Metabolomics, Co-expression network

Shuangshuang Liu[ab], Ziwen Li[ab], Suowei Wu[ab], Xiangyuan Wan[ab] (a. Zhongzhi International Institute of Agricultural Biosciences, Shunde Graduate School, Research Center of Biology and Agriculture, University of Science and Technology Beijing, Beijing 100096, China, b. Beijing Engineering Laboratory of Main Crop Bio-Tech Breeding, Beijing International Science and Technology Cooperation Base of Bio-Tech Breeding, Beijing Solidwill Sci-Tech Co. Ltd., Beijing 100192, China) **The essential roles of sugar metabolism for pollen development and male fertility in plants, The Crop Journal, Available online 26 August 2021**

Sugar metabolism plays an essential role in plant male reproduction. Defects in sugar metabolism during anther and pollen development often result in genic male sterility (GMS). In this review, we summarize the recent progresses of the sugar metabolism-related GMS genes and their roles during plant anther and pollen development, including callose wall and primexine formation, intine development, pollen maturation and starch accumulation, anther dehiscence, and pollen germination and tube growth. We predict 112 putative sugar metabolic GMS genes in maize based on bioinformatics and RNA-seq analyses, and most of them have peak expression patterns during middle or late anther developmental stages. Finally, we outline the potential applications of sugar metabolic GMS genes in crop hybrid breeding and seed production. This review will deepen our understanding on sugar metabolic pathways in controlling pollen development and male fertility in plants.

Keywords: Sugar metabolism, Genic male sterility, Pollen development, Crop hybrid breeding, Maize

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Success artificial pollination with viable pollen is crucial process in the production chain of date palms. This study evaluated the impact of pollen storage temperature and duration, pollination time following spathe cracking, and the hour of daytime on pollen viability, germinability, fruit set and yield of 'Deglet Nour' date palm cultivar. In in vitro tests, fresh pollen showed the maximum viability (96.3%) and germination (85%) but it decreased thereafter upon the storage temperature (28, 4 and −30 °C) and duration (3, 6, 9 and 12 months). In this respect, pollen stored at −30 °C retained highest viability and germinability followed by those stored at 4 and then at 28 °C. In filed experiments, fruit set was 85, 75, 65, and 45% with pollination using fresh pollen, or pollen stored at −30, 4 and 28 °C, respectively. Fruit set was 95%, 75%, and less than 50%, for pollination performed on the same day of spathe cracking, 6 and 12 days later, respectively. The highest fruit set percentage and yield/bunch were obtained with pollination performed between 12.0 pm and 15.0 pm in contrast to 8.0–11.0 am or 16.0–17.0.

Keywords: Date palm, Pollination, Pollen viability, Pollen germinability, Fruit set, Yield

Yan Ju[125], Jing Yuan[125], Daniel S.Jones[46], Weiwei Zhang[23], Christopher J.Staiger[123], Sharon A.Kessler[127] (1. Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN 47907, USA, 2. Purdue Center for Plant Biology, Purdue University, West Lafayette, IN 47907, USA, 3. Department of Biological Sciences, Purdue University, West Lafayette, IN 47907, USA, 4. Department of Microbiology and Plant Biology, University of Oklahoma, Norman, OK 73019, USA) **Polarized NORTIA accumulation in response to pollen tube arrival at synergids promotes fertilization, Developmental Cell, Volume 56, Issue 21, 8 November 2021, Pages 2938-2951**

Signal-mediated regulation of protein trafficking is an elegant mechanism for controlling the delivery of molecules to a precise location for critical signaling events that occur over short time frames. During plant reproduction, the FERONIA receptor complex is critical for intercellular communication that leads to gamete delivery; however, the impact of the FERONIA signal transduction cascade on protein trafficking in synergid cells remains unknown. Live imaging of pollen tube reception has revealed that a key outcome of FERONIA signaling is polar accumulation of the MLO protein NORTIA at the filiform apparatus in response to signals from an arriving pollen tube. Artificial delivery of NORTIA to the filiform apparatus is sufficient to bypass the FERONIA signaling pathway and to promote interspecific pollen tube reception. We propose that polar accumulation of NORTIA leads to the production of a secondary booster signal to ensure that pollen tubes burst to deliver the sperm cells for double fertilization.

Keywords: Arabidopsis, synergid, NORTIA, FERONIA, pollen tube reception, interspecific, MLO, gametophyte, pollination, polarity

Biotechnology Policy Issue

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The OECD Council Recommendation on Recombinant DNA Safety Considerations is a legal instrument which has been in force since 1986. It outlines the safety assessment practices that countries should have in place for

agricultural and environmental biotechnology. This article suggests possible updates to make it suitable for the modern era.

Keywords: recombinant DNA, food and feed safety, environmental safety, risk assessment, international harmonisation, OECD

Agricultural Biotechnology

Rita Saleh, Angela Bearth, Michael Siegrist (Consumer Behavior, Institute for Environmental Decisions, ETH Zurich, Universitaetstrasse 22, 8092 Zurich, Switzerland) How chemophobia affects public acceptance of pesticide use and biotechnology in agriculture, Food Quality and Preference, Volume 91, July 2021, 104197

Protecting crops from infestations is critical to ensuring stable, safe food production. However, many consumers are concerned about the use of pesticides and agricultural biotechnology (agri-biotech) applications. A lack of consumer acceptance can prevent potentially beneficial applications from being utilized. This study examines consumer acceptance of pesticide use in conventional and organic agriculture and agri-biotech applications as crop-protection measures. An online between-subject experiment was conducted with participants from the German-speaking part of Switzerland (N = 643). The results revealed that consumers were most willing to accept gene transfers as a protection measure, provided the gene came from a wild variety of the same species as the cultivated plant. Both chemophobia and the importance of naturalness in food influence consumer acceptance of pesticide use and agri-biotech applications. Addressing chemophobia and informing consumers about the role of technologies in pest-management and crop-protection could lead them to trust and accept related agricultural policies.

Keywords: Agricultural biotechnology, Pesticides, Gene editing, Gene modification, Public acceptance

Bioenergy

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A relatively high (0.2–4.3) digestate recirculation ratio (RR) is typically adopted to raise the pH and provide the dark fermentation reactor (DF) with alkalinity and hydrogen-producing microorganisms in a two-stage anaerobic digestion process. This study examined the production of bio-H2 and bio-CH4 from readily biodegradable organic waste in a large scale recirculated two-stage thermophilic anaerobic system to determine the effect of low RR on biofuel and bioenergy recovery. The performance of the two-stage system was evaluated at 2 hydraulic retention times (HRT) (1.1 and 2.5 d) in DF and 4 RR (0, 0.11, 0.18 and 0.25). The pH in DF was not controlled and ranged from 3.8 to 4.2. Hydrogen yield was negatively affected by digestate recirculation, while CH4 yield, as well as H2 and CH4 production rates, first tended to increase and then decrease with increasing RR. Overall, biofuel and bioenergy were best recovered at an RR of 0.11, namely 1.48 L H2/L/d, 0.88 L CH4/L/d, 106.2 mL H2/g VSinit.,161.3 mL CH4/g VSinit., 7.7 kJ/g VSinit. and 88.2 kJ/L/d were obtained depending on HRT in DF. It has been shown that a low RR can improve the performance of the two-stage anaerobic digestion process.

Keywords: Biohydrogen, Biomethane, Anaerobic digestion, Two-stage, Digestate recirculation, Low pH

M.M.Ghangrekar[12], Santosh Kumar[2], Azhan Ahmad[1], Sovik Das[1] (1. Department of Civil Engineering, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal, India, 2. PK Sinha Centre for Bioenergy and Renewables, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal, India) **Chapter 17 - Concomitant bioenergy production and wastewater treatment employing microbial electrochemical technologies, Biofuels and Bioenergy, Opportunities and Challenges, 2022, Pages 359-385**

Energy and water are the two most prized lifelines for the future generation. In the recent years, wastewater treatment with concomitant bioenergy production has gained considerable attention of the scientific community. Moreover, wastewater from industrial and domestic streams is considered to be the major contributor to environmental pollution. Microbial electrochemical technology (MET) can be envisioned as one of the budding technologies employed for wastewater treatment with concurrent bioenergy recovery, biomass production, and CO2 sequestration. The METs are sustainable engineered systems that use microorganisms as catalyst to harvest electrical energy by transforming the chemical energy present in biodegradable organic matter existing in polluted water or, under application of external electrical energy, synthesize different compounds either biotically or abiotically. However, there are significant bottlenecks toward the upscaling and practical applications of these METs. This chapter expounds the scope of applications of METs as a sustainable wastewater treatment technology with simultaneous bioenergy generation at an efficient engineering level and also elucidates the limitations associated with METs.

Keywords: Bioelectricity, Biofuel, Carbon sequestration, Microbial electrochemical technology, Microbial fuel cell, Wastewater treatment

Muhammad Nurariffudin Mohd Idris, Haslenda Hashim (Process Systems Engineering Centre (PROSPECT), School of Chemical and Energy Engineering, Research Institute for Sustainable Environment (RISE), Universiti Teknologi Malaysia, Johor, Malaysia) **Chapter 23 - Renewable energy transformation in Malaysia through bioenergy production: Policy insights from spatially-explicit modeling, Value-Chain of Biofuels, Fundamentals, Technology, and Standardization, 2022, Pages 535-552**

International Energy Agency has highlighted the vital role of bioenergy in the advent of circular economy. Bioenergy could significantly contribute to the substitution of primary energy demands in different national sectors such as power, industries, and transport. In Malaysia, after more than 10 years of efforts since Feed-in Tariff was first introduced, bioenergy has remained as small-scale renewable energy generator (<20 MW) despite its promising potential from palm oil-based activity. With limited time available to meet the national targets of the Paris Agreement during this decade, policies related to renewable energy sector development should be strengthened in order to promote more bioenergy capacity deployment. This chapter examines the effectiveness of different financial mechanisms to promote flexible bioenergy market with stable feedstock supply in Malaysia. Number of scenarios related to incremental policy support levels under different cost parameter variations are modeled using a spatially-explicit techno-economic optimization model. The findings suggest that by integrating bio-based resource use from palm oil and other crops in the energy sectors, the unconditional decarbonization target set under the Paris Agreement can be met with a low to medium level of policy supports by either increasing the incentives to bioelectricity producers or penalizing all energy-producing activities that emit carbon dioxide. Other insights were also suggested from this assessment, related to which energy sectors need to be focused on in the near-term if a type of policy instrument is preferred over one another, and what degree of transformation is needed to meet the technological and infrastructural requirement of deploying bioenergy at a national scale.

Keywords: Bioenergy, decarbonization, energy policy, oil palm biomass, spatial analysis, techno-economic tool

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Catole coconut (Syagrus cearensis) is produced in abundance in the Northeastern region of Brazil, but still remains relatively unexploited for bioenergy purposes because of the little relevant scientific information available. In this context, this study aims to investigate the kinetics and thermodynamics that describe the pyrolysis of catole coconut through a multi-component approach, aiming to highlight its bioenergy potential. Thermogravimetric analysis of catole coconut was performed in an inert atmosphere with different heating programs (10, 20 and 30 °C min−1) to establish its pyrolysis behavior. The resulting pyrolysis behavior was subjected to deconvolution by the symmetrical Gaussian function to specify three independent components: pseudo-hemicellulose, pseudo-cellulose, and pseudo-lignin. By using four isoconversional methods, the average activation energy estimated is in the range of 124.2–133.5 kJ mol−1 for pseudo−hemicellulose, 159.7–170.1 kJ mol−1 for pseudo−cellulose, and 151.5–162.8 kJ mol−1 for pseudo−lignin. Based on the kinetic compensation effect, the pre-exponential factors were determined to be in the range of 3.5 × 1011–5.4 × 1014 min−1. Statistical results (R2>0.954 and Fit>0.944) indicate that the proposed summative kinetic expression proved to be valuable in reproducing the experimental pyrolysis behavior. The promising findings acquired from this study justify the interest in exploring catole coconut as a new bioenergy feedstock.

Keywords: Catole coconut, Bioenergy potential, Isoconversional methods, Gaussian function, Thermodynamic parameters

Wenlong Cheng[12] (1. Department of Chemical Engineering, Monash University, Clayton, Victoria 3800, Australia, 2. The Melbourne Centre for Nanofabrication, Clayton, Victoria 3800, Australia) **On-demand bioenergy from a fingertip, Trends in Chemistry, Volume 3, Issue 10, October 2021, Pages 800-802**

Wearable biosensors can monitor biological vital signs of health continuously but require sustainable power technology to realize a paradigm shift towards connected healthcare anytime, anywhere. A recent article in Joule (Yin et al.) reports a fingertip-based self-powered wearable device that can harvest sustainable bioenergy more efficiently than previous technologies.

Keywords: wearable energy, biofuel cell, piezoelectric generator, self-powered device, wearable sensor

Mwansa Kaoma[ab], Shabbir H.Gheewala[ab] (a. The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Bangkok, Thailand, b. Center of Excellence on Energy Technology and Environment (CEE), PERDO, Ministry of Higher Education, Science, Research and Innovation, Bangkok, Thailand) **Sustainability performance of lignocellulosic biomass-to-bioenergy supply chains for Rural Growth Centres in Zambia, Sustainable Production and Consumption, Volume 28, October 2021, Pages 1343-1365**

This study provides insight into the sustainability performance of bioenergy systems for providing cooking and electricity-enabled energy services in the rural growth centres of Zambia. This is achieved by modeling and optimizing a bioenergy supply chain for the provision of these services, and then comparing its sustainability performance to that of existing energy systems. The findings indicate that using biomass-based gasifier-internal combustion engines instead of diesel generators for the provision of electricity-enabled services could result in greenhouse gas, NOX, and SO2 emission reductions of 36, 8, and 97%, respectively. When pellet-gasifier cookstoves are used instead of firewood/three-stone cookstoves for providing cooking services, greenhouse gas

and PM2.5 emissions are reduced by 57 and 94%, respectively. Furthermore, households that use bioenergy systems instead of traditional energy systems to deliver cooking and electricity-enabled services can save approximately 275 and 11 US dollars per year, respectively. In general, bioenergy systems outperform existing systems in providing the two energy services in question from a sustainability standpoint. Hence, policymakers must consider their use as alternative energy systems to the existing ones in order to foster sustainable development in rural areas.

Keywords: Bioenergy, Biomass supply chain, Rural areas, Sustainability Performance

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Wind and solar power are already the major pillars of renewable power generation in Germany and will become even more dominant in the future. At the same time, dispatchable power plants phasing out. The expected increase of fluctuations in the residual load could be partial balanced by flexible bioenergy. However, there is currently no assessment approach for quantifying the systemic GHG impacts for flexible bioenergy generation.

Based on the merit order concept, we develop an empirical approach to systemically assess the GHG emissions impact for electricity generated by flexible bioenergy plants. We estimate price response functions using the historical data of market prices and feed-in time series for the different forms of dispatchable non-renewbale dispatchable generation (NRDG). By calculating the expected NRDG based on these functions, and using specific emission factors, we are able to estimate the net impact for a switch from invariable to flexible bioenergy generation.

The calculated net impact ranges from −20 to −36 g CO2eq per kWh, which is equivalent to a benefit of −10% to −18% respectively for an average carbon footprint of 200 g CO2eq per kWh. The calculation tools are written in Python and freely accessible on ZENODO and GitLab.

Keywords: Greenhouse gas emissions, Energy system, German power market, Flexible bioenergy generation, Biogas plants, Empirical assessment

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, November 2021, Pages 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

Nano Biotechnology

Jieying Liang[a], Kang Liang[ab] (a. School of Chemical Engineering, Australian Centre for NanoMedicine, The University of New South Wales, Sydney, NSW 2052, Australia, b. Graduate School of Biomedical Engineering, The University of New South Wales, Sydney, NSW 2052, Australia) Nano-bio-interface engineering of metal-organic frameworks, Nano Today, Volume 40, October 2021, 101256

Metal-organic frameworks (MOFs) have been widely investigated in various fields owing to their highly attractive structural and functional features. The nano-bio-interface engineering of MOFs enables biomacromolecules or living systems with novel properties out of their scope of evolution. As the research progress, there is an intensive desire to revel the interfacial interactions of MOFs and biosystems, which has anticipated to significantly broaden their applications. Herein, the recent achievements in nano-bio-interface engineering of MOFs via designing and integrating MOFs with a wide range of biomacromolecules and living systems, such as enzymes, non-enzymatic proteins and living systems (i.e., prokaryotic cells, eukaryotic cells, and multi-cellular living systems), are critically summarized. Their interfacial interactions, dynamic biomolecular structural information in the MOF microenvironment, and their self-organization process are mainly focused. Then their most emerging applications ranging from on-demand smart nano/microrobotics to gene knockdown/editing to self-powered/on-site biosensors are described. Finally, exciting perspectives are recapitulated. These advances are anticipated to bridge the gap between life science and materials science, and provide a new capability for designing bio-inspired nanomaterials towards versatile biotechnological applications.

Keywords: Metal-organic frameworks, Nano-bio-interface, Advanced materials, Biomacromolecules, Nanobiohybrids

Hassan El-Ramady[a], Neama Abdalla[b], Heba Elbasiouny[c], Fathy Elbehiry[d], Tamer Elsakhawy[e], Alaa El-Dein Omara[e], Megahed Amer[f], Yousry Bayoumi[g], Tarek A.Shalaby[g], Yahya Eid[h], Muhammad Zia-ur-Rehman[i] (a. Soil and Water Department, Faculty of Agriculture, Kafrelsheikh University, 33516 Kafr El-Sheikh, Egypt, b. Plant Biotechnology Department, Genetic Engineering and Biotechnology Division, National Research Center, 12622 Cairo, Egypt, c. Department of Environmental and Biological Sciences, Home Economy faculty, Al-Azhar University, 31732 Tanta, Egypt, d. Central Laboratory of Environmental Studies, Kafrelsheikh University, 33516 Kafr El-Sheikh, Egypt, e. Agriculture Microbiology Department, Soil, Water and Environment Research Institute (SWERI), Sakha Agricultural Research Station, Agriculture Research Center (ARC), 33717 Kafr El-Sheikh, Egypt, f. Soils Improvement Department, Soils, Water and Environment Research Institute (SWERI), Sakha Station, Agricultural Research Center (ARC), 33717 Kafr El-Sheikh, Egypt, g. Horticulture Department, Faculty of Agriculture, Kafrelsheikh University, 33516 Kafr El-Sheikh, Egypt, h. Poultry Department, Faculty of Agriculture, Kafrelsheikh University, 33516 Kafr El-Sheikh, Egypt, i. Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan) Nano-biofortification of different crops to immune against COVID-19: A review, Ecotoxicology and Environmental Safety, Volume 222, 1 October 2021, 112500

Human health and its improvement are the main target of several studies related to medical, agricultural and industrial sciences. The human health is the primary conclusion of many studies. The improving of human health may include supplying the people with enough and safe nutrients against malnutrition to fight against multiple diseases like COVID-19. Biofortification is a process by which the edible plants can be enriched with essential nutrients for human health against malnutrition. After the great success of biofortification approach in the human struggle against malnutrition, a new biotechnological tool in enriching the crops with essential nutrients in the form of nanoparticles to supplement human diet with balanced diet is called nano-biofortification. Nano biofortification can be achieved by applying the nano particles of essential nutrients (e.g., Cu, Fe, Se and Zn) foliar or their nano-fertilizers in soils or waters. Not all essential nutrients for human nutrition can be biofortified in the nano-form using all edible plants but there are several obstacles prevent this approach. These stumbling blocks are increased due to COVID-19 and its problems including the global trade, global breakdown between countries, and global crisis of food production. The main target of this review was to evaluate the nano-biofortification process and its using against malnutrition as a new approach in the era of COVID-19. This review also opens many questions, which are needed to be answered like is nano-biofortification a promising solution against malnutrition? Is COVID-19 will increase the global crisis of malnutrition? What is the best method of applied nano-nutrients to achieve nano-biofortification? What are the challenges of nano-biofortification during and post of the COVID-19?

Keywords: Malnutrition, Selenium nanoparticles, SARS-CoV-2, Iron nanoparticles, Zinc, Copper nanoparticles

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1D, 2D and 3D- materials glazed biosensing has evolved and emerged as a new archetype for real-time health monitoring as well as a flawless human–machine interaction to perform point-of-care diagnostics. Smart nano bioengineering has emerged as a flawless system to fulfill the key requirements. Graphene glazed nanosystems have emerged as the foremost State-of-the-art materials due to their electrochemical activity, hydrophilicity, and functional group activity which makes it advantageous for nano-devices based wearable assembly. Thin film fabrication, functionalization and controlled bio-active loading could be highly sensitive and selective nano-devices for early diagnosis of biomarkers at femtomolar level for early diagnosis of disease biomarkers. In this letter, an overview has been provided on the potential of 2D-graphene of for nano- bio-sensing system.

Keywords: Nanocomposite, Wearable assembly, Biomarker diagnosis, Human-machine interaction, Graphene, Selective detection

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Co-immobilization of multi-enzymes has emerged as a promising concept to design and signify bio-catalysis engineering. Undoubtedly, the existence and importance of basic immobilization methods such as encapsulation, covalent binding, cross-linking, or even simple adsorption cannot be ignored as they are the core of advanced co-immobilization strategies. Different strategies have been developed and deployed to green the twenty-first century bio-catalysis. Moreover, co-immobilization of multi-enzymes has successfully resolved the limitations of individual enzyme loaded constructs. With an added value of this advanced bio-catalysis engineering platform, designing, and fabricating co-immobilized enzymes loaded nanostructure carriers to perform a particular set of reactions with high catalytic turnover is of supreme interest. Herein, we spotlight the emergence of co-immobilization strategies by bringing multi-enzymes together with various types of nanocarriers to expand the bio-catalysis scope. Following a brief introduction, the first part of the review focuses on multienzyme co-immobilization strategies, i.e., random co-immobilization, compartmentalization, and positional co-immobilization. The second part comprehensively covers four major categories of nanocarriers, i.e., carbon based nanocarriers, polymer based nanocarriers, silica-based nanocarriers, and metal-based nanocarriers along with their particular examples. In each section, several critical factors that can affect the performance and successful deployment of co-immobilization of enzymes are given in this work.

Keywords: Multienzymes, Co-immobilization, Nanocarriers, Nano-catalysis, Carbon materials, Polymeric cues, Silica, Metal particles

Biomimicry

Yun LuTee[a], Tobias Maconachie[b], Philip Pille[b], Martin Leary[b], Truong Do[c], Phuong Tran[ab] (a. Department of Civil and Infrastructure Engineering, RMIT University, VIC 3000, Australia, b. RMIT Centre for Additive Manufacture, RMIT University, Melbourne, Australia, c. College of Engineering and Computer Science, VinUniversity, Hanoi 14000, Vietnam) From nature to additive manufacturing: Biomimicry of porcupine quill, Materials & Design, Volume 210, 15 November 2021, 110041

A porcupine's quill is an extraordinary natural armor capable of withstanding high compression load. By unravelling the unique properties of the porcupine quill design, the bioinspired structures can be applied in engineering applications. The present work investigates both the mechanical and chemical properties of a porcupine quill. An axial compression test is conducted on the natural material in three states: the entire composite quill structure and the response of shell and foam phases individually. These mechanical responses are reported, and compressive failure modes are quantified by scanning electron microscopy (SEM) and micro-computed tomography (μCT). Fourier-transform infrared (FTIR) spectroscopy is conducted and a slight compositional variation is found between the shell and foam phases of the porcupine quill. The design of a porcupine quill inspired structure is achieved through fabrication by stereolithography (SLA) additive manufacturing (AM) technology. Based on these design workflows, the properties of the structures, including struts length and relative density are analysed. Random workflow has a higher number of short struts while longer struts dominate reflected workflow. Relative density increases with the increasing number of seeds. However, it decreases with a growing number of sectors. Qualitative analysis of the numerical simulation presented shows the importance of struts connectivity for efficient stress distribution.

Keywords: Additive manufacturing, Biomimicry, Bioinspired design, Porcupine quill, Voronoi structure, 3D Printing, Lattice structurePrinting, Lattice structure

Roberto Portillo-Lara, Josef A Goding, Rylie A Green (Department of Bioengineering, Imperial College London, SW7 2BP, London, United Kingdom) Adaptive biomimicry: design of neural interfaces with enhanced biointegration, Current Opinion in Biotechnology, Volume 72, December 2021, Pages 62-68

Neural interfaces (NIs) have traditionally used inorganic device constructs paired with electrical stimulation to bypass injured or diseased electroactive tissues. These bioinert devices have significant impact on the neural tissue, being synthetic and causing large volumetric changes to the biological environment. The concept of biomimicry has become popular for tissue engineering technologies, reflecting biological properties as a component of material design. Tissue engineering strategies can be harnessed in bioelectronic device design to improve biological tolerance, but the need for improved integration with the native tissue remains an unmet need. Adaptive biomimetic designs that respond to the changing neural tissue environment associated with wound healing can actively address the immune response to improve biointegration. These adaptive approaches include responsive materials paired with stem cells and bioactive molecules as integrated components of NIs. Combining adaptive biomimetics with NIs provides a new, more natural approach for communicating with the nervous system.

Keywords: Biomimicry

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
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26. Biological Agriculture and Horticulture
27. Biomass and Bioenergy
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34. Biotechnolgy Letters
35. Biotechnology Advances
36. Biotechnology and Applied Biochemistry
37. Biotechnology and Bioengineering
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40. Cell & Tissue Banking
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46. Current Science
47. Cytotechnology
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