ENVIS RESOURCE PARTNER

on

ENVIRONMENTAL BIOTECHNOLOGY

Abstract Vol. XXXX

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ENVIRONMENTAL BIOTECHBNOLOGY

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BACKGROUND

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

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

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

This is the 40th publication of Abstract Volume of this ENVIS Centre. This contains the abstracts of research papers collected from the various areas of Environmental Biotechnology from different journals published in last six months upto June 2022. In this issue, various topics like Bioenergy, Bioengineering, Bio-degradation, Bio-remediation, Bio-transformation etc. have been covered. We are grateful to the various libraries and their staff for their cooperation extended to us during the collection of the articles.

Abstract Format

The format of the abstract is as follows:

Abstract: The abstracts are arranged in different subheads.

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

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

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

GENERAL INFORMATION

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

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

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

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

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

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

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

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

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

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

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

1. Bacterial Biofertilizer
2. Algal Biofertilizer

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ABBREVIATIONS USED IN ADDRESSES AND CITED JOURNALS

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

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

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

Bioaccumulation

Lei Zhao[a], Jun-Liang Zhao[c], Zhihui Bai[a], Jiahua Du[a], Yanchao Shi[a], Yi Wang[a], Yuyao Wang[a], Yunzhuo Liu[a], Zhe Yu[b], Mu-Yang Li[a] (a. College of Animal Science and Veterinary Medicine, Heilongjiang Bayi Agricultural University, Daqing, Heilongjiang 163319, China, b. Sino-Norway Joint Lab on Fish Gut Microbiota, Institute of Feed Research, Chinese Academy of Agricultural Sciences, Beijing 100081, China, c. Graduate School of Environmental and Life Science, Okayama University, 1-1-1 Tsushima-naka, Okayama 700-8530, Japan) Polysaccharide from dandelion enriched nutritional composition, antioxidant capacity, and inhibited bioaccumulation and inflammation in Channa asiatica under hexavalent chromium exposure. International Journal of Biological Macromolecules, Volume 201(2022): 557-568

Taraxacum mongolicum polysaccharide (TMP) exhibits anti-inflammatory and antioxidant activity, making it an attractive candidate for aquatic-product-safety applications. Here, this study was aimed to investigate the effects of dietary TMP on the growth, nutritional composition, antioxidant capacity, bioaccumulation and inflammation in Channa asiatica under hexavalent chromium stress. The C. asiatica was randomly distributed into five groups: The first group served as the blank control group (CK), the subsequent groups were fed TMP-supplemented feed (0, 0.5, 1.0 and 2.0 g/kg), respectively, and exposed to waterborne Cr^{6+} for 28 days. Our results indicated that the TMP effectively increased ($P < 0.05$) C. asiatica muscle flavour amino acid, total free amino acids, monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA), and EPA + DHA contents, enhanced positively antioxidant enzyme activity (GPX, SOD, CAT, T-AOC), reduced oxidative stress parameters (MDA, PC), and up-regulated antioxidant-related genes mRNA expression. Meanwhile, the appropriate amount of TMP supplementation also inhibited the bioaccumulation of Cr^{6+} in tissues and alleviated the inflammatory response ($P < 0.05$). Furthermore, sensory evaluation implied that the overall score of sashimi and cooked fillet in the 2.0 g/kg TMP group was the highest in the experimental group, second only to CK. In brief, these results elucidate that TMP-supplemented diets excellently ameliorated the growth, enriched nutritional composition and antioxidant capacity, and inhibited bioaccumulation and inflammation in C. asiatica exposed to waterborne Cr^{6+}.

Keywords: Dandelion polysaccharide, Bioaccumulation, Meat quality, Antioxidant, C. asiatica

Haniyeh Nikokherad[a], Abbas Esmaili-Sari[b], Ali Mashinchian Moradi[a], Nader Bahramifar[b], Pargol Ghavam Mostafavi[a] (a. Department of Marine Biology, Faculty of Natural Resources and Environment, Science and Research Branch, Islamic Azad University, Tehran, Iran, b. Department of Environmental Sciences, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, P.O. Box 46414-356 Nour, Mazandaran, Iran) Bioaccumulation capacity of Chlorella vulgaris and Spirulina platensis exposed to silver nanoparticles and silver nitrate: Bio- and health risk assessment approach. Algal Research, Volume 64(2022): 102671

This study investigated the bioaccumulation capacity of Chlorella vulgaris and Spirulina platensis exposed to silver nanoparticles (AgNPs) and silver nitrate ($AgNO_3$) affecting the cell growth, viability, pigment content, and health status. Toxicity experiment was conducted using concentrations of 0, 0.005, 0.001, 0.05, 0.01, 0.5, and 0.1 for AgNPs and $AgNO_3$ during a 96-h

exposure period. Results illuminated that S. platensis could largely bioaccumulate silver nanoparticles while C. vulgaris greatly absorbed ionic silver ($AgNO_3$), and both microalgae showed a concentration-dependent manner in response to silver materials. $AgNO_3$, compared to AgNPs, affected significantly the average specific growth and yield of algal populations. A concentration-dependent decrease was observed in the content of pigments in exposure to both forms of silver, albeit this biological factor showed the highest severity to $AgNO_3$. Moreover, the content of chlorophyll a, b, and total chlorophyll in S. platensis decreased after 48 and 72 h. The pigment response of C. vulgaris to ionic silver was more severe than the respective nanoparticles. Bioconcentration factor in C. vulgaris populations exposed to 0.001 mg L^{-1} of $AgNO_3$ and AgNPs (14,109.7 and 6819.7010, respectively) was in the highest level among other treatments, and the lowest BCF calculated for S. platensis at 86.6066 (0.05 mg L^{-1} $AgNO_3$) and 170.2482 (0.5 mg L^{-1} AgNPs). Target hazard quotient ordered at THQY > THQM > THQTW > THQD for both microalgae, and maximum allowable limits (CR) reduced considerably with the increase of silver-based materials concentration in S. platensis and C. vulgaris. Taken together, C. vulgaris and S. platensis are strong bioaccumulators for AgNPs and $AgNO_3$ and their biological properties and health status could be disturbed, which is dangerous for both aquatic ecosystem and human health.

Alaa A. Alsuwayyid, Alanoud S. AlslimahKah, kashan Perveen, Najat A. Bukhari, Latifah A. Al-Humaid. (Department of Botany & Microbiology, College of Science, King Saud University, Riyadh 11495, Saudi Arabia) Effect of zinc oxide nanoparticles on Triticum aestivum L. and bioaccumulation assessment using ICP-MS and SEM analysis. Journal of King Saud University - Science, Volume 34(4) (2022): 101944

The impact of zinc oxide nanoparticles (ZnONPs) on Triticum aestivum L. has been explored in this study. The wheat seedlings were allowed to grow on Hoagland and Knop agar medium supplemented with different concentrations of ZnONPs (2500, 5000, 7500, 10,000, and 15,000 ppm) for three weeks. To determine their effect, the growth parameters, viz., wheat seed germination, seedling growth, and chlorophyll content, were taken into consideration. Moreover, the bioaccumulation of ZnONPs in root cells was determined by means of SEM, and zinc content in ZnO NP treated seedlings was measured by ICP-MS. The abatement in seed germination was observed at all concentrations of ZnONPs used, except at 2500 ppm. The plant growth and chlorophyll content also declined with an increase in ZnONPs concentration, except at 2500 ppm. The maximum reduction in shoot height (23.7%), root length (66.8%), seedling fresh weight (33.8%), and dry weight (54.8%) was noticed at the highest concentration of ZnONPs (15,000 ppm). At 15,000 ppm of ZnONPs, the chlorophyll a, chlorophyll b, and total chlorophyll were reduced by 80.6%, 74.2%, and 78.5%, respectively. An elevation in Zn concentration was noticed with an increase in the concentration as revealed by the ICP-MS analysis. The TEM micrographs exhibit the accumulation of ZnONPs within the root cells of wheat seedlings treated with ZnONPs (15,000 ppm). Thus, nanoparticles may have a destructive effect on the plant, and therefore their considerate use is advisable.

Keywords: Zinc oxide nanoparticles, ICP-MS, Wheat plant, Phytotoxicity, Bioaccumulation

Liwen Zhang[a], Siying Dua[b], Deping Liu[a], Deming Dong[a], Wenming Zhang[c], Zhiyong Guo[a] (a. Key Laboratory of Groundwater Resources and Environment, Ministry of Education, Jilin Provincial Key Laboratory of Water Resources and Environment, College of New Energy and Environment, Jilin University, Changchun 130012, China, b. State Grid Sichuan Economic Research Institute, Chengdu 610041, China, c. Department of Civil and Environmental Engineering, University of Alberta, Edmonton, AB T6G 1H9, Canada).

Antibiotics in fish caught from ice-sealed waters: Spatial and species variations, tissue distribution, bioaccumulation, and human health risk. Science of The Total Environment, Volume 821(2022): 153354

Antibiotics are increasingly detected in fish caught in ice-free waters, but information on fish caught in ice-sealed waters is insufficient. The concentrations of 23 antibiotics in the gills, muscles, kidneys, livers, biles, and brains of Cyprinus carpio and Hypophthalmichthys nobilis caught during winter fish-hunting activities in Chagan Lake, Haernao Reservoir, and Shitoukoumen Reservoir were systematically studied to ascertain the variations among fish species and fishing regions, tissue distribution, and bioaccumulation, as well as the potential risk to humans via the consumption of contaminated fish. The results indicated that the individual antibiotic concentration in tissues ranged from undetectable to 35.0 ng/g ww. The total antibiotic concentration in fish muscles from Shitoukoumen Reservoir was lower than that from Chagan Lake and Haernao Reservoir, but showed no significant difference between Cyprinus carpio and Hypophthalmichthys nobilis. Chloramphenicols had a high proportion in most fish tissues ranging from 28.3% to 44.0%, and the antibiotics were mainly distributed in the livers with a total concentration of 54.8 ± 9.9 ng/g ww. The mean values of bioaccumulation factors (BAF) of antibiotics in tissues ranged from 79.4 to 1000 L/kg, with the higher values found in the fish livers. The hazard quotient and hazard index value of antibiotics in the muscles of fish from ice-sealed were less than 1, indicating a negligible risk to human health via the consumption of fish muscles. This study revealed that the total antibiotic concentration in muscles showed spatial variations but not fish species-dependence. The antibiotics mainly accumulated in the livers. In addition, the target antibiotic concentrations in the muscles of fish from ice-sealed waters met the safe for consumption criteria.

Keywords: Winter fish-hunting, Antibiotics, Fish tissues, Bioaccumulation, Human health risk

Anna Pouch, Agata Zaborska, Anna Maria Dąbrowska, Ksenia Pazdro. (Institute of Oceanology, Polish Academy of Sciences, Powstańców Warszawy 55, 81-712 Sopot, Poland) Bioaccumulation of PCBs, HCB and PAHs in the summer plankton from West Spitsbergen fjords. Marine Pollution Bulletin, Volume 177(2022): 113488

Concentrations of seven polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), and twelve polycyclic aromatic hydrocarbons (PAHs) were examined in plankton collected in summer from different Arctic fjords (Hornsund, Kongsfjorden, Adventfjorden). The levels of all target contaminants in arctic protists have been analyzed for the first time. This is also the first report on PAH levels in arctic fjords zooplankton. ∑7 PCB, HCB and ∑12 PAH concentrations were up to 3.58 ng/g w.w., 0.28 ng/g w.w. and 249 ng/g w.w., respectively. Among the zooplankton species, the highest concentrations of the most analyzed contaminants were detected in Themisto abyssorum. This could be explained by the predatory feeding strategy of this species. The importance of diet was confirmed by the low concentrations of contaminants detected in the herbivorous copepod Calanus spp. Depending on contaminant, bioaccumulation occurred in 50 to 100% studied cases. Studies have shown significant biomagnification of PCBs and PAHs in zooplankton predator-prey pairs.

Keywords: Polychlorinated biphenyls, Hexachlorobenzene, Polycyclic aromatic hydrocarbons, Arctic fjords, Zooplankton, Bioaccumulation

M Ratheesh Kumar, K Anoop Krishnan, V Vimexen. (Biogeochemistry Group, National Centre for Earth Science Studies (NCESS), Akkulam, Thiruvananthapuram, Kerala, India). Effect of trace metal contamination in sediments on the bioaccumulation of bivalve Meretrix meretrix. Marine Pollution Bulletin, Volume 176(2022): 113422

A quinquennial seasonal study (2015–2019) has been conducted to evaluate the bioaccumulation pattern of trace metals in Meretrix meretrix. The concentration of trace metals in the clam was observed as Cr > Cu > Ni > Zn > Pb > Cd > Hg, (Body> Mantle > Gills), similar to sediments. Contamination Factor of Cu and Cr in sediments showed strong association with the corresponding metal concentration in the body (r = 0.687, r = 0.962), mantle (r = 0.880, r = 0.956) and gills (r = 0.937, r = 0.863). Bioconcentration Factor was high for Cr followed by Ni. Mean Metal Concentration Rate (MMCR) of Cr was high and Hg was low (Body>Mantle>Gills). Our study establishes that the trace metal intake by Meretrix meretrix is associated with seasonal variation, physicochemical factors, sediment texture, chemical speciation and the metabolic stress created within the species induced from increased demand for protein synthesis. The latter resulted in the augmented rate of accumulation of Cu and Cr.

Keywords: Bioaccumulation, Trace metals, Sediments, Meretrix meretrix

Wenping Xie[a], Jiangang Zhao[b], Xinping Zhu[a], Shanshan Chen[c], Xunan Yang[d] (a. Key Laboratory of Tropical and Subtropical Fishery Resource Application and Cultivation of Ministry of Agriculture, Laboratory of Seafood Quality and Security Evaluation of Ministry of Agriculture, Pearl River Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou 510380, China, b. Research Center of Hydrobiology, Key Laboratory of Eutrophication and Red Tide Prevention of Guangdong Higher Education Institutes, Jinan University, Guangzhou 510632, China, c. Guangdong Provincial Key Laboratory of Water Quality Improvement and Ecological Restoration for Watersheds, Institute of Environmental and Ecological Engineering, Guangdong University of Technology, Guangzhou 510006, China, d. State Key Laboratory of Applied Microbiology Southern China, Institute of Microbiology, Guangdong Academy of Sciences, Guangzhou 510070, China). Pyrethroid bioaccumulation in wild fish linked to geographic distribution and feeding habit. Journal of Hazardous Materials, Volume 430(2022): 128470

The accumulation of pyrethroid insecticides in aquatic food webs has attracted increased research attention. Fish are key species in aquatic food webs, directly connecting invertebrates and human consumption. However, little is known about the bioaccumulation of pyrethroids in wild fish species. In this study, 19 species of wild fish were collected from 11 sites in the Pearl River, China, and the levels of seven pyrethroids in the fish were determined. Linear mixed-effects models were applied to estimate the means of pyrethroid concentrations, in which sample site and fish species were set as random effects. The concentrations of Σ_7 pyrethroids in fish ranged from 4.99 to 50.82 ng/g. Permethrin and bifenthrin were present at the highest concentration (8.89 ± 1.47 ng/g) and frequency (100%) in fish muscle, respectively. The composition patterns of pyrethroids varied in fish organs. Fish species contributed a higher proportion of the variance than geographic distribution (28.6% vs. 26.4%). The pyrethroids in carnivorous fish (23.5 ± 2.9 ng/g) were significantly higher than in omnivorous (14.6 ± 1.9 ng/g) and phytophagous fish (16.0 ± 4.7 ng/g). To our knowledge, this is the first report examining the effect of feeding habits on pyrethroid bioaccumulation in wild fish. The results can provide evidence for the risk of pyrethroid pollution in aquatic ecosystems.

Keywords: Pyrethroid, Bioaccumulation, Wild fish, Feeding habit, Fish organ

P. Rodríguez-Velarte, J.M.F. Babarro, A. Cobelo-García. (Instituto de Investigacións Mariñas (IIM-CSIC), Eduardo Cabello 6, 36208 Vigo, Spain). Bioaccumulation patterns of trace elements by native (M. galloprovincialis) and invasive (X. securis) mussels in coastal systems (Vigo Ria, NW Iberian Peninsula). Marine Pollution Bulletin, Volume 176(2022): 113463

A number of trace elements (Mn, Fe, Co, Ni, Cu, Zn, As, Nb, Mo, Ag, Cd, Pb, U and the rare earth elements – REE) were analyzed in the dissolved phase, suspended particulate matter and in different organs (gills, hepatopancreas, and the rest of soft tissue) in mussels of the native Mytilus galloprovincialis and invasive Xenostrobus securis species in the Vigo Ria (NW Iberian Peninsula) in order to assess potential differences in their bioaccumulation patterns. Results obtained do not show significant differences in the bioaccumulation of trace elements by M. galloprovincialis and X. securis, except for Zn and Ag. In the case of Zn, a 4-fold enrichment in M. galloprovincialis compared to X. securis was found. The most important differences between species were observed for Ag, with approximately 40-fold higher concentrations in X. securis. Such elevated Ag bioaccumulation by X. securis can be useful for Ag biomonitoring using these invasive species in this area.

Keywords: Mytilus galloprovincialis, Xenostrobus secures, Metals, Bioaccumulation, Vigo Ria

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

Keywords: Heavy metals; Pollution; Bioaccumulation; Solid waste; Bioremediation

Bioremediation

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The present study aimed to characterize the bacterial community and functional diversity in co-composting microcosms of crude oil waste sludge amended with different animal manures, and to evaluate the scope for biostimulation based in situ bioremediation. Gas chromatography–mass spectrometry (GC–MS) analyses revealed enhanced attenuation (>90%) of the total polyaromatic hydrocarbons (PAHs); the manure amendments significantly enhancing (up to 30%) the degradation of high molecular weight (HMW) PAHs. Microbial community analysis showed the dominance (>99% of total sequences) of sequences affiliated to phyla Proteobacteria, Firmicutes, Actinobacteria and Bacteroidetes. The core genera enriched were related to hydrocarbon metabolism (Pseudomonas, Delftia, Methylobacterium, Dietzia, Bacillus, Propionibacterium, Bradyrhizobium, Streptomyces, Achromobacter, Microbacterium and Sphingomonas). However, manure-treated samples exhibited high number and heterogeneity of unique operational taxonomic units (OTUs) with enrichment of additional hydrocarbon-degrading bacterial taxa (Proteiniphilum, unclassified Micrococcales, unclassified Lachnospiraceae, Sphingobium and Stenotrophomonas). Thirty-three culturable hydrocarbon-degrading microbes were isolated from the co-composting microcosms and mainly classified into Burkholderia, Sanguibacter, Pseudomonas, Bacillus, Rhodococcus, Lysinibacillus, Microbacterium, Brevibacterium, Geobacillus, Micrococcus, Arthrobacter, Cellulimicrobacterium, Streptomyces Dietzia,etc,. that was additionally affirmed with the presence of catechol 2,3-dioxygenase gene. Finally, enhanced in situ degradation of total (49%), LMW (>75%) and HMW PAHs (>35%) was achieved with an enriched bacterial consortium of these microbes. Overall, these findings suggests that co-composting treatment of crude oil sludge with animal manures selects for intrinsically diverse bacterial community, that could be a driving force behind accelerated bioremediation, and can be exploited for engineered remediation processes.

Keywords: Animal manure, Bioremediation, Bacterial diversity, Co-compost, Catechol 2,3-dioxygenase

Anna Dzionek, Danuta Wojcieszyńska, Urszula Guzik. (University of Silesia in Katowice, Faculty of Natural Sciences, Institute of Biology, Biotechnology and Environmental Protection, Jagiellońska 28, 40–032 Katowice, Poland). Use of xanthan gum for whole cell immobilization and its impact in bioremediation - a review. Bioresource Technology, Volume 351(2022): 126918

Xanthan gum is one of the exo-polysaccharides produced by bacteria and is characterized by unique non-Newtonian properties. Its structure and conformation strongly depend on the fermentation conditions and such factors as temperature and ions concentration. The properties of the xanthan gum were appreciated in the controlled drug delivery but in the crosslinked form. Due to its ability to enhance the survival rate of immobilized bacteria, the potential of a crosslinked form is promising. Unfortunately, xanthan gum crosslinking procedures often require toxic substances or harsh environmental conditions, which cannot be used in the entrapment of living cells. In this study, we summarised a crosslinking method that could potentially be modified to reduce its toxicity to living cells. Moreover, this review also includes using xanthan gum in bioremediation studies and possible utilization methods to avoid carrier accumulation in the environment.

Keywords: Xanthan gum, Immobilization, Bioaugmentation, Microorganisms, Crosslinking, Entrapment

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The present work evaluates the bioremediation potential of the microalgae Chlorella sp. cultivated in industrial wastewaters of a metallurgy facility for CO2 fixation. Its growth in wastewaters was investigated experimentally and growth rate was determined based on different dilutions. Taguchi's experimental design was carried out and values found in laboratory were compared to those of a mathematical model adjusted based on growth rate. Process efficiency was evaluated to reduce organic load, nutrient consumption, and cell count during the initial and final stages via microscopy. After the biological treatment, reduction percentages of 99% for COD (Chemical Oxygen Demand) and 95% for SS (Sedimentable Solids) were achieved, in addition to 86% and 93% of nutrient and cyanide removal, respectively, and average CO2 biofixation of 0.1854 gL-1d-1. These values are close to those found in literature for other cultivation media. It was also observed that biomass productivity and CO_2 fixation data are in agreement with those obtained in other studies, thus evidencing the efficiency of Chlorella sp. microalgae and its high photosynthetic capacity.

Keywords: Effluent, Chlorella sp., Bioremediation, CO_2 biofixation

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A multilevel index system of organophosphate flame retardant bioremediation effect in an e-waste handling area was established under three bioremediation scenarios (scenario I, plant absorption; scenario II, plant–microbial combined remediation; scenario III, microbial degradation). Directional modification of OPFR substitutes with high selective bioremediation was performed. The virtual amino acid mutation approach was utilised to generate high-efficiency selective absorption/degradation mutant proteins (MPs) in a plant–microbial system under varying conditions. In scenario III, the MP's microbial degrading ability to replace molecules was increased to the greatest degree (165.82%). Appropriate foods such as corn, pig liver, and yam should be consumed, whereas the simultaneous consumption of high protein foods such as pig liver and walnut should be avoided; sweet potato and yam are believed to be prevent OPFRs and substitute molecules from entering the human body through multiple pathways for reduced genotoxicity of OPFRs in the populations of e-waste handling areas (the reduction degree can reach 85.12%). The study provides a theoretical basis for the development of ecologically acceptable OPFR substitutes and innovative high-efficiency bioremediation MPs, as well as for the reduction of the joint toxicity risk of multiple ingestion route exposure/gene damage of OPFRs in high OPFR exposure sites.

Keywords: Molecular directionally modification, Site-specific mutagenesis, Molecular dynamics, Gene damage, Dietary regulation scheme

Zuzana Roskova, Radek Skarohlid, Lenka McGachy. (Department of Environmental Chemistry, University of Chemistry and Technology Prague, Technická 5, 16628 Prague, Czech Republic). Siderophores: an alternative bioremediation strategy? Science of The Total Environment, Volume 819(2022): 153144

Siderophores are small molecular weight iron scavengers that are mainly produced by bacteria, fungi, and plants. Recently, they have attracted increasing attention because of their potential role in environmental bioremediation. Although siderophores are generally considered to exhibit high specificity for iron, they have also been reported to bind to various metal and metalloid ions. This unique ability allows siderophores to solubilise and mobilise heavy metals and metalloids from soil, thereby facilitating their bioremediation. In addition, because of their redox nature, they can mediate the production of reactive oxygen species (ROS), and thus promote the biodegradation of organic contaminants. The aim of this review is to summarise the existing knowledge on the developed strategies of siderophore-assisted bioremediation of metals, metalloids, and organic contaminants. Additionally, this review also includes the biosynthesis and classification of microbial and plant siderophores.

Keywords: Siderophores, Natural chelating agents, Bioremediation, Phytoremediation, Toxic metals and metalloids, Organic contaminants

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Crude oil contamination severely deteriorates soils quality. Bioremediation utilizing soil indigenous organisms could be employed to decompose petroleum hydrocarbons thanks to its low cost and minor environmental disturbance. However, slow kinetics limit the successful application of this biotechnique. Pretreating oil-contaminated soils with Fenton pre-oxidation could accelerate the subsequent bioremediation process. This study was to explore the

mechanisms behind the rapid propagation of indigenous petroleum-degrading bacteria (IPDB) and the efficient degradation of total petroleum hydrocarbons (TPH) in soil after Fenton pre-oxidation with biostimulated iron. Biostimulated iron and non-biostimulated iron were used in the experiments, where Fenton pre-oxidation was combined with the bioremediation of oil-contaminated soil (TPH = 13221 mg/kg). Although the amount of Fenton pre-oxidized TPH (3331–3775 mg/kg) was similar with biostimulated and non-biostimulated irons, the biodegradation of TPH after Fenton pre-oxidation with biostimulated iron (5840 mg/kg) was much higher than that with non-biostimulated iron (3034–4034 mg/kg). Moreover, abundant nutrients and a high population of residual IPDB were found after Fenton pre-oxidation with biostimulated iron, which benefited stable consumption of NH_3–N and dissolved organic carbon (DOC) by IPDB during the subsequent bioremediation. However, Fenton pre-oxidation with non-biostimulated iron either resulted in greater damage to IPDB or produced fewer nutrients, thereby failing to ensure the continuous propagation of IPDB during the subsequent bioremediation. Therefore, we propose that Fenton pre-oxidation with biostimulated iron should be applied to heavily oil-contaminated soils prior to bioremediation.

Keywords: Biostimulated iron, Fenton, Bioremediation, Petroleum-degrading bacteria, Heavily oil-contaminated soil

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Arsenic (As) contamination is a global problem, and seriously threatens the ecosystems and human health. Over decades, numerous efforts regarding the microorganism-mediated bioremediation have been attempted to control the As-contaminated environments. This review article introduces the distribution feature, health risk, and remediation methods of As contamination, and systematically elaborates the characteristics and classification of As-remediating microorganism, including bacteria (e.g., Stenotrophomonas spp.), archaea (e.g., Halorubrum spp.), and fungi (e.g., Aspergillus spp.). Furthermore, functional microorganism can interact with As in various forms including redox, biomethylation, biosorption, and bioaccumulation, thereby playing an important role in As bioremediation and ecological balance. Studies on molecular mechanisms of microorganism-mediated As-bioremediation enhance the understanding of interaction between microorganism and As, and further guide the alleviation and removal of As contamination. Although bioremediation is recognized as a promising novel way in the prevention and control of As-contaminated environments, further studies are encouraged to provide more valuable data for its practical application.

Keywords: As contamination, Health risk, As-remediating microorganism, As-bioremediation, Molecular mechanisms

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Phase II, Campus for Research Excellence and Technological Enterprise (CREATE), 1 CREATE Way, Singapore, 138602, Singapore, c. Plant Molecular Biology Laboratory, Department of Botany, Dayanand Anglo-Vedic (PG) College, Chhatrapati Shahu Ji Maharaj University, Kanpur-208001, India, d. Tecnologico de Monterrey, School of Engineering and Sciences, Monterrey, 64849, Mexico, e. Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive, 117585, Singapore). Omics approaches in bioremediation of environmental contaminants: An integrated approach for environmental safety and sustainability. Environmental Research, Volume 211(2022): 113102

Non-degradable pollutants have emerged as a result of industrialization, population growth, and lifestyle changes, endangering human health and the environment. Bioremediation is the process of clearing hazardous contaminants with the help of microorganisms, and cost-effective approach. The low-cost and environmentally acceptable approach to removing environmental pollutants from ecosystems is microbial bioremediation. However, to execute these different bioremediation approaches successfully, this is imperative to have a complete understanding of the variables impacting the development, metabolism, dynamics, and native microbial communities' activity in polluted areas. The emergence of new technologies like next-generation sequencing, protein and metabolic profiling, and advanced bioinformatic tools have provided critical insights into microbial communities and underlying mechanisms in environmental contaminant bioremediation. These omics approaches are meta-genomics, meta-transcriptomics, meta-proteomics, and metabolomics. Moreover, the advancements in these technologies have greatly aided in determining the effectiveness and implementing microbiological bioremediation approaches. At Environmental Protection Agency (EPA)-The government placed special emphasis on exploring how molecular and “omic” technologies may be used to determine the nature, behavior, and functions of the intrinsic microbial communities present at pollution containment systems. Several omics techniques are unquestionably more informative and valuable in elucidating the mechanism of the process and identifying the essential player's involved enzymes and their regulatory elements. This review provides an overview and description of the omics platforms that have been described in recent reports on omics approaches in bioremediation and that demonstrate the effectiveness of integrated omics approaches and their novel future use.

Biotransformation

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Per- and polyfluoroalkyl substances (PFASs) used in aqueous film-forming foam (AFFF) comprise some perfluoroalkyl substances but a larger variety of polyfluoroalkyl substances. Despite their abundance in AFFF, information is lacking on the potential transformation of these polyfluoroalkyl substances. Due to the biological and chemical stability of the repeating

perfluoroalkyl -$(CF2)_n$- moiety common to all known AFFF-derived PFASs, it is not immediately evident whether the microbial biotransformation mechanisms observed for other organic contaminants also govern the microbial biotransformation of polyfluoroalkyl substances. Herein, we aim to: 1) review the literature on the aerobic or anaerobic microbial biotransformation of AFFF-derived polyfluoroalkyl substances in environmental media; 2) compile and summarize proposed microbial biotransformation pathways for major classes of polyfluoroalkyl substances; 3) identify the dominant biotransformation intermediates and terminal biotransformation products; and 4) discuss these findings in the context of environmental monitoring and source allocation. This analysis revealed that much more is currently known about aerobic microbial biotransformation of polyfluoroalkyl substances, as compared to anaerobic biotransformation. Further, there are some similarities in microbial biotransformations of fluorotelomer and electrochemical fluorination-derived polyfluoroalkyl substances, but differences may be largely due to head group composition. Dealkylation, oxidation, and hydrolytic reactions appear to be particularly important for microbial biotransformation of AFFF-derived polyfluoroalkyl substances, and these biotransformations may lead to formation of some semi-stable intermediates. Finally, this review discusses key knowledge gaps and opportunities for further research.

Keywords: Microbial degradation, Polyfluorinated substance biotransformation, Pathway, Degradation database

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The changes of biotransformation enzymes will substantially affect the host's ability to metabolize drugs and other xenobiotic compounds. In order to further elucidate this process and promote the development in treatment of echinococcosis, we investigated the effects of Echinococcus multilocularis infection and drug treatment on biotransformation enzymes in mouse liver. In microsomal and cytosolic fractions, from the six activities assayed, significant decrease of glutathione S-transferases (GST) activity and significant increase of 7-pentoxyresorufin (PROD) and NADPH-cytochrome P450 reductase (CPR) activity were observed in the mice infected with E. multilocularis metacestodes. In addition, after six weeks treatment of albendazole in E. multilocularis infected mice, significant decreased GST activity and significant increase of 7- ethoxyresorufin (EROD), PROD, and particularly 3-fold higher 7-methoxyresorufin (MROD) activity were observed. The 3-bromopyruvate treated mice only exhibited significantly lower GST activity. Our results demonstrate that E. multilocularis metacestodes infection can affect the activities of main hepatic biotransformation enzymes and such alterations of activity may further affect the hepatic biotransformation of xenobiotics. Moreover, albendazole and 3-bromopyruvate, the promising potential drug against Echinococcus, affected different hepatic biotransformation enzymes and may affect their metabolism. The findings will help to develop rational treatments with less side effects and promote the development of more efficient treatments against E. multilocularis.

Keywords: Echinococcus multilocularis, Biotransformation, Liver drug metabolizing enzyme, Albendazole, 3-bromopyruvate

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Managed aquifer recharge (MAR) systems provide effective removal of many water contaminants including suspended solids, organic matter, pathogens, and numerous trace organic chemicals (TOrCs). TOrC removal is primarily driven by biotransformations performed by subsurface microbial communities. However, variable extents of TOrC biotransformation have been reported across MAR systems. This review discusses major parameters affecting the biotransformation of TOrCs and summarizes recent efforts to enhance its efficiency in MAR systems. Approaches to enhance biotransformation of TOrCs during MAR include optimization of environmental conditions (redox conditions, substrate availability), inoculation of specific TOrC degraders and stimulation of degrader activity by providing growth substrates or co-factors. While concepts to optimize environmental conditions have been tested at different scale, inoculation and biostimulation approaches were mostly tested as a means to remove contaminants in biologically active sand filters or for the remediation of contaminated groundwater. Their application in MAR systems needs further research.

Keywords: Biostimulation, Biotransformation, Managed aquifer recharge, Sequential managed aquifer recharge, Trace organic chemicals

Fabian Thomas, Oliver Kayser. (Department of Technical Biochemistry, TU Dortmund University, 44227 Dortmund, Germany). Natural deep eutectic solvents enhance cannabinoid biotransformation. Biochemical Engineering Journal, Volume 180(2022): 108380

Numerous studies in cannabinoid biotechnology focus extensively on cytosolic biosynthesis or biotransformation, neglecting to consider non-aqueous solvents. In this study, we show that it is advantageous to perform cannabinoid biotransformations in natural deep eutectic solvents (NADES). NADES are composed of two or more natural compounds, which, when mixed lower the melting point of the solution significantly below those of the individual components. Thus, initially solid sugars, amino acids, or organic acids are complexed into solvents that are liquids at room temperature. We comprehensively assess these novel "green solvents" for their capabilities to facilitate in vitro biotransformations by the three known cannabinoid synthases. Compared to aqueous biosynthesis, NADES doubled cannabinoid production of tetrahydrocannabinolic acid synthase and more than tripled production of cannabichromenic acid synthase. Data allows us to suggest solvent compositions that flexibly boost total cannabinoid content or alter cannabinoid specificity. This knowledge can equip researchers and bioengineers with the tools to tailor cannabinoid production to their needs without taking on the demanding task of enzyme engineering.

Keywords: Cannabinoids, Natural Deep Eutectic Solvents, Tetrahydrocannabinol, Cannabidiol, Cannabichromene, Natural Product Biotechnology

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Jožef Stefan International Postgraduate School, Ljubljana, Slovenia, c. Water, Environmental and Food Chemistry Unit, Department of Environmental Chemistry, Institute of Environmental Assessment and Water Research, Spanish National Research Council, Barcelona, Spain). UHPLC-HRMS data from non-targeted screening for biotransformation products of cytostatic drug imatinib. Data in Brief, Volume 41(2022): 107991

Imatinib is a selective tyrosine kinase inhibitor used to treat chronic myeloid leukemia. It enters the environment by excretion from the body through urine and feces and is transferred with wastewater to a wastewater treatment plant. There, it can be degraded by activated sludge, forming a number of biotransformation products. Presence of imatinib and its potential transformation products in the environment can impose a high risk to aquatic organisms and human health, therefore it is important to obtain knowledge of its environmental fate. The data presented here is a result of a simulated biodegradation of imatinib at two levels of activated sludge using a batch biotransformation setup, with and without carbon source. The data was acquired with UHPLC-HRMS/MS and processed by MzMine2.36 [1]. The dataset presents a table of $[M+H]^+$ features with retention times and corresponding MS/MS data. With development of new data mining tools this data can be used to identify new transformation products of imatinib and with it fully understand its environmental fate and the risk associated with its presence in the environment.

Keywords: Biodegradation, Wastewater, Anticancer, Drug, Transformation product

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The assessment of the bioaccumulation potential of chemicals is an essential and mandatory part of their regulatory environmental risk and hazard assessment. So far, in vitro data on fish metabolism is rarely available for biocidal active substances such as anticoagulant rodenticides. In this case study we present in vitro biotransformation rates of eight biocidal and one pharmaceutical anticoagulants in rainbow trout (Oncorhynchus mykiss) liver subcellular S9 fraction (RT-S9) determined following the Organisation for Economic Co-operation and Development test guideline 319B method at two different incubation temperatures (i.e., 12 ± 1 °C and 23 ± 2 °C). Furthermore, we address challenges associated with the usability and interpretation of in vitro data to support the decision making within the regulatory bioaccumulation assessment in bridging the gap between in silico methods and in vivo studies. According to our results, four of the tested substances (i.e., chlorophacinone, coumatetralyl, bromadiolone, and difenacoum) exhibited significant intrinsic clearance ($p < .001$) in the RT-S9 assay. Overall, the observed metabolism was (very) slow and clearance rates were temperature-dependent. Whether the determined in vitro biotransformation rate had a substantial influence on the predicted bioconcentration factor during extrapolation was subject to the lipophilicity of the test substance. Further improvements of existing concepts are needed to overcome uncertainties in the prediction of bioconcentration factors for chemicals such as anticoagulants.

Keywords: Bioaccumulation, Biocides, Chemical regulation, OECD 319B

Xin-Xin Liu[1], Hong-Yun Zhang[1], Xin Song1, Ying Yang[2], Zhi-Qiang Xiong[1], Yong-Jun Xia[1], Lian-Zhong Ai[1] (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(11) (2021): 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.

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

Biomarker

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Keywords: Genomics, Transcriptomics, Proteomics, Metabolomics, Artificial intelligence, Biomarkers, Heart failure

Jianan Zheng[a,1], Yuan Zheng[b,1], Wenjing Li[a], Jinxiu Zhi[a], Xinjie Huang[b], Wei Zhu[b], Zhongqiu Liu[a,c], Lingzhi Gong[a,c] (a. International Institute for Translational Chinese Medicine, Guangzhou University of Chinese Medicine, Guangzhou, Guangdong 510006, PR China, b. Department of Cardiothoracic Surgery, The Second Clinical College of

Guangzhou University of Chinese Medicine, Guangzhou, Guangdong 510006, PR China, c. Guangdong-Hong Kong-Macau Joint Lab on Chinese Medicine and Immune Disease Research, Guangzhou University of Chinese Medicine, Guangzhou, Guangdong 510006, PR China). Combined metabolomics with transcriptomics reveals potential plasma biomarkers correlated with non-small-cell lung cancer proliferation through the Akt pathway. Clinica Chimica Acta, Volume 530(2022): 66-73

Non-small-cell lung cancer (NSCLC) is one of the main types of lung cancer. Due to lack of effective biomarkers for early detection of NSCLC, the therapeutic effect is not ideal. This study aims to reveal potential biomarkers for clinical diagnosis.

The plasma metabolic profiles of the patients were characterized by liquid chromatography-mass spectrometry (LC-MS). Differential metabolites were screened by p less than 0.05 and VIP greater than 1. Multivariate statistical analysis was used to search for potential biomarkers. Receiver operating characteristic (ROC) curve was used to evaluate the predictors of potential biomarkers. Pathway enrichment analysis was performed on metabolomics data by Ingenuity Pathway Analysis (IPA) and transcriptomics data from GEO were used for validation.

A plasma metabolite biomarker panel including 13(S)-hydroxyoctadecadienoic acid (13(S)-HODE) and arachidonic acid was chose. The area under the ROC curve were 0.917, 0.900 and 0.867 for the panel in the different algorithm like Partial Least Squares Discrimination Analysis (PLS-DA), Support Vector Machine (SVM), Random Forest (RF). The candidate biomarkers were associated with the Akt pathway. Genes involved in the biological pathway had significant changes in the expression levels.

13(S)-HODE and arachidonic acid may be potential biomarkers of NSCLC. The Akt pathway was associated with this biomarker panel in NSCLC. Further studies are needed to clarify the mechanisms of disruption in this pathway.

Keywords: Non-small-cell lung cancer, Metabolomics, Transcriptomics, Biomarker, Pathway

Nicholas J. Robert[a,1], Janet L. Espirito[a,1], Liwei Chen[a,1], Esmond Nwokeji[a,1,2], Mandar Karhade[a,1], Makenzi Evangelist[b,c,1], Alexander Spira[c,d,1], Marcus Neubauer[c,e,1], Susie Bullock[c,1], Jennifer Walberg[c,1], Steven K. Cheng[e,1], Robert L. Coleman[c,1] (a.Ontada, 6555 State Highway 161, Irving, TX 75039, USA, b. New York Oncology Hematology, 400 Patroon Creek Blvd Suite 1, Albany, NY 12206, USA, c. US Oncology Research, 10101 Woodloch Forest Dr, The Woodlands, TX 77380, USA, d. Virginia Cancer Specialists, Fairfax, VA 22031, USA, e. The US Oncology Network, 10101 Woodloch Forest Dr, The Woodlands, TX 77380, USA). Biomarker testing and tissue journey among patients with metastatic non-small cell lung cancer receiving first-line therapy in The US Oncology Network. Lung Cancer, Volume 166(2022): 197-204

The MYLUNG (Molecularly Informed Lung Cancer Treatment in a Community Cancer Network) consortium pragmatic study assessed real-world biomarker testing rates and turnaround times within a large community-based oncology network.

This retrospective observational chart review study investigated patients with mNSCLC initiating first-line (1L) systemic therapy between 01-April-2018 and 31-March-2020. Biomarker testing rates and timing relative to 1L therapy for EGFR, ALK, ROS1, BRAF, and PD-L1 were assessed, including use of next-generation sequencing (NGS).

Among 3474 adults: 74% had adenocarcinoma and 76% had a documented ECOG performance status of 0 or 1. Ninety percent had testing for at least one biomarker, and 46% received all 5 biomarker tests. Changes in testing rates from 2018 to 2020 were 71% to 71% for EGFR, 71% to 70% for ALK, 69% to 67% for ROS1, 51% to 59% for BRAF, 82% to 84% for PD-L1, and 42% to 49% for all 5 biomarkers. NGS testing increased from 33% to 45% ($p < 0.0001$). Median time from mNSCLC diagnosis to 1L therapy was 35 days. Median turnaround times from biomarker testing orders to results ranged from 10 to 15 days for the individual biomarkers and 18 days for NGS.

In this real-world study, while most patients received at least one biomarker test prior to 1L, <50% received all 5 tests. NGS testing also occurred in < 50% of patients but appeared to increase over time. The next phase of MYLUNG will evaluate contemporary ordering practices and turnaround times prospectively.

Keywords: NSCLC, Biomarker testing, Next-generation sequencing

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Molecular radionuclide therapy (MRT) is an effective treatment for both localised and disseminated tumours. Biomarkers can be used to identify potential subtypes of tumours that are known to respond better to standard MRT protocols. These enrolment-based biomarkers can further be used to develop dose-response relationships using image-based dosimetry within these defined subtypes. However, the biological identity of the cancers treated with MRT are commonly not well-defined, particularly for neuroendocrine neoplasms. The biological heterogeneity of such cancers has hindered the establishment of dose-responses and minimum tumour dose thresholds. Biomarkers could also be used to determine normal tissue MRT dose limits and permit greater injected doses of MRT in patients. An alternative approach is to understand the repair capacity limits of tumours using radiobiology-based biomarkers within and outside patient cohorts currently treated with MRT. It is hoped that by knowing more about tumours and how they respond to MRT, biomarkers can provide needed dimensionality to image-based biodosimetry to improve MRT with optimized protocols and personalised therapies.

Keywords: Biomarker, MRT, PRRT, Repair capacity, NET, mCRPC, γH2AX, PARP, Biodosimeter

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Breast cancer (BC) biomarkers can radically improve the early detection in patients and, as a result, reduce mortality rate, whether for detecting individuals at increased risk of developing cancer or in the screening process. Finding a successful biomarker for breast cancer would be a fast and low-cost first solution to predicting BC, and it could potentially lead to a decline in the global BC mortality rate. However, biomarker exploration translates into the role of feature ranking and selection in machine learning terminology. This study explores the influence of

using a particular biomarker or combinations of different biomarkers as predictors for breast cancer. Three different classification algorithms were integrated with a sequential backward selection model: support vector machine (SVM), random forests (RF), and Decision Trees (DTs). The result shows that the optimal set of biomarkers comprises Glucose, Resistin, homo, BMI, and Age using the SVM model. The sensitivity and specificity were 0.94 and 0.90, respectively and the 95% confidence interval for the AUC was [0.89, 0.98]. The result indicates that Glucose, Resistin, homo, BMI, and Age combined can serve as a crucial BC biomarker in BC screening and detection.

Keywords: Breast cancer, Biomarkers, Feature ranking, Classification

Mohammed Merae Alshahrani. (Department of Clinical Laboratory Sciences, Faculty of Applied Medical Sciences, Najran University, 1988, Najran 61441, Saudi Arabia). A glance at the emerging diagnostic biomarkers in the most prevalent genitourinary cancers. Saudi Journal of Biological Sciences, Volume 29(4) (2022): 2072-2084

Genitourinary cancers comprise of a heterogenous group of cancers of which renal cell carcinoma, urothelial bladder carcinoma, and prostate adenocarcinoma are the most commonly encountered subtypes. A lot of research is ongoing using various strategies for exploration of novel biomarkers for genitourinary cancers. These biomarkers would not reduce the need for invasive diagnostic techniques but also could be used for early and accurate diagnosis to improve the clinical management required for the disease. Moreover, selecting the appropriate treatment regimen for the responsive patients based on these biomarkers would reduce the treatment toxicity as well as cost. Biomarkers identified using various advanced techniques like next generation sequencing and proteomics, which have been classified as immunological biomarkers, tissue-specific biomarkers and liquid biomarkers. Immunological biomarkers include markers of immunological pathways such as CTLA4, PD-1/PDl-1, tissue biomarkers include tissue specific molecules such as PSA antigen and liquid biomarkers include biomarkers detectable in urine, circulating cells etc. The purpose of this review is to provide a brief introduction to the most prevalent genitourinary malignancies, including bladder, kidney, and prostate cancers along with a major focus on the novel diagnostic biomarkers and the importance of targeting them prior to genitourinary cancers treatment. Understanding these biomarkers and their potential in diagnosis of genitourinary cancer would not help in early and accurate diagnosis as mentioned above but may also lead towards a personalized approach for better diagnosis, prognosis and specified treatment approach for an individual.

Keywords: Genitourinary cancers, Immunological biomarkers, Tissue molecular biomarkers, Liquid molecular biomarkers, Specific, Sensitive, Less cost

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Gastrointestinal (GI) disorders refer to gastrointestinal tract conditions, ranging from dyspepsia to inflammatory bowel diseases (IBDs) and malignant tumors. Biomarkers, which are assessable indicators of the presence or severity of the disorders, are indispensable agents to diagnose GI conditions. Diagnostic biomarkers, including serological biomarkers, antibodies, immunological biomarkers, fecal biomarkers, and genetic biomarkers (Non-encoding RNAs), are investigated and categorized in this review. Furthermore, we have discussed the essential biological functions and diagnostic roles and the advantages and disadvantages of these biomarkers, besides novel genetic biomarkers such as miRNA-146a and their role in GI diseases.

Keywords: Biomarker, Gastrointestinal disorders, Inflammatory bowel diseasesmi, RNAs, Crohn's disease

Biofertilizer

Beatriz Santiago, María Teresa Moreira, Gumersindo Feijoo, Sara González-García. (CRETUS Institute, Department of Chemical Engineering, School of Engineering, University of Santiago de Compostela, 15782 Santiago de Compostela, Spain). Environmental comparison of banana waste valorisation strategies under a biorefinery approach. Waste Management, Volume 142(2022): 77-87

Banana wastes can be valorised in bioethanol due to its high content in cellulose (more than 30% of total on a dry basis) and hemicelluloses (25% of total). Large amount of these wastes is generated during the banana cultivation and harvesting stage. This study proposes the use of, beside conventional acid sulphuric, different organic acids (tartaric, oxalic and citric) during acid pretreatment step, to suppress the unwanted compounds formation and improve bioethanol production. Instead, bioethanol production generates a solid waste flow that is managed in an anaerobic digestion plant, obtaining biogas, to be converted into energy, and digestate, considered as a potential biofertiliser. Life cycle assessment methodology is used to analyse the environmental profiles of four valorisation scenarios to produce bioethanol from banana peel waste. According to the results, reported per kilogram of bioethanol, the citric acid-based scenario has the worst environmental profile due to the background processes involved in the acid production (around 55% for most impact categories). Conversely, the oxalic acid-based scenario has the best environmental profile, with a decrease of around 20% and 35%, depending on the impact category, compared to the citric acid scenario. The energy requirements production (mostly thermal energy) is the main hotspot in numerous subsystems regardless of the scenario (ranging from 30% to 50% depending on the impact category). Therefore, the use of renewable energy sources to satisfy energy requirements combined with an energy optimisation of the valorisation strategies through the reuse of some internal steams, is proposed as improvement activities.

Keywords: Banana peel, Bioethanol, Biofertiliser, Environmental impacts, Life Cycle Assessment, Process simulation

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Iran, eDepartment of Agricultural Extension and Education, School of Agriculture, Shiraz University, Shiraz, Iran). The promotion of biofertilizer application on farms: Farmers' intentional processes. Environmental Technology & Innovation, Volume 28(2022): 102722

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

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

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Spread of antibiotic resistance or the presence of antibiotic resistance genes (ARGs) in pathogens is a globally recognized threat to human health. Numerous studies have shown that application of organic fertilizers may increase the risk of ARGs, however, the risk of resistance genes associated with biofertilizers is largely unknown. To investigate whether biofertilizer application introduces ARGs to the soil, we used high-throughput quantitative polymerization chain reaction (HT-qPCR) to explore the effect of biofertilizer application over three years on soil ARGs in three orchards with different locations in China. Redundancy analysis showed specific and significant differences in the beta diversity of soil bacteria and fungi between treatments (fertilizer *vs.* no fertilizer). One-way ANOVA analysis revealed findings of the main driver of the significant difference in microbial community structure between fertilizer and control treatment was the change in soil properties following the application of biofertilizer. A total of 139 ARGs and 27 MGEs (mobile genetic elements), and 46 ARGs and 6 MGEs from 11 major taxa were detected in biofertilizer and soil samples, respectively. Only the samples from Guangxi had significant differences in the detected number of ARGs and MGEs between fertilization and control. Through structural equation modeling (SEM), we found that soil properties indirectly affected ARGs by shaping bacterial diversity, while bacterial abundance directly affected ARGs. Biofertilizer application did not significantly alter the relative

abundance of ARGs in soil due to the complexity of the soil environment and competition between exogenous and native microorganisms. This study provided new insights into the spread of the antibiotic resistome of the soil through biofertilizer applications.

Keywords: Biofertilizer; Soil quality; Microbial diversity; ARG risk; High-throughput quantitative PCR

Yongqi Zhu, Mingtao Zhong, Weidi Li Yue, Qiu Haijiang Wang, Xin Lv. (Agricultural College, Shihezi University, Shihezi, Xinjiang 832003, PR China). Cotton straw biochar and *Bacillus* compound biofertilizer decreased Cd migration in alkaline soil: Insights from relationship between soil key metabolites and key bacteria. Ecotoxicology and Environmental Safety, Volume 232(2022): 113293

Cadmium (Cd) contamination greatly impacts soil health and ecological environment. In recent years, cotton straw biochar and *Bacillus* compound biofertilizer have been paid much attention in the remediation of Cd-contaminated soils. In this study, the effects of cotton straw biochar (3%, w/w) and *Bacillus* compound biofertilizer (1.5%, w/w) on the Cd fractions, Cd migration, bacterial community succession, and metabolites in the soils with different concentrations of Cd (1, 2, and 4 mg kg^{-1}) were explored. The results showed that the relative abundance of Actinobacteriota, Acidobacteriota, Firmicutes, and Cyanobacteric and soil enzyme activities in Cd-contaminated soils decreased, and the soil metabolic pathways also changed compared with those in the control. After the application of cotton straw biochar and *Bacillus* compound biofertilizer, the soil available Cd concentration in Cd-contaminated soils decreased, and many exchangeable and carbonate-bound Cd were transformed into residual Cd, which decreased the bioavailability of Cd in the soil and the accumulation of Cd in cotton organs. In addition, the application of cotton straw biochar and *Bacillus* compound biofertilizer improved the activity of soil enzymes and the abundance of dominant bacteria and stimulated Verrucomicrobiota, Methylomirabilota, and Cyanobacteria to secrete organic acids and amino acid compounds, which decreased the toxicity of Cd. Besides, compared with cotton straw biochar, *Bacillus* compound biofertilizer was more effective in immobilizing Cd and improving soil environment. This study provides guidance for the remediation of Cd-contaminated alkaline soil, and makes contributions to the soil health and sustainable development.

Keywords: Biochar; Biofertilizer; Cd stress; Bacterial diversity; Metabolites

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Potassium is the third most essential element for plant growth. It plays a vital role in the expansion, metabolism, and growth of plants. In soil, it is found in organic and inorganic forms, but plants consume it only in soluble form. Insoluble potassium can be changed to the solubilized form by soil microorganisms. Additionally, these microorganisms assist in improving nutrient and water retention, nutrient cycles of soil, stress management, and yield while also imparting disease resistance to crops. Potash-based biofertilizers are endowed with such abilities and provide the requisite supply of potassium via their unique composition. They also participate in the enhancement of the soil rhizosphere. In comparison to chemical fertilizers, biofertilizers

are cost-effective and ecofriendly. Thus, it is quite necessary to promote the use of biofertilizers rather than chemical fertilizers. In this chapter, we describe potash biofertilizers, their formulation, and field applications for the development of sustainable agriculture.

Keywords: Bioinoculant; Potassium-solubilizing bacteria; Soil; Plant nutrient; Sustainable agriculture

Biocomposting

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This article describes the technology of organic recycling of polylactide/halloysite biocomposites using the sugar-protein condensation theory. For this purpose, polymer biocomposites were produced with a polylactic acid structure and reinforced in the form of halloysite nanoparticles by 1; 2.5; and 5% by mass. A new method of decomposition of the produced biocomposites was developed. For this purpose, the composting process uses complex sugars in the form of beet molasses. This action is based on Stevenson's theory of protein-sugar condensation. Thus, the validity of this theory was confirmed, as research showed that this modification significantly influences the acceleration of the composting process of the produced biomaterials. For each phase of the process, the parameters of accelerated composting were defined by determining the temperature, degree of humidity, and quantitative scale of acidity and alkalinity. The degree of decomposition of biocomposites was assessed based on microbiological tests, hardness, weight loss, viscosity-average molecular weight tests, and structure assessment using macro and microscopic examinations (SEM). Based on the microbial tests, it was shown that composting also seems to be an alternative method of infectious waste disposal in the case of using biocomposites for products, e.g., medical products.

Keywords: Recycling; Composting; Biocomposites; PLA; Halloysite; Beet molasses

Biopesticides

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Globally, the issue of food security is in endangered condition due to various factors, one of them is biotic stress which is based on insect pest and pathogens. To protect the agriculturally important crops and to maintain the homeostasis balance between chemical pesticides and environment, biopesticides is a novel as well as alternative approach in the present situation. Application of biopesticide includes seed treatment, soil drenching and foliar spray. Among the different seed treatment methods seed priming is one of them. Seed treatment with beneficial microbes is known as biopriming. Biopriming with beneficial microbes facilitate nutrient supply to the crops, helps in bioaccumulation of inorganic compounds and phytoremediation of metal contaminated soils, induces resistance responses regulated by three phytohormones (via crosstalk among themselves through a complex signal networking) i.e. salicylic acid(SA), Jasmonic acid (JA) and ethylene against herbivores and phytopathogens. Inducible defence responses are of two types based on elicitors i.e. induced systemic resistance (ISR) and systemic acquired resistance (SAR). By and large, it is recognized as a promising approach as it helps in synchronized seed germination and seedling establishment within a short time span which protects the young seedlings by developing strong immune responses. Subsequently, the crop fight back naturally to remain disease free and thus reduces the input cost on chemical. In this review we have focused on attaining agricultural sustainability by reducing the dependence on chemical inputs via implementation of biopriming combined with beneficial microbes as biopesticide.

Keywords: Biopesticides, Biopriming, Sustainable agriculture, Beneficial microbes, Immune response

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To isolate and characterize a novel phytocystatin from walnut and investigate it for biopesticide development.

A battery of methodology was employed. Initially, phytocystatin was extracted and purified from walnut using ammonium sulfate saturation (60–80%), followed by gel filtration

chromatography on the Sephacryl S-100 HR column. Further characterization studies including pH and temperature stability, molecular weight, secondary structure, protease inhibitory assay and antimicrobial activity were carried using various techniques viz: spectroscopy, electrophoresis, and circular dichroism (CD) techniques.

Thiol protease inhibitor from walnut (WCPI) was isolated and purified with high (71.4%) yield and 184-fold purification. The molecular weight of the purified inhibitor was found to be around 11.2 kDa. Kinetic tests revealed that the inhibitor competitively inhibited papain and other cysteine proteases such as ficin and bromelain. It also exhibited significant antimicrobial activity against bacterial species.

Walnut cysteine protease inhibitor (WCPI) from Juglans regia (Kashmiri walnut) was isolated to homogeneity and had features of other members of the phytocystatin family. It demonstrated potential antimicrobial activity and may serve as an initial step towards developing enhanced pest control methods based on natural molecules.

Keywords: Cystatin, SDS-PAGE, Chromatography, Antimicrobial activity

Renata Garcia Dus[ia,b], Lais da Silva Morais[a], Natália Mendes Gomes Magalhães[a], Lorena Carneiro Albernaz[a], Chris J. Hamilton[b], Laila Salmen Espindola[a] (a. Laboratório de Farmacognosia, Universidade de Brasília, Campus Universitário Darcy Ribeiro, Brasília 70910-900, DF, Brazil, b. School of Pharmacy, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, UK). Potential of garlic oil as a biopesticide against all Aedes aegypti life stages. Industrial Crops and Products, Volume 181(2022): 114780

Vector control remains the most effective approach to prevent dengue, chikungunya and Zika arboviruses transmission. Conventional insecticides have historically failed to control the Aedes aegypti mosquito due to acquired resistance, environmental impact and toxicity. This study evaluated the potential of garlic oil as a biopesticide against the eggs, larvae, pupae and adult forms of Ae. aegypti, in accordance with the World Health Organization recommendations. The larvicidal and pupicidal LC_{50} values were 1.0 ppm and 20.3 ppm after 72 h, respectively. The oil maintained its activity in simulated field trials, killing all larvae and pupae at the concentrations tested. At 100 ppm, garlic oil inhibited 59.6 ± 10.6% egg hatching. Toxicity against the adult form was observed as was its potent spatial repellency. Garlic oils composed of different diallyl polysulfide ratios did not significantly impact insecticidal activity although the garlic oil polysulfide mixtures were more potent than the isolated polysulfides. The ovicidal, larvicidal, pupicidal, adulticidal and repellent assays showed the broad activity of garlic oil against Ae. aegypti. These results, together with the activity in simulated field trials, support the applicability of garlic oil in an integrated mosquito vector control program.

Jennifer Lorena Garcia-Riaño, Lissette Aracelly Torres-Torres, Adriana Marcela Santos-Díaz, Erika Paola Grijalba-Bernal.(Corporación Colombiana de Investigación Agropecuaria- AGROSAVIA, 250047, Colombia). In vitro compatibility with soybean agrochemicals and storage stability studies of the Beauveria bassiana biopesticide. Biocatalysis and Agricultural Biotechnology, Volume 39(2022): 102275

Beauveria bassiana is an insect pathogen with a significant host range and specificity. A biopesticide was developed as an emulsifiable concentrate (EC) using B. bassiana strain Bv060 to be integrated into soybean production systems. The aim of this study was to assess the storage stability and in vitro compatibility of this biopesticide with recommended fungicides,

insecticides, and herbicides commonly used in soybean cropping. In vitro compatibility was evaluated using response variables conidia germination (%) and viability (CFU/mL). The biopesticide was compatible with several insecticides and herbicides (except Gramoxone® after 6 contact hours) but was incompatible with all the fungicides evaluated. The EC storage stability was evaluated at 8°C, 18°C and 28°C for six months. Conidial germination was maintained at >80% for 6 months under all temperatures assessed. Germination kinetics were used to estimate the shelf-life of the biopesticide by using different mathematical models. The results obtained can be used in the implementation of this biopesticide based in B. bassiana (Bv060) in an integrated pest management program.

Keywords: Fungi entomopathogens, Fungicides, Herbicides, Insecticides, Shelf life, Conidial germination

Lena Schnarr[a,1], Mateus L. Segatto[b,1], Oliver Olsson[a], Vânia G. Zuin[a,b,c], Klaus Kümmerer[a,d] (a. Institute of Sustainable Chemistry, Leuphana University of Lüneburg, Universitätsallee 1, 21335 Lüneburg, Germany, b. Department of Chemistry, Federal University of São Carlos, Rod. Washington Luís (SP-310), km 235, 13565-905 São Carlos, SP, Brazil, c. Green Chemistry Centre of Excellence, University of York, Heslington, York YO10 5DD, UK, d. Research and Education, International Sustainable Chemistry Collaborative Centre (ISC3), Leuphana University of Lüneburg, Universitätsallee 1, 21335 Lüneburg, Germany). **Flavonoids as biopesticides – Systematic assessment of sources, structures, activities and environmental fate. Science of The Total Environment, Volume 824(2022): 153781**

Biopesticides obtained from renewable resources and associated with biodegradability have the potential to address resource limitations and environmental pollution, often caused by many conventional pesticides, due to the facility of natural products to run in natural nutrient cycles. Flavonoids are considered benign substitutes for pesticides, however, little comprehensive information of their pesticidal activities and critical evaluation of their associated advantages is available. Therefore, this systematic review assessed sources, structures, activities and the environmental fate of flavonoids on a basis of 201 selected publications. We identified 281 different flavonoids that were investigated for their pesticidal activity as either a pure compound or a flavonoid-containing extract, with quercetin, kaempferol, apigenin, luteolin and their glycosides as the most studied compounds. Agricultural or food waste, a potential sustainable source for flavonoids, represent 10.6% of the plant sources of flavonoids within these studies, showing the currently underutilization of these preferable feedstocks. Analysis of pesticidal activities and target organisms revealed a broad target spectrum for the class of flavonoids, including fungi, insects, plants, bacteria, algae, nematodes, molluscs and barnacles. Little information is available on the environmental fate and biodegradation of flavonoids, and a connection to studies investigating pesticidal activities is largely missing. Emerging from these findings is the need for comprehensive understanding of flavonoids pesticidal activities with emphasis on structural features that influence activity and target specificity to avoid risks for non-target organisms. Only if the target spectrum and environmental fate of a potential biopesticide are known it can serve as a benign substitute. Then, flavonoids can be integrated in a valorization process of agricultural and food waste shifting the extract-produce-consume linear chain to a more circular economy.

Keywords: Flavonoids, Biopesticides, Target specificity, Waste valorisation, Circular economy, Biodegradation

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DDTs, organophosphates, and carbamates are regularly used as pesticides in the fields and on to eradicate the harmful pests which also disturb the crops eco-systems. This demands a better and alternate strategy to deal with the problem and the government looks towards the use of biopesticides for better pest management. There are enormous lists of materials and biological entities that can be classified as biopesticides, wherein the biopesticides are swapping the chemical based pesticides to daze their damaging consequences on off-targeted beings. Here we have kept our focus on the use of plant viruses as biopesticides such as Baculoviruses like Nuclear polyhedrosis viruses, Recombinant viruses, etc. This article reviews the pesticidal properties of plant viruses, the latest development, commercial market status, and future prospects.

Key Words: Plant virus, Biopesticide, Recombinant viruses, Baculoviruses, Nuclear polyhedrosis viruses

Biodegradation

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Three different fungi were tested for their ability to degrade 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid and for the role of laccases and cytochromes P450-type in this process. We studied a white-rot fungus Rigidoporus sp. FMD21, which has a high laccase activity, for its efficiency to degrade these herbicides. A positive corre- lation was found between its laccase activity and the corresponding herbicide degradation rate. Even more, the doubling of the enzyme activity in this phase corresponded with a doubling of the herbicide degradation rate. It is, therefore, tempting to speculate that laccase is the most dominant enzyme in the degradation of 2,4-D and 2,4,5-T under these conditions. In addition, it was shown that

Rigidoporus sp. FMD21 partly relies on cytochromes P450-type for the break- down of the herbicides as well. Two filamentous fungi were isolated from soil contaminated with herbicides and dioxins located at Bien Hoa airbase. They belong to genera Fusarium and Verticillium of the phylum Ascomycota as judged by their 18S rRNA gene sequences. Both isolated fungi were able to degrade the herbicides but with different rates. Their laccase activity, however, was very low and did not correlate with the rate of breakdown of the herbicides. These data indicate that the white-rot fungus most likely synthesizes laccase and cytochromes P450-type for the breakdown of the herbicides, while the types of enzyme used for the breakdown of the herbicides by the two Ascomycota remain unclear.

Keywords: Biodegradation; 2,4-Dichlorophenoxyacetic acid; 2,4,5-Trichlorophenoxyacetic acid; Laccase; CYP; inhibitors; Rigidoporus

Ángel A. Ramos-García, Claudia Walecka-Hutchison & David L. Freedman. (Department of Environmental Engineering & Earth Sciences, Clemson University, Clemson, SC, 29634-0919, USA, The Dow Chemical Company, Midland, MI, 48674, USA, Corresponding author: Correspondence to David L. Freedman). Effect of biostimulation and bioaugmentation on biodegradation of high concentrations of 1,4-dioxane. Biodegradation, volume 33(2) (2022): 157–168

1,4-Dioxane is a pervasive and persistent contaminant in numerous aquifers. Although the median concentration in most contaminant plumes is in the microgram per liter range, a subset of sites have contamination in the milligram per liter range. Most prior studies that have examined 1,4-dioxane concentrations in the hundreds of milligrams per liter range have been performed with industrial wastewater. The main objective of this study was to evaluate aerobic biodegradation of 1,4-dioxane in microcosms prepared with soil and groundwater from a site where concentrations range from ~ 1500 $mg \cdot L^{-1}$ in the source zone, to 450 $mg \cdot L^{-1}$ at a midpoint of the groundwater plume, and to 6 $mg \cdot L^{-1}$ at a down-gradient location. Treatments included biostimulation with propane, addition of propane and a propanotrophic enrichment culture (ENV487), and unamended. The highest rates of biodegradation for each location in the plume occurred in the bioaugmented treatments, although indigenous propanotrophs also biodegraded 1,4-dioxane to below 25 $\mu g \cdot L^{-1}$. Nutrient additions were required to sustain biodegradation of propane and cometabolism of 1,4-dioxane. Among the unamended treatments, biodegradation of 1,4-dioxane was detected in the mid-gradient microcosms. An isolate was obtained that grows on 1,4-dioxane as a sole source of carbon and energy and identified through whole-genome sequencing as *Pseudonocardia dioxivorans* BERK-1. In a prior study, the same strain was isolated from an aquifer in the southeastern United States. Monod kinetic parameters for BERK-1 are similar to those for strain CB1190.

Keywords: Aerobic; Bioaugmentation; Biostimulation; 1,4-Dioxane; ENV487; Propanotrophs

Ángeles Martínez-Toledo, María del Carmen Cuevas-Díaz, Owsaldo Guzmán-López, Jaime López-Luna & César Ilizaliturri-Hernández. (Facultad de Medicina, Coordinación para la Aplicación de la Ciencia y la Tecnología–Centro de Investigación Aplicada en Ambiente y Salud (CIACyT–CIAAS), San Luis Potosí, Mexico, Facultad de Ciencias Químicas, Universidad Veracruzana, Avenida Universidad Km. 7.5 Coatzacoalcos, Veracruz, Mexico, Instituto de Estudios Ambientales, Universidad de la Sierra Juárez, Oaxaca, Mexico). Evaluation of in situ biosurfactant production by inoculum of P. putida and nutrient addition for the removal of polycyclic aromatic hydrocarbons from aged oil-polluted soil. Biodegradation volume 33 (2) (2002): 135–155

This work aimed to conduct a laboratory study to evaluate the use of Pseudomonas putida CB-100 and nutrient addition for the removal of PAHs from an aged oil-polluted soil of Veracruz, Mexico. Pseudomonas putida is a biosurfactant-producing bacterium capable of metabolizing polycyclic aromatic hydrocarbons (PAHs), which are toxic compounds with low water solubility, high melting, and boiling points, and low vapor pressure; characteristics that increase as their molecular weight increases and make them more recalcitrant. The methodology consisted in sampling the long-term oil-polluted soil and testing the use of Gamma irradiation (25 kGy) for the sterilization of the soil for abiotic control. We evaluated serological bottles containing 20 g of 35% moist soil (irradiated and non-irradiated) with the following treatments: the addition of nutrients (NH4Cl, NaNO3, KH2PO4, and K2HPO4), an inoculum of P. putida, and both P. putida and nutrients. The parameters assessed were pH, organic matter, humidity, available phosphorus, total nitrogen, cultivable heterotrophic microorganisms, CO2 production, rhamnolipids, surface tension, and the removal of eleven PAHs. The non-irradiated soil added with P. putida was the most efficient in the removal of PAHs; the pattern was: Benzo(a)anthracene > Phenanthrene > Fluoranthene > Benzo(k)fluoranthene > Chrysene > Pyrene > Anthracene > Acenaphthylene > Benzo(b)fluoranthene. In conclusion, P. putida in the non-irradiated soil produced in situ biosurfactants (1.55 mg/kg of rhamnolipids and an 11.9 mN/m decrease in surface tension) and removed PAHs in 10 days.

Keywords: Bioremediation; Biostimulation; Bioaugmentation; Gamma irradiation; Rhamnolipids

Zhi-Qing Zhao, Xiao-Meng Wei, Xiao-Li Shen, Ghulam Abbas, Rui Fan & Yi Jin. (College of Chemical & Material Engineering, Quzhou University, Quzhou, 324000, People's Republic of China, College of Environment & Resource Sciences, Zhejiang University, Hangzhou, People's Republic of China, Key Laboratory of Agro-Ecological Processes in Subtropical Region & Changsha Research Station for Agricultural and Environmental Monitoring, Institute of Subtropical Agriculture, Chinese Academy of Sciences, Hunan, 410125, China, Department of Chemical Engineering, University of Gujrat, Gujrat, 50700, Pakistan). Aerobic degradation of 4-fluoroaniline and 2,4-difluoroaniline: performance and microbial community in response to the inocula. Biodegradation volume 32 (1) (2002): 53–71

In this study, a distinct inoculum was investigated as an isolated variable within sequencing batch reactors via a comparison of the 4-fluoroaniline (4-FA) or 2,4-difluoroaniline (2,4-DFA) removal amounts. The inocula were derived from a treatment plant for treating pharmaceutical wastewater plus a small amount of municipal sewage (PMS), a treatment plant for treating fluoridated hydrocarbon wastewater (FHS), and a treatment plant for treating the comprehensive wastewater in an industrial park (CIS). There were slight differences among the degradation patterns of the 4-FA for the three inocula, whether during the enrichment period or the high concentration shock period. In contrast, it was observed that the degradation efficiency of 2,4-DFA initially varied with the inocula. The FHS-derived inoculum was determined to be optimal, exhibiting the earliest degradation reaction only after an acclimation of 7 days had the highest degradation rate constant of 0.519 h^{-1}, and had the fastest recovery time of three weeks after high concentration shock. Additionally, compared with the PMS-derived inoculum, the CIS-derived inoculum exhibited an earlier degradation reaction within three weeks, and a higher microbial diversity, but a lower shock resistance and degradation rate constant of 0.257 h^{-1}. High-throughput sequencing demonstrated that each final consortium was different in

composition, and the microbial consortia developed well on the inoculum and substrate. In comparison of the similarity among the three 2,4-DFA enrichment cultures, the higher similarity (63.9–70.0%) among three final consortia enriching with 4-FA was observed. The results indicated that the inoculum played an important role in the degradation of FAs and the microbial bacterial communities of final consortia, and the effect extent might well depend on the fluorinated level of FAs.

Keywords: Inoculum; Acclimation; 4-fluoroaniline; 2,4-difluoroaniline; Microbial community

Xiyin Yu[a1], Ge Zhu[a1], YongyiGao[a], Zhendong Wu[a], PengZhang[a], Xinyue Zhang[a], Cheng Qian[a], Fu Chen[a], Yongming Zhang[a], RuiLiu[b], Bruce E.Rittmann[c]. ([a]Department of Environmental Engineering, School of Environmental and Geographical Science, Shanghai Normal University, Shanghai, 200234, PR China, [b]Zhejiang Provincial Key Laboratory of Water Science and Technology, Department of Environmental Technology and Ecology, Yangtze Delta Region Institute of Tsinghua University, Zhejiang, Jiaxing, 314006, PR China, [c]Biodesign Swette Center for Environmental Biotechnology, Arizona State University, Tempe, AZ, 85287-5701, USA). Roles of *Pseudomonas aeruginosa* and *Ensifer adhaerens* in accelerating nitrobenzene biodegradation by removing an inhibitory intermediate. International Biodeterioration & Biodegradation, Volume 171(2022): 105419

Pseudomonas aeruginosa and *Ensifer adhaerens* were isolated from aerobic biomass acclimated to nitrobenzene (NB) based on ability to biodegrade NB and its intermediate, *o*-aminophenol. Bioaugmenting either of them into the acclimated biomass accelerated NB biodegradation. The NB removal rates were as 19% and 144% faster, respectively, with *P. aeruginosa* and *E. adhaerens*, compared to the acclimated biomass, even though the dry-weight concentrations of *P. aeruginosa* and *E. adhaerens* were only ~10% of the acclimated biomass. Biodegradation was further accelerated by another 36%–217% when *P. aeruginosa* and *E. adhaerens*, respectively, were bioaugmented into the acclimated biomass at ~10% of the dry weight. The primary benefit of *P. aeruginosa* and *E. adhaerens* came from their ability to biodegrade rapidly an inhibitory intermediate of NB biodegradation, *o*-aminophenol. Phylogenetic analysis showed that *Thauera*, which is known to be active in NB biodegradation, was by far the dominant genus in the acclimated biomass. Although the abundances of *E. adhaerens* and *P. aeruginosa* were minimal in the acclimated biomass (~0.01%), they played an important role in accelerating NB biodegradation by bioaugmention once they were isolated, enriched, and bioaugmented.

Keywords: Nitrobenzene; Bioaugmentation; Toxicity; *Pseudomonas aeruginosa;Ensifer adhaerens*

Yu-Hang Zhang[abcdfg], Jun-DeDong[abcdf], You-ShaoWang[a], Ji-DongGu[e], Jian-PingYin[ab], ManzoorAhmad[a], JuanLing[abcdf]. ([a]CAS Key Laboratory of Tropical Marine Bio-resources and Ecology, Guangdong Provincial Key Laboratory of Applied Marine Biology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, 510301, China, [b]Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou), Guangzhou, 511458, China, [c]Key Laboratory of Tropical Marine Biotechnology of Hainan Province, Sanya Institute of Oceanology, SCSIO, Sanya, 572000, China, [d]Sanya National Marine Ecosystem Research Station, Tropical Marine Biological Research Station in Hainan, Chinese Academy of Sciences, Sanya, 572000, China, [e]Environmental Science and Engineering Program, Guangdong Technion - Israel Institute of Technology, Shantou, Guangdong, 515063, China, [f]Innovation Academy of South China Sea Ecology and Environmental Engineering, Chinese Academy of Sciences, Guangzhou, 511458, China, [g]University of Chinese Academy of Sciences, Beijing, 100049, China). Comparative

genomics reveals the evidence of aromatic hydrocarbons degradation potential in genus *Roseovarius* in marine environment. International Biodeterioration & Biodegradation, Volume 171(2022): 105408

Aromatic compounds are eco-toxic organic pollutants widely distributed in the marine environment, and microbes of the genus *Roseovarius* have demonstrated high potential for bioremediation and degradation of aromatic compounds. However, rare comprehensive comparative genomic studies of the genus *Roseovarius* on their diversity and aromatic degrading functions are available. In this work, the whole genome of phenanthrene-degrading strain *Roseovarius* sp. SCSIO 43702 was sequenced and comparatively analyzed with other 44 isolated *Roseovarius* strains. We have detected a weak significant (ANOSIM, $R = 0.3804$, $p = 0.01$) between the phylogenetic clades and the geographic source, and found a complete phenanthrene metabolic pathway presented in most *Roseovarius* strains. Further, nine investigated *Roseovarius* strains were selected for the phenanthrene biodegradation assay, and eight marine originated strains exhibited significant higher the degrading ability (T-test, $p < 0.05$) than control group. Collectively, these results showed the environmental adaptation and aromatic degradation potential of the genus *Roseovarius* at the genomic and phenotypic levels, and provided references to evaluate applicable prospects of *Roseovarius* strains in aromatic bioremediation of the marine environment.

Keywords: Aromatic compounds; Bioremediation; *Roseovarius;* Comparative genomic analysis; Degradation potential

Huo-YongJiang[a], Hong-KaiWu[a], Pan-PanYuan[a], Jing-JingGuo[b], LiWang[a], Yi-JunDai[a]. ([a]Jiangsu Key Laboratory for Microbes and Functional Genomics, Jiangsu Engineering and Technology Research Center for Industrialization of Microbial Resources, College of Life Science, Nanjing Normal University, Nanjing, 210023, People's Republic of China, [b]Nanjing Normal University Zhongbei College, Zhenjiang, 212334, People's Republic of China). **Biodegradation of sulfoxaflor by *Pseudomonas stutzeri* CGMCC 22915 and characterization of the nitrile hydratase involved. International Biodeterioration & Biodegradation, Volume 170(2022): 105403**

Sulfoxaflor (SUL), a novel sulfoximine insecticide, causes environmental contamination and poses potential risks to animals. However, there are few reports of SUL degradation by pure microbes. In this study, a novel isolated bacterium, *Pseudomonas stutzeri* CGMCC 22915, rapidly degraded SUL to SUL-amide via hydration. *P. stutzeri* CGMCC 22915 degraded 58.2% of SUL (814.28 μmol/L) within 2 h with a half-life of 1.6 h. *P. stutzeri* CGMCC 22915 effectively facilitated SUL degradation in soil and surface water. The nitrile hydratase *Ps*NHase with a different gene orientation of <*β*-subunit> <*α*-subunit> <accessory protein> was responsible for the formation of SUL-amide from SUL and transformed other nitrile-containing insecticides thiacloprid and acetamiprid to their amides. Nitrile hydratases with this gene orientation have never been reported to degrade nitrile-containing insecticides. *E. coli* expressing *Ps*NHase degraded 90.4% of SUL (798.29 μmol/L) within 5 min with a half-life of just 0.59 min. *Ps*NHase showed the highest activity in SUL degradation among reported NHases (V_{max} 21.69 U/mg, K_m 1.62 mmol/L). Modeling of *Ps*NHase suggested that *β*-His62 was important for its highest enzymatic activity toward SUL. *P. stutzeri* CGMCC 22915 is promising for application in the bioremediation of SUL in contaminated soil and surface water.

Keywords: *Pseudomonas stutzeri;* Biodegradation; Sulfoxaflor; Nitrile hydratase; Surface water; Soil

Jun Tu[b], Caicai Lu[ab], Zhi Chen[c], Qiang Zhang[c], Yuanyuan Song[b], Haibo Li[b], Yi Han[b], Yanan Hou[b], Jianbo Guo[b]. ([a]Experimental and Practical Innovation Education Center, Beijing Normal University, Jinfeng Road 18, Zhuhai, 519000, China, [b]School of Environmental and Municipal Engineering, Tianjin Key Laboratory of Aquatic Science and Technology, Tianjin Chengjian University, Jinjing Road 26, Tianjin, 300384, China, [c]College of Urban and Environmental Sciences, Northwest University, Xuefu Avenue 1, Xi'an, 710127, Shanxi, China). Protective effect of β-cyclodextrin to microorganisms during anaerobic degradation of azo dyes. International Biodeterioration & Biodegradation, Volume 170(2022): 105401

Azo dyes bio-decolorization produces aromatic amines, which are toxic to microorganisms and affect microbial activity. In this paper, the protective effect of β-cyclodextrin (β-CD) on the azo dyes bio-decolorization and the mechanism were investigated. The bio-decolorization rate of direct lake blue in 0.5 mM β-CD supply system was increased by 1.3, 2.6 and 4.2 folds, in the period of 0–24 h, 24–48 h and 48–72 h, respectively. The electrochemical characteristics of the bio-decolorization process of direct lake blue were improved by β-CD. Electron donor (NADH) content and electron transfer system activity were increased by β-CD, which were beneficial to the electron generation and electron transfer. ATP content, β-galactosidase and CAT activities were increased by β-CD, which indicated that β-CD effectively improved microbial activity. In addition, β-CD promoted the secretion of extracellular polymers, which was conducive to resisting the adverse effects. Inhibitors test showed that β-CD alleviated the inhibitory effects of toxic substances on microorganisms, which proved the protective effect of β-CD on microorganisms. This study showed that β-CD possessed a protective effect on microorganisms during azo dyes bio-decolorization and application prospect in biological treatment of toxic contaminants.

Keywords: β-cyclodextrin; Azo dyes; Bio-decolorization; Protective; Toxic

Shunli Hu[a1], Long Zhang[b1], Guiping Liu[a], Yufeng Gan[a], BaozhanWang[a], Fang Wang[c], Jiandong Jiang[a]. ([a]Department of Microbiology, Key Lab of Microbiology for Agricultural Environment, Ministry of Agriculture, College of Life Sciences, Nanjing Agricultural University, 210095, Nanjing, China, [b]College of Life Sciences, Huaibei Normal University, 235000, Huaibei, China, [c]Institute of Soil Science, Chinese Academy of Sciences, 210008, Nanjing, China). Selective removal of the non-herbicidal (*S*)-enantiomer of dichlorprop from agricultural soil by an *in-situ* enriched consortium. International Biodeterioration & Biodegradation, Volume 170(2022): 105398

Rac-dichlorprop [(*R*,*S*)-2-(2,4-dichlorophenoxy)propanoic acid], a commonly used chiral phenoxyalkanoic acid herbicide, is frequently detected in various environments, posing threats to human health and environmental safety. The (*S*)-enantiomer of dichlorprop shows a lower herbicidal activity but a higher toxicity as compared to the (*R*)-enantiomer of dichlorprop. It is of great importance to enantioselectively remove the non-herbicidal (*S*)-dichlorprop from the *rac*-dichlorprop in the application sites. In this study, the dissipation of (*R*)- and (*S*)-dichlorprop in an agricultural soil was investigated. We found that the dissipation rate of (*S*)-dichlorprop was higher than that of (*R*)-dichlorprop in an agricultural soil. Although the influences of different enantiomers of dichlorprop on soil bacterial community were not different, *Sphingobium* was significantly enriched in the (*S*)-dichlorprop-treated soil as compared to (*R*)-dichlorprop, indicating that *Sphingobium* species played important roles in the dissipation of (*S*)-dichlorprop.

Furthermore, a bacterial consortium containing *Sphingobium* sp. strain SP-2 (enantioselectively transforming (*S*)-dichlorprop to 2,4-dichlorophenol) and *Sphingopyxis* sp. strain DP-21 (mineralizing 2,4-dichlorophenol), which synergistically mineralized the (*S*)-enantiomer of dichlorprop, was isolated from the agricultural soil. Bioaugmentation with the *in-situ* isolated consortium (strains SP-2 and DP-21) resulted in the enhanced removal of the non-herbicidal (*S*)-dichlorprop from the soil and in the adaptation of the inoculated degrading strains. This study offers new insights into the enhanced bioremediation of the non-herbicidal (*S*)-dichlorprop contaminated soils while simultaneously ensuring environmental safety and crop yield.

Keywords: Dichlorprop; (*S*)-Enantiomer; Soil bacterial community; *In-situ* consortium; Bioaugmention

Amit Bafana. (Health and Toxicity Cell, CSIR-NEERI (National Environmental Engineering Research Institute), Nagpur, 440020, India). Identification and characterization of azoreductase enzyme AzoR2 from *Bacillus velezensis* for biodegradation of azo dyes. International Biodeterioration & Biodegradation, Volume 167(2022): 105351

Azoreductase presents an interesting group of enzymes due to its widespread occurrence in all living forms, high sequence heterogeneity and debatable physiological role. Some bacteria have been reported to contain multiple azoreductase enzymes with differing properties, raising questions about their phylogenetic, functional and structural relationships. A YhdA azoreductase was characterized from *Bacillus velezensis* strain AB earlier. The present investigation reports another azoreductase AzoR2 from this culture. The amino acid sequence, physico-chemical and kinetic properties of AzoR2 were very different from YhdA, indicating that these enzymes were phylogenetically distant. AzoR2 was a flavoprotein containing FMN with subunit molecular weight of 25 kDa. It preferentially utilized NADH as electron donor with V_{max} and K_m of 400 U/mg and 40.2 μM respectively for methyl red decolourization. It also decolourized methyl orange and congo red effectively. The highest activity was observed at pH 7. The optimum temperature for enzyme activity was 20 °C with 84.8% activity at 60 °C. The 3-D enzyme structure was modeled, where the FMN binding residues were found to be conserved and the enzyme was predicted to be homodimeric. It is the first report on AzoR2-type enzyme from *B. velezensis* according to our extensive literature review.

Keywords: Azoreductase; Purification; Michaelis-Menten constants; Recombinant expression; Structure prediction

Biosensor

Ritu Deswal[a], Vinay Narwal[b], Parveen Kumar[b], Vaishali Verma[a], Amita Suneja Dang[a], C.S. Pundir[b] (a. Centre for Medical Biotechnology, M.D. University, Rohtak, 124001, Haryana, India, b. Department of Biochemistry, M.D. University Rohtak, 124001, Haryana, India). An improved amperometric sarcosine biosensor based on graphene nanoribbon/chitosan nanocomposite for detection of prostate cancer. Sensors International ,Volume 3(2022): 100174

We describe herein an improved amperometric biosensor for detection of sarcosine, a potential biomarker for prostate cancer. The biosensor is based on covalent immobilization of sarcosine

oxidase (SOx) onto nanocomposite of chitosan (CHIT) and graphene nanoribbons (GNRs) electrodeposited onto Au electrode. The GNRs were studied by transmission electron microscopy and UV spectroscopy. The working electrode (SOx/CHIT/GNRs/AuE) exhibited maximum current at a potential of 0.1V against Ag/AgCl, generated from electrochemical oxidation of H_2O_2, from sarcosine by immobilized SOx. The biosensor showed optimum response i.e. current (mA) within 2s at pH 7.3 and 35 °C. There was a linearity between current (mA) and sarcosine concentration in a wider range 0.001–100 μM with a minimum detection limit of 0.001 μM and a high sensitivity of 277.5 μA/μM/cm. Analytical recoveries of added sarcosine in sera were 97.35%, within and between-batch coefficients of variation were 1.08% and 1.40% respectively. A good correlation (R_2 = 0.99) was obtained between sera sarcosine values, as measured by the standard immuno kit method and present biosensor. The biosensor measured sarcosine levels in sera of prostate cancer patients, which was significantly higher than in apparently healthy persons. The enzyme electrode lost 20% of its initial activity during 180days, when stored dry at 4°C.

Keywords: Sarcosine, Sarcosine-biosensor, Graphene-nanoribbons, Chitosan, Serum, Prostate-cancer

Zahra Soltanabadi, Akbar Esmaeili. (Department of Chemical Engineering, North Tehran Branch, Islamic Azad University, PO Box 1651153311, Tehran, Iran). Invention of a fast response biosensor based on Au-PolyPyrrole nanocomposite-modified quartz crystal to detect morphine concentration. Journal of Photochemistry and Photobiology A: Chemistry, Volume 429(2022): 113919

A biosensor based on a 20 MHz oscillator was designed by modifying the quartz surface with the Au nanoparticle in PolyPyrrole (AuNP-PPy) layer. In this design, a new field programmable gate array board was used. The AuNP-PPy composite was layered on a quartz surface with 5 μm thick using centrifugal force as simple method. Biosensor components were characterized by FESEM, XRD and FTIR spectrum. The recording of the frequency of the biosensors before the detection of morphine showed that the syntheses were the same, the frequency of all the sensors were almost equal and the experiments were repeatable. The biosensor was stable up to 50 °C but performed better at 28 °C. The limit of morphine concentration detection by biosensor was 0.1 $ngml^{-1}$.Detection of morphine concentration in unknown samples showed a detection error of less than 4%. Regeneration results showed that this biosensor can be used up to 8 times in a row.

Keywords: Biosensors, Au-PolyPyrrole nanocomposite, Quartz crystal, Morphine, Monoclonal antibody

Lei Qin[1,2], Xia Liu[3], Ke Xu[4], Chun Li[1,2,3] (1. Key Lab for Industrial Biocatalysis, Ministry of Education, Department of Chemical Engineering, Tsinghua University, Beijing, 100084, PR China, 2. Center for Synthetic & Systems Biology, Department of Chemical Engineering, Tsinghua University, Beijing, 100084, PR China, 3. Key Laboratory of Medical Molecule Science and Pharmaceutics Engineering, Ministry of Industry and Information Technology, Institute of Biochemical Engineering, School of Chemistry and Chemical Engineering, Beijing Institute of Technology, Beijing, 100081, PR China, 4. Tangshan Key Laboratory of Agricultural Pathogenic Fungi and Toxins, Department of Life Science, Tangshan Normal University, Tangshan, 063000, PR China). Mining and design of biosensors for engineering microbial cell factory. Current Opinion in Biotechnology, Volume 75(2022): 102694

Improving the yield of target product is the purpose in the construction and optimization of microbial cell factory. Conferring biosensor-based intelligence on the strains is an important way

to solve the engineering problems such as imbalance of metabolic flux and accumulation of toxic intermediates. In recent years, genetically encoded biosensors for both metabolites and environmental signals are rapidly created and developed via rational design, directed evolution or machine learning. In addition to being a rapid detection method for high-throughput screening, biosensors are more and more applied for directed evolution of strains and dynamic regulation of metabolic pathway. Biosensor-based intelligence will play more important role in the construction of microbial cell factory.

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Biosensors have emerged as a potential tool for selective and sensitive detection. Biomolecules like enzymes, deoxyribonucleic acid (DNA), and antibodies are used as recognition sites in biosensors due to their high selectivity, sensitivity, and signal-to-noise ratio. Nowadays, biosensors are used to detect many vital biomolecules such as glucose, urea, and cholesterol. Exploiting enzymes for the selective detection of target molecules are very good but may not be easily accomplished as enzymes often need to be immobilized onto support materials, which requests either modifying the surface or using appropriate linkers to synthesize biosensors. Currently, many biosensors' signal strength and stability still are low, which encourages the fabrication of functionalized nanomaterials/nanoparticles to enhance electrochemical performance. The review covers current progress in modifying enzyme immobilized biosensors to detect biologically essential molecules (glucose, urea, cholesterol). A discussion of the different types of enzyme immobilization is also provided. This review may be helpful for researchers to build rational and novel biosensors for efficient enzyme immobilization and sensing applications.

Keywords: Enzyme immobilization, Biosensors, Nanomaterials, Electrochemical sensing, Biomolecules

Emmi Puhakka, Ville Santala. (Tampere University, Korkeakoulunkatu 7, 33720 Tampere, Finland). Method for acrylic acid monomer detection with recombinant biosensor cells for enhanced plastic degradation monitoring from water environments. Marine Pollution Bulletin, Volume 178(2022): 113568

Plastic debris degrades in the water environments due to various factors such as mechanical stress. Small-sized degradation products, including plastic monomers, are currently monitored using equipment which might be unsuitable for screening. Here, we developed a recombinant whole-cell bacterial biosensor, which could be used for this type of monitoring. The Escherichia coli pBAV1K-ACU-lucFF cells contain a luciferase-based reporter system under the control of acrylic acid specific promoter. The biosensor cells were used to detect acrylic acid monomers from both sterile water and spiked lake water samples, indicating usability with environmental samples. Furthermore, poly(acrylic acid) was incubated in salt water, and the biosensor cells could identify acrylic acid monomers originating from it. Thus, the cells could be used to observe similar processes in the environment. The results show that the bacterial biosensors

could complement the current research methods of plastic monomer monitoring in water environments with a potential for higher throughputs.

Keywords: Biosensor cells, Plastic degradation, Monomer detection, Acrylic acid, Poly(acrylic acid), Water environments

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The transient response of amperometric enzyme-based biosensors working in trigger mode is discussed. Nonlinear time-dependent partial differential equations for Michaelis–Menten reaction kinetics are solved analytically using a new approach of homotopy perturbation technique. The simple and closed-form analytical expression for concentration profiles are provided. Subsequently, the biosensor's current, sensitivity, resistance, and amplification are derived from the concentration profiles. The current response is predicted under steady-state conditions when , proving the validity of the mathematical analyses. The limiting situations of catalytic sites (unsaturation and saturation) are considered. The compatibility of analytical results with simulation and limiting case results can be observed from the graphs and tables presented. The existence of the moving boundary between the two categories of catalytic sites is also discussed.

Keywords: Mathematical modelling, Nonlinear reaction-diffusion equations, Enzymatic trigger reactions, Amperometric biosensor, Homotopy perturbation method

Yeşeren Saylan, Semra Akgönüllü, Adil Denizli. (Hacettepe University, Department of Chemistry, Ankara, Turkey). Preparation of magnetic nanoparticles-assisted plasmonic biosensors with metal affinity for interferon-α detection. Materials Science and Engineering: B, Volume 280(2022): 115687

Sensitive, accurate, and rapid detection of biomolecules from complex matrices still remains a critical challenge. Herein, we designed magnetic nanoparticles which were coupled with plasmonic surfaces to detect a clinically important biomarker (interferon-α) in buffer solutions and artificial plasma samples. At first glance, the magnetic nanoparticles were synthesized and comprehensively characterized. Then, any potential external factors on magnetic nanoparticles were examined, thereby benchmarking detection performance. After determining optimum conditions, the plasmonic biosensor surface was modified with these magnetic nanoparticles for detecting interferon-α in real-time. The kinetic performance of magnetic nanoparticles-assisted plasmonic biosensor provided a high correlation coefficient (0.99) and a low limit of detection (41 IU/mL) in a broad range of interferon-α concentrations. Consequently, this method holds a great potential to detect other biomolecules with high sensitivity and low interference and would be employed as an alternative approach for biomarker detection at different perspectives ranging from medical diagnosis to pharmaceutical industry.

Keywords: Interferon-α detection, Magnetic nanoparticle, Plasmonic biosensor, Metal affinity

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based on molybdenum doped ZnO nanowires field effect transistor biosensor; a comparative study to PCR test results. Analytica Chimica Acta, Volume 1195(2022): 339442

In this paper, a bio-sensing setup for investigating hepatitis B virus deoxyribonucleic acid (HBV DNA) diagnosis including rapid testing and field effect transistor (FET) in label free assay is proposed. The FET biosensor was fabricated by molybdenum doped ZnO nanowires (NWs) in easy method and cost-free approach. The materialized NWs were synthesized by physical vapor deposition (PVD) growth mechanism. The molybdenum dopant could bring about vacancy sites for DNA adsorption and electric charge transfer. The capability of the fabricated biosensor was evaluated by investigating the PCR-verified samples known as True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN). The FET biosensor could materialize the clinical tests on samples TP, TN, FP and FN and could distinguish the clinical samples from each other. The designed biosensor showed more precision than the PCR-outcomes by exhibiting more sensitivity on labeled samples known as FN. This research has analytical and comparative study on fabricated biosensor performance. The achieved results show that the biosensor had significant response to samples which have not been carefully detected by PCR test. The fabricated biosensor showed high accuracy, precision, sensitivity, specificity and reproducibility for differentiating (TP), (TN), (FP) and (FN) samples from healthy and normal sample. The response sensitivity was calculated and biosensor showed a detection limit (LOD) of 1 pM. The biosensor demonstrated high response and satisfied signal in the concentration ranges from 1 pM to 10 μM.

Keywords: Biosensor, Hepatitis B Virus, Molybdenum doped ZnO Nanowires, Field-effect transistor, Label-free mechanism

Bioengineering

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

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

Keywords: Biofertilizer; Plant nutrients accessibility; Bioengineering; GMOs; Sustainable agriculture

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Lignin is considered to represent the second most abundant terrestrial biopolymer next to cellulose. Although quite variable across vascular plants, its content can account for up to 30% of total biomass in certain woody species. Lignin plays important roles in plants, but often represents hurdles to the utilization of cellulosic biomass in different sectors such as pulp industry, forage digestibility, and bioenergy. Certain natural or mutagenesis-induced lignin mutants, which are notorious for exhibiting brown midribs in grasses or red-brown wood in trees, have long been recognized to produce biomass more amenable to animal digestion, biological conversion, and other agro-industrial processes. Advances in molecular biology techniques for DNA sequencing and manipulation have facilitated the identification of genes involved in lignin biosynthesis and enabled the modification of their expression. The first reports on plants modified in lignin via genetic engineering techniques trace back to the mid 90's. Since then, with the emergence of genome sequencing capabilities and the deployment of large-scale transcriptomic, proteomic, and metabolomic approaches, our understanding on lignin metabolism and regulation has expanded. Correspondingly, substantial efforts have been made in tailoring lignin biosynthesis. In this chapter, we cover several bioengineering strategies that leverage recent knowledge obtained on the mechanistic understanding of lignin formation and chemical composition. Modification of lignin content and/or monomeric composition can be achieved not only by tailoring gene expression, but also by exploiting enzyme post-translational modifications, altering enzyme cofactors and co-substrates, and rerouting lignin metabolic precursors.

Keywords: Lignin, Cell wall, Forage, Bioenergy crops, Phenylpropanoids, Monolignol, CRISPR, Shikimate, Genetic engineering, Biofuels

Clémence Moreau[a], Marylise Cottet[a], Anne Rivière-Honegger[a], Adeline François[b], André Evette[b] (a. Université de Lyon, CNRS, ENS de Lyon, UMR 5600 Environnement Ville Société, France, b. Univ. Grenoble Alpes, INRAE, LESSEM, F-38402, St-Martin-d'Hères, France). **Nature-based solutions (NbS): A management paradigm shift in practitioners' perspectives on riverbank soil bioengineering. Journal of Environmental Management, Volume 308(2022): 114638**

Nature-based Solutions (NbS) are promoted as practical and theoretical solutions that simultaneously provide human well-being and biodiversity benefits. One example is soil bioengineering using construction techniques based on living vegetation, and is frequently used for riverbank stabilization, flood protection, and erosion control. Compared with civil engineering, NbS offer many advantages such as cost reduction, limited impact on the environment, and production of ecosystem services. However, their use is still marginal for riverbank control, especially in urban areas. In this paper, we focus on soil bioengineering techniques for riverbank protection in an urban context from the practitioners' perspective. We question to what extent NbS require a shift in management paradigm. We used qualitative methods to interview 17 practitioners working in the Rhone Alps basin (France). Our results reveal that switching from civil engineering to soil bioengineering is not only a technical change, but also requires a shift from a "predict and control" paradigm to an "adaptive management"

paradigm because of three major reasons. First, soil bioengineering techniques require redefinition of the performance of engineering structures with the inclusion of ecological and social dimensions. Second, the adoption of soil bioengineering techniques requires that practitioners, elected people and inhabitants reconsider risk sharing and acceptance. Third, the techniques require practitioners to adopt a new posture, with new soft skills (humility and daring) and a new collective organization (collective feedback). Finally, we identify three levers for a broader use of such techniques: (i) systematic assessment of the ecological, economical, and social benefits of such techniques; (ii) improving risk acceptance and sharing; (iii) fostering of social learning among practitioners through collective or technical feedback.

Keywords: Soil bioengineering techniques, Nature-based solutions, Riverbank erosion control, River management, Paradigm shiftPractitioners' perceptions

Tomasz Jakimowicz[a,‡], Stanislaw Przywara[b,‡], Jakub Turek[c,‡], Alison Pilgrim[d], Michal Macech[e], Norbert Zapotoczny[c], Tomasz Zubilewicz[b], Jeffrey H. Lawson[d,f], Laura E. Niklason[d] (a. Medical University of Warsaw, Department of General, Vascular and Transplant Surgery, Warszawa, Poland, b. Medical University in Lublin, Department of Vascular Surgery and Angiology, Lublin, Poland, c. Regional Hospital at Wrocław, Vascular Surgery Department, Wrocław, Poland, d. Humacyte, Inc., Durham, NC, USA, e. Medical University of Warsaw; Department of General, Vascular and Transplant Surgery, ul. 10 Banacha 1A, 02-091 Warszawa, Poland, f. Duke University, Department of Surgery, Durham, NC, USA). Five Year Outcomes in Patients with End Stage Renal Disease Who Received a Bioengineered Human Acellular Vessel for Dialysis Access. EJVES Vascular Forum, Volume 54(2022): 58-63

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

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

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

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

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

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Acute myeloid leukemia (AML) is the most lethal leukemia with an extremely poor prognosis and high relapse rates. In leukemogenesis, adhesion abnormalities can readily guide an imbalance between hematopoietic progenitor cells and bone marrow stromal cells, altering the normal hematopoietic bone marrow microenvironment into leukemic transformation that enhances leukemic proliferation. Here, we have firstly studied the PLEKHA7 expression in leukemic cells to assess their growth capability affected by the restoration of PLEKHA7 in the cells. The efficacy of PLEKHA7-loaded cRGD-mediated PEGylated cationic lipid nanoparticles for efficient PLEKHA7 delivery in leukemic cells as well as the effect of PLEKHA7 on the regulated induction of AML behavior and growth alterations were investigated. PLEKHA7 re-expression diminished colony-forming ability and reinforced the incidence of growth retardation without apoptosis in AML cell lines. PLEKHA7 regulated the restoration of cell surface adhesion and integrity during normal homeostasis. Our findings revealed that PLEKHA7 functions as a behavior and growth modulator in AML. To our knowledge, the role of PLEKHA7 in AML had not been studied previously and our data could be exploited for further mechanistic studies and insights into altering human AML behavior and growth.

Keywords: Acute myeloid leukemia, PLEKHA7, Nanoparticles, Modulator, Normal homeostasis

Davood Nasiry[1], Ali Reza Khalatbary[2], Mohammad-Amin Abdollahifar[1], Mohammad Bayat[1], Abdollah Amini[1], Mohammad Kazemi Ashtiani[3], Sarah Rajabi[3], Afshin Noori[3], Abbas Piryaei[1,4] (1. Department of Biology and Anatomical Sciences, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran 1985717443, Iran, 2. Molecular and Cell Biology Research Center, Department of Anatomy, Faculty of Medicine, Mazandaran University of Medical Sciences, Sari 4815733971, Iran, 3. Department of Cell Engineering, Cell Science Research Center, Royan Institute for Stem Cell Biology and Technology, ACECR, Tehran 1665659911, Iran, 4. Department of Stem Cells and Developmental Biology, Cell Science Research Center, Royan Institute for Stem Cell Biology and Technology, ACECR, Tehran 1665659911, Iran). **SDF-1α loaded bioengineered human amniotic membrane-derived scaffold transplantation in combination with hyperbaric oxygen improved diabetic wound healing. Journal of Bioscience and Bioengineering, Volume 133(5) (2022): 489-501**

Based on its multifactorial nature, successful treatment of diabetic wounds requires combinatorial approach. In this regard, we hypothesized that engraftment of a bioengineered micro-porous three-dimensional human amniotic membrane-scaffold (HAMS) loaded by SDF-1α (SHAMS) in combination with hyperbaric oxygen (HBO), throughout mobilization and recruitment of endothelial progenitor cells (EPCs), could accelerate wound healing in rats with type 1 diabetes mellitus. To test this hypothesis, 30 days after inducting diabetes, an ischemic wound was created in rat skin and treatments were performed for 21 days. In addition to

wounded non-diabetic (ND) group, diabetic animals were randomly divided into non-treated (NT-D), HBO-treated (HBO-D), HBO-treated plus HAMS transplantation (HBO+HAMS-D) or HBO-treated in combination with SHAMS transplantation (HBO+SHAMS-D) groups. Our results on post-wounding days 7, 14 and 21 showed that the wound closure, volume of new dermis and epidermis, numerical density of basal cells of epidermis, fibroblasts and blood vessels, number of proliferating cells, deposition of collagen and biomechanical properties of healed wound were considerably higher in both HBO+HAMS-D and HBO+SHAMS-D groups in comparison to those of the NT-D and HBO-D groups, and were the highest in HBO+SHAMS-D ones. The transcripts for Vegf, bFgf, and Tgf-β genes were significantly upregulated in all treatment regimens compared to NT-D group and were the highest for HBO+SHAMS-D group. This is while expression of Tnf-α and Il-1β as well as cell density of neutrophil and macrophage decreased more significantly in HBO+SHAMS-D group as compared with NT-D or HBO-D groups. Overall, it was found that using both HAMS transplantation and HBO treatment has more impact on diabetic wound healing. Moreover, SDF-1α loading on HAMS could transiently improve the wound healing process, as compared with the HBO+HAMS-D group on day 7 only.

Key words: Diabetic wound healing, Human amniotic membrane, Three-dimensional scaffold, Regenerative medicine, Hyperbaric oxygen, SDF-1α

Nathan James Cunningham[1], Rahulkumar Bhoi[2], Huaxiao Yang[2] (1. Cardiovascular Institute, Stanford University, Stanford, CA, United States, 2. Department of Biomedical Engineering, University of North Texas, Denton, TX, United States). Chapter 4 - hiPSC disease modeling with 3D organoids: bioengineering perspective. Current Topics in iPSCs Technology, Volume 17 in Advances in Stem Cell Biology (book) (2022): 63-93

The discovery of human induced pluripotent stem cells (hiPSCs) grants an unprecedented opportunity to study human organogenesis and pathogenesis in vitro. The derivation of the organ-based lineages provides a valuable platform to interrogate the genotype–phenotype relationship. In comparison to the conventional 2D culture, organoids are directly derived from stem cells in a heterogeneous three-dimensional (3D) cell construct, establishing the spatiotemporal development of the representative organ and subsequent disease in vitro. Through analogizing the structure and function of organs, the organoid is found to incredibly benefit the studies of organ development, human diseases, and further applications. In this chapter, we discuss the fabrication of organoids representing four major organs: the brain, kidney, heart, and liver. We then review conventional and cutting-edge bioengineered 3D culture systems used to adapt organoid platforms for biomedical applications, including disease modeling and pharmacological evaluation and discovery. Moreover, how the introduction of a number of emerging technologies demonstrates the potential to advance the application of organoid system. Finally, we culminate with the perspectives and trending concepts that map both the limitations and future directions of organoid technologies in organoid vascularization and assembloid to leverage our understanding of organ development, function, and disease.

Keywords: 3D culture, Assembloid, Bioengineering, Biofabrication, Brain organoid, Disease modeling, Heart organoid, High-throughput screening, Human induced pluripotent stem cells (hiPSCs), Hydrogel, Kidney organoid, Liver organoid, Organ on chip, Pharmaceutical discovery, Stem cell differentiation, Vascularization

S. Sharareh Mahdavi, Shohreh Mashayekhan. (Department of Chemical and Petroleum Engineering, Sharif University of Technology, Tehran, Iran). Chapter 7 - Emerging

bioengineering strategies for regulating stem cell fate: Scaffold physical and biochemical cues, Tissue Engineering. Current Status and Challenges(2022): 125-156

Stem cell therapy has been introduced as an emerging approach for injured tissue regeneration. This chapter addresses developing regenerative medicine techniques for controlling stem cell behavior. Recent studies have been reviewed and novel approaches have been divided into four main categories: 3D bioprinting, lithography, microfluidics, and electrospinning. Moreover, the impact of applied biophysical and/or biochemical cues to the designed scaffold on controlling stem cell activity has been discussed. The potential of using stem cells for various soft and hard tissue regenerations has been explored in different bioengineered scaffolds and the applied techniques for controlling stem cell fate have been discussed.

Keywords: Stem cell therapy, Tissue engineered scaffold, 3D bioprinting, Lithography, Microfluidics, Electrospinning

Yunni Hao[a,1], Chang Su[b,1], Xintong Liu[a], Haijuan Sui[c], Yijie Shi[a], Liang Zhao[a] (a. School of Pharmacy, Jinzhou Medical University, Jinzhou 121000, PR China, b. School of Veterinary Medicine, Jinzhou Medical University, Jinzhou 121000, PR China, c. Department of Pharmacology, Jinzhou Medical University, Jinzhou 121000, PR China). **Bioengineered microglia-targeted exosomes facilitate Aβ clearance via enhancing activity of microglial lysosome for promoting cognitive recovery in Alzheimer's disease. Biomaterials Advances, Available online (2022): 212770**

Aggregation of amyloid in the form of senile plaques is currently considered to be one of the main mechanisms driving the development of Alzheimer's disease (AD). Therefore, targeting amyloid homeostasis is an important treatment strategy for AD. Microglia, as the main immune cells, contribute to endocytosis and clearance of amyloid beta (Aβ) via lysosome mediated degradation. As abnormal lysosomal function in microglia is associated with inefficient clearance of Aβ in AD, we designed bioengineered microglia-targeting exosomes to promote the targeted delivery of gemfibrozil (Gem) and restore the lysosomal activity of microglia in clearing Aβ aggregation. Our results suggested that mannose-modified exosomes laden with Gem (MExo-Gem) can not only bind with Aβ but also specifically target microglia through the interaction between Exo-delivered mannose and mannose receptors expressed in microglia, thus promoting Aβ entry into microglia. Exosomal Gem activated lysosomal activity and accelerated lysosome-mediated clearance of Aβ in microglia. Finally, MExo-Gem improved the learning and memory ability of AD model mice.

Keywords: Alzheimer's disease, Aβ, Microglia, Exosomes, Gemfibrozil, Lysosome

Pollen Biotechnology

Ruifen Ren[a,b], Jianzhou Gao[a], Hao Zhou[a], Mengting Zhu[a], Yan Liu[a] (a. Beijing Laboratory of Urban and Rural Ecological Environment, Beijing Municipal Education Commission, Beijing Key Laboratory of Ornamental Plants Germplasm Innovation & Molecular Breeding, National Engineering Research Center for Floriculture, College of Landscape Architecture, Beijing Forestry University, Beijing, 100083, China, b. College of Forestry, Shanxi Agricultural University, Taigu, 030801, China). **Changes of pollen viability after preservation of Paeonia lactiflora in different provenances. Cryobiology, Volume 105(2022): 10-19**

Pollen contains all the haploid genetic information of species and is of great significance to preserve germplasm resources safely and effectively. The acquisition of high quality materials is a very important step in germplasm preservation. This study compared the viability and physiological condition of Paeonia lactiflora pollen from several provenances after preservation, to explore the effect of provenance difference on pollen viability and physiological responses after preservation. The results showed that: the pollen viability of two cultivars were significantly different in provenances after preserved at −20 °C or liquid nitrogen (LN) for 3 months, the pollen viability of 'Fen Yu Nu' showed Lanzhou > Beijing > Luoyang > Heze, while the pollen viability of 'Zi Feng Chao Yang' showed Luoyang > Beijing > Heze. Similarly, the oxidative stress levels of the Paeonia lactiflora pollen after preservation with LN or −20 °C were also significantly different among the provenances, and there was a relationship between the viability and the oxidative stress levels produced by the provenances differences. Reactive oxygen species (ROS) content, malondialdehyde (MDA) content, superoxide dismutase (SOD) activity and glutamate reductase (GR) activity in pollen from different provenances were contrary to the changes of viability; while catalase (CAT), ascorbic acid peroxidase (APX), ascorbic acid (AsA) and glutathione (GSH) were consistent with the changes of viability. The results indicated that the responses of antioxidant systems of two cultivars pollen to preservation with LN or −20 °C were different in provenances, and this difference was one of the reasons for the different viability of pollen after preservation with LN or −20 °C.

Keywords: Germplasm preservation, Pollen, Provenances, Viability, Physiological response

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

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

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The reproductive development process of rice is not only important for basic developmental biology research, but also of great benefit to production practice. However, current understanding of the reproductive growth process is relatively limited, especially in the later stages of development. Here we report that OsGAMYBL2, a homologous gene of GAMYB, is required for pollen maturation and germination in rice, and that loss of function of OsGAMYBL2 leads to male sterility in rice. We generated three alleles of OsGAMYBL2 knockout mutants using CRISPR/Cas9 system, all of them lost fertility when grown in the paddy field. Semi-section and electron microscopy observations revealed that there are no visible morphological changes in the outer and inner surfaces of anther and in the surface of mature pollens between mutants and wild type. However, pollens at late developmental stages exhibited much lighter pollen viability staining and some of them shriveled. In vitro and in vivo germination experiments showed that mutant pollens fail to germinate, leading to abnormal pollen tube formation and subsequent defective pollination. Furthermore, we observed that as compared with high temperature at 30 °C, low-temperature at 22 °C affects less on osgmybl2 fertility. Collectively, we proposed that OsGAMYBL2 is likely involved in the regulation of starch accumulation during later pollen development with a thermal-sensitive way, which improves our understanding on the reproductive development in plants.

Keywords: OsGAMYBL2, Anther, Pollen maturation, Germination, Sterility, Rice

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

Hemerocallis is a floriferous species, which presents numerous genotypes that are constantly crossed, generating new cultivars. The germination and viability of pollen are influenced both by factors that are intrinsic and extrinsic to the pollen. In view of the above, the purpose of this study was to establish a growth medium for the germination of pollen grains. Cultivar Morgana was used in the experiments performed to establish the growth medium, in which four pH ranges were tested alongside four agar concentrations. For the next test, five sucrose concentrations were tested. Afterwards, four boric acid concentrations were added to the medium, finally followed by four calcium nitrate concentrations. After the definition of the growth medium, the incubation time for pollen grains germination of the species was evaluated. The results were then applied to four cultivars in order to verify the respective germination percentages. It was noted that the highest percentage of in vitro germination occurred with the concentrations of 4 g L^{-1} agar, 74.6 g L^{-1} sucrose, 800 mg L^{-1} boric acid and 590 mg L^{-1} calcium nitrate, with a pH of 5.74 and ideal incubation time of 3 h. Regina being to cultivar with the highest germination percentage.

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

Dhika Amanda[1], Felix P. Frey[1], Ulla Neumann[1], Marine Przybyl[1], Jan Šimura[2], Youjun Zhang[3,4], Zongliang Chen[5], Andrea Gallavotti[5,6], Alisdair R. Fernie[3,4], Karin Ljung[2], Iván F. Acosta[1,7] (1. Max Planck Institute for Plant Breeding Research, 50829 Cologne, Germany, 2. Umeå Plant Science Centre, Department of Forest Genetics and Plant Physiology, Swedish University of Agricultural Sciences, 90183 Umeå, Sweden, 3. Max

Planck Institute of Molecular Plant Physiology, 14476 Potsdam, Germany, 4. Center of Plant Systems Biology and Biotechnology, 4000 Plovdiv, Bulgaria, 5. Waksman Institute of Microbiology, Rutgers University, Piscataway, NJ 08854, USA, 6. Department of Plant Biology, Rutgers University, New Brunswick, NJ 08901, USA). Auxin boosts energy generation pathways to fuel pollen maturation in barley. Current Biology, Volume 32(8) (2022): 1798-1811.e8

Pollen grains become increasingly independent of the mother plant as they reach maturity through poorly understood developmental programs. We report that the hormone auxin is essential during barley pollen maturation to boost the expression of genes encoding almost every step of heterotrophic energy production pathways. Accordingly, auxin is necessary for the flux of sucrose and hexoses into glycolysis and to increase the levels of pyruvate and two tricarboxylic (TCA) cycle metabolites (citrate and succinate). Moreover, bioactive auxin is synthesized by the pollen-localized enzyme HvYUCCA4, supporting that pollen grains autonomously produce auxin to stimulate a specific cellular output, energy generation, that fuels maturation processes such as starch accumulation. Our results demonstrate that auxin can shift central carbon metabolism to drive plant cell development, which suggests a direct mechanism for auxin's ability to promote growth and differentiation.

Keywords: pollen, auxin, metabolism, starch, barley, anther, stamen maturation, plant male fertility

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The N-terminal acetylation of proteins is a key modification in eukaryotes. However, knowledge of the biological function of N-terminal acetylation modification of proteins in plants is limited. Naa50 is the catalytic subunit of the N-terminal acetyltransferase NatE complex. We previously demonstrated that the absence of Naa50 leads to sterility in Arabidopsis thaliana. In the present study, the lack of Naa50 resulted in collapsed and sterile pollen in Arabidopsis. Further experiments showed that the mutation in Naa50 accelerated programmed cell death in the tapetum. Expression pattern analysis revealed the specific expression of Naa50 in the tapetum cells of anthers at 9–11 stages during pollen development, when tapetal programmed cell death occurred. Reciprocal cross analyses indicated that male sterility in naa50 is caused by sporophytic effects. mRNA sequencing and quantitative PCR of the closed buds showed that the deletion of Naa50 resulted in the upregulation of the cysteine protease coding gene CEP1 and impaired the expression of several genes involved in pollen wall deposition and pollen mitotic division. The collective data suggest that Naa50 balances the degradation of tapetum cells during anther development and plays an important role in pollen development by affecting several pathways.

Keywords: Arabidopsis, N-terminal acetyltransferase, Naa50, Tapetum degradation, Pollen development

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The application of salting out assisted liquid-liquid extraction for the rapid and simple simultaneous determination of pyrrolizidine alkaloids and related N-oxide in honey and pollen was evaluated. The determination of PAs and PANOs was obtained by ultra high performance liquid chromatography coupled with tandem mass spectrometry. The critical parameters (pH of the aqueous solution, extraction solvent, type and amount of salting-out agents) affecting SALLE performance were carefully studied and optimized using a chemometric approach. Under the optimal experimental conditions, the developed procedure showed excellent extraction efficiency (82–104 %) and recoveries (82–113 %) for all target analytes, except for Intermedine N-oxide, at three concentration levels (0.25, 2.5 and 25 μg kg−1 and 2.5, 25 and 250 μg kg-1 for honey and pollen samples, respectively), and satisfactory intra-day (<10) and inter-day (<13) precisions. The proposed method showed negligible matrix effect for both studied matrices and method quantification limits at very low levels (0.1−0.2 and 1−2 μg kg-1 for honey and pollen, respectively). The method was successfully applied to the analysis of honey (n = 71) and pollen (n = 6) samples. The 97 % and the 67 % of analyzed honey and pollen samples, respectively, turned out to be contaminated by at least one PA. Echimidine, echimidine N-oxide, intermedine and intermedine N-oxide significantly contributed to the contamination of the samples.

Keywords: Salting-out assisted liquid-liquid extraction, Pyrrolizidine alkaloids, UHPLC-MS/MS, Beehive products, Honey, Pollen

Biotechnology Policy Issue

SuxiaLiu[af], MajkenDeichmann[abfh], Mariú A.Moro[bf], Lars S.Andersen[c]FulinLi[d], TommyDalgaard[e], Ursula S.McKnight[bg]. ([a]Key Laboratory of Water Cycle and Related Land Surface Processes, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, PR China, [b]Department of Environmental Engineering, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark, [c]ChinaRM, 4792 Askeby, Denmark, [d]Water Resources Research Institute of Shandong Province, Jinan 250013, PR China, [e]Aarhus University, Department of Agroecology, Section for Agricultural Systems and Sustainability, 8830 Tjele, Denmark, [f]Sino-Danish College/College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 10049, PR China, [g]Swedish Meteorological and Hydrological Institute, Folkborgsvägen 17, SE-601 76 Norrköping, Sweden, [h]SEGES Innovation, Crops & Environment, 8200 Aarhus N, Denmark). Targeting sustainable greenhouse agriculture policies in China and Denmark: A comparative study. Land Use Policy, Volume 119(2022): 106148

Greenhouse agriculture has become vitally important in promoting sustainable food supplies globally, especially by encouraging local production and consumption practices. However, it also represents an industry with a high risk for groundwater pollution due to much higher application limits allowed for nitrogen fertilizers compared to conventional agriculture.

Although sufficient focus has been placed on characterizing any environmental impacts stemming from agriculture, including greenhouses, the influence of social, economic and political aspects on this process are generally overlooked. This one-sided focus may be partly due to the complexity of environmental systems, i.e. in measuring the state of the system accurately. However, any actions taken by a government, i.e. in the form of policy instruments, will play a key role in ensuring the safety and quality of agricultural products and the surrounding environmental systems. Insufficient knowledge regarding policy and related influential factors may thus slow the achievement of the UN Sustainable Development Goals and ultimately inhibit environmental protection. In light of this, a cross-national comparative study was carried out to enable a systematic understanding of Chinese and Danish greenhouse agriculture policy using the agro-environmental DPSIR (Driver, Pressure, State, Impact, Response) indicator framework. We critically examined whether current legislative steps for mitigating anthropogenic sources of N-pollution are suitably aimed at the parameters controlling (driving) specific pressures/impacts on groundwater. The potential for reaction (feedback/responses) within each legislative system, as well as the key gaps in policy responses for monitoring both water and N-fertilizer applied in greenhouses were identified. Notably, most responses are found to target only the pressure component of the framework. This discovery opens the door for the development of additional response mechanisms, which together could result in more sustainable policy measures for greenhouse agriculture that may be more effective, more quickly. Although many countermeasures exist for control of land, water and fertilizer use at the national level in both countries, their deployment depends heavily on effective stakeholder engagement and local-level adoption strategies, indicating a more holistic and multi-objective (less fragmented) policy approach is needed. Importantly, this paper demonstrates an alternative implementation of the DPSIR framework, where comparative study applications may be used to enable mutual learning that may enhance the uptake of disruptive solutions (technological and/or policy advancement), recognizing that incremental change may not be cost-efficient or sustainable especially for regions with critical water issues.

Keywords: DPSIR; Land use; N-fertilizer; Stakeholder; National level; Local level; Groundwater; Environment

Anna Dawiec-Liśniewska[a], Daria Podstawczyk[b], Anna Bastrzyk[b], Krystian Czuba[b], Kornelia Pacyna-Iwanicka[b], Oseweuba Valentine Okoro[c], Amin Shavandi[c]. ([a]Department of Advanced Material Technologies, Faculty of Chemistry, Wroclaw University of Science and Technology, Norwida 4/6, 50-373 Wrocław, Poland, [b]Department of Process Engineering and Technology of Polymer and Carbon Materials, Faculty of Chemistry, Wroclaw University of Science and Technology, Norwida 4/6, 50-373 Wroclaw, Poland, [c]Université libre de Bruxelles (ULB), École polytechnique de Bruxelles - BioMatter unit, Avenue F.D. Roosevelt, 50 - CP 165/61, 1050 Brussels, Belgium). New trends in biotechnological applications of photosynthetic microorganisms. Biotechnology Advances, Volume 59(2022): 107988

As a source of several valuable products, photosynthetic microorganisms (microalgae and cyanobacteria) have many applications in biomedical, electrochemical, and urban-space fields. Microalgal and cyanobacterial (photoautotrophs) implementations have been the subject matter of several reviews, which mainly focused on exploring effective methods of their harvesting, optimal cultivation conditions, energy conversion efficiency, and new strategies for microalgal health-promoting compound recovery. This review highlights recent investigations into

biomedical, urban, environmental, and electrical engineering microalgae and cyanobacteria applications over the last seven years. A brief historical outline of advances in photoautotroph-based technologies is presented prior to an exploration of the important role of these microorganisms in combating global warming and food and energy insecurity. Special attention is given to the photosynthetic oxygen production of algae and the possibility of treating hypoxia-associated diseases such as cancer or tissue injuries. Photoautotroph applications in microrobotics, drug delivery and wound healing systems, biosensors, and bioelectronics are also introduced and discussed. Finally, we present emerging fabrication techniques, such as additive manufacturing, that unleash the full potential of autotrophic, self-sufficient microorganisms at both the micro- and macroscales. This review constitutes an original contribution to photoautotroph biotechnology and is thought to be impactful in determining the future roles of microalgae and cyanobacteria in medical, electrical, or urban space applications.

Keywords: Microalgae; Drug delivery systems; Microrobots; Bioprinting; Artificial tissue; Functional food; Biophotovoltaics; Urban space; Immobilization

Agricultural Biotechnology

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

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

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

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

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

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

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Prague 6, Czech Republic, c. Department of Solid State Engineering, University of Chemistry and Technology, Prague, Technická 5, 166 28 Prague 6, Czech Republic). Noble metal nanoparticles in agriculture: impacts on plants, associated microorganisms, and biotechnological practices. Biotechnology Advances, Available online (2022) :107929

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

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

Hassan Etesami. (Department of Soil Science, University of Tehran, Tehran, Iran) Root nodules of legumes: A suitable ecological niche for isolating non-rhizobial bacteria with biotechnological potential in agriculture, Current Research in Biotechnology, Volume 4, 2022, Pages 78-86

Rhizobial bacteria have been established not to be the only residents of the root nodules of legumes. Non-rhizobial bacteria have also been found in legume root nodules, but their ecological roles are not fully understood. However, the interaction between these bacteria and rhizobial bacteria inside nodules might influence the fitness and behavior of their host legume plants. Although a diverse population of the non-rhizobial bacteria within nodules does not elicit nodulation or nitrogen fixation, they have been found to have multiple-plant growth-promoting (PGP) characteristics. Co-inoculation of legumes with nodule non-rhizobial bacteria has synergistic effects on plant growth and yield, beyond those of single inoculation, in legumes under both stress and non-stress conditions. In this graphical review, the potential importance of beneficial non-rhizobial bacteria within legume root nodules is highlighted, and their benefits to the host plants are also discussed. The use of nodule non-rhizobial strains with multiple PGP potential may be a promising method to boost the effectiveness of rhizobial bacteria biofertilizers in sustainable agriculture, under both stress and non-stress conditions.

Keywords: Multiple plant growth-promoting traits, Nodule bacteria, PGPR, Rhizobium bio-fertilizers

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

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

Keywords: Abiotic stress, Biologically active metabolites, Biostimulants, Genome sequencing, Microbial diversity, Sustainable plant health

Bioenergy

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

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

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Bioenergy can play an essential role as an alternative energy source owing to adverse effects on the environment due to excessive usage of fossil fuels. The primary sources of bioenergy are biomass. But many problems arise in preliminary processes for biomass conversion into

bioenergy, such as enzymatic hydrolysis, pretreatment, and biomass cultivation. The nanomaterials can play an essential role in overcoming problems associated with biomass sources for conversion and storage into bioenergy. It provides unique active sites for reaction and process. Further, nanomaterials also have great potential to enhance the efficiency of bioenergy generation from biomass. Thus, this featured article discusses the role of nanomaterials in biomasses, biofuel, bioethanol, and biodiesel to strengthen the efficiency of bioenergy storage and conversion. In addition, this article will also address the limitations and challenges of using nanomaterials for biomasses, biofuel, bioethanol, and biodiesel systems.

Keywords: Biomass, Bioenergy, Biofuel, Nanomaterials, Bioethanol, Biodiesel

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Bioenergy, a means to reach a sustainable economy, is being driven by governments by devising incremental regulations and more instrumental policies in parallel. These constant-changing regulations bring uncertainty to bioenergy supply chain optimization problems. An increasing number of recent studies on bioenergy supply chain optimization addressing environmental concerns have highlighted the need for an overview indispensable. The purpose of this paper is to present a review of the incorporated policies and regulations and to examine whether constraints or targets set by governments are fully met in optimizing of bioenergy supply chains. To this end, first, bioenergy policies and regulations enacted in the EU, the global leader in the energy transition, as a benchmark are reviewed based on the bioenergy supply chain steps. Then, the optimization problems employing policies and regulations are classified and discussed. The review reveals visible gaps between what policies demand and what is proposed in the literature, and underpin the regulations which need to be considered in future work. Examination of the literature also suggests that a globally drawn standard may lead to better bioenergy supply chain development considering other green energy developments.

Our key finds are:

• Many regulations limited to biomass supply management –CAP, GAECs, LULUCF, low ILUC-risk biofuels, and cascading principles –are overlooked.

• Instrumental policies, such as FIT, FIP, TGC for electricity, Quota system for transportation, and Tariffs and subsidies for heating and cooling sector, mostly were not incorporated into the models.

• Facing the variety and complexity of regulations, it seems conducive to introduce international standards for biomass supply and management.

Keywords: Bioenergy supply chain optimization, Sustainability, Bioenergy policies and regulations, Literature review

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177 Yorston St., Williams Lake, BC, V2G 1G6, Canada). Greenhouse gas mitigation potential of replacing diesel fuel with wood-based bioenergy in an arctic Indigenous community: A pilot study in Fort McPherson. Canada, Biomass and Bioenergy, Volume 159(2022): 106367

Remote and northern communities surrounded by forested areas are well positioned to use wood-based bioenergy to meet their energy needs and thereby reduce their greenhouse gas (GHG) emissions. However major gaps remain regarding the GHG mitigation potential considering the challenges along the biomass supply chain. Using Fort McPherson, an Indigenous community located in the Northwest Territories (NWT), Canada, we developed a life cycle assessment based model to estimate the potential GHG emission reductions and timing. We also built two main bioenergy scenarios testing 1) wood chips made from locally harvested willow or 2) imported pellets made from sawmill residues including key parameters like transport distances, boiler efficiency, and emission factors. We found that replacing diesel fuel with bioenergy resulted in GHG savings as high as 32,166 t of CO_2 eq over 100 years. GHG benefits can be achieved within 0–20 years for local wood chips or 2–37 years for imported sawmill residue pellets. Increases in transport distance and decreases in biomass boiler efficiency resulted in delays in GHG emissions benefits for both local chips and imported pellets. This study shows that the use of local or imported forest biomass to replace diesel in remote northern communities' energy systems can generate GHG savings within a time-frame that is relevant to current climate change concerns. In addition to GHG mitigation potential, we discuss the socio-economic and environmental factors to take into consideration at the community level when deciding between local or imported biomass supply chains.

Keywords: Bioenergy, Carbon parity time, Climate change, Wood chips, Wood pellets, Supply chains

Cem Emeksiz, Abdullah Yüksel. (Department of Electric-Electronic Engineering, Faculty of Engineering and Architecture, Tokat Gaziosmanpasa University, 60150 Tokat, Turkey). A suitable site selection for sustainable bioenergy production facility by using hybrid multi-criteria decision making approach. case study: Turkey, Fuel, Volume 315(2022): 123214

Biofuels are rapidly taking their place amongst the renewable energy sources which are gaining importance day by day. Turkey procures a large portion of its energy needs with imported fossil fuels. This brings forward problems related to energy security and it also caused an increase in the greenhouse gas emissions of the country in the last decade. However, there are no satisfactory studies or investments related to biofuel potential and the evaluation of this potential. The research of the biomass energy potential in Turkey is of particular importance in terms of strengthening the energy policy. In this study, a multi-stage approach is presented for the first time in the appropriate site selecting for production facility to be established in a country. This is the most basic fact that distinguishes the study from other literature studies and makes it unique. Initially, the plant species and production amounts to be used in bioenergy production at the country scale were determined and theoretical biodiesel and bioethanol potentials were calculated. Then, the most suitable product-based site for the bioenergy production facility was determined with a hybrid method using the entropy-based multiple-attribute utility theory. Thus, contrary to the literature studies on potential determination only, the most suitable location for the bioenergy production facility was also selected by using determined potentials. The results show that Turkey has a biodiesel and bioethanol potential 1.666.176 tons, 13.546.751 tons, respectively. The products with the highest potential were

determined for biodiesel and bioethanol production as sunflower (774.741 tons) and wheat (7.051.602 tons).

Keywords: Biodiesel, Bioethanol, Multi-attribute utility theory, Sustainable development, Turkey

Lakshika Kulyal, Poonam Jalal. (Department of Geology, Kumaun University, Nainital, Uttarakhand, India). Bioenergy, a finer alternative for India: Scope, barriers, socio-economic benefits and identified solution. Bioresource Technology Reports, Volume 17(2022): 100947

To mitigate adverse impacts and fossil fuels demands the investments by oil trading countries are inclining towards green energy. Various forms of sustainable energies are being addressed today, but major barrier to all renewables is their cost. Therefore, cost-effectiveness, sustainability, least environment and health impact are what make any source preferable. As increasing population, fuel demand and waste generation are well accorded, this paper aims to underline a better renewable alternative which besides being renewable can deal with various other problems like waste management and pollution. Bioenergy is evolving worldwide especially in agriculture dominated countries. Here, a comparative status for renewable energies, technological advancements across the globe are put forward, further focusing on India as an agriculture hub, i) scope- the estimated potential and unutilized source, ii) barriers – unorganized management, financial and technological aspects, iii) identified solution – R&D, infrastructure and iv) socio-economic – mutual benefits between society and environment are discussed.

Keywords: World energy status, Bioenergy, Case studies, Indian scenarioIndian potential, Solutions

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

Publicly available toolkits for cost calculation in renewable energy projects were reviewed, and their main characteristics, strengths and weaknesses identified. An original Life-Cycle Cost (LCC) modelling toolkit was developed to address some of the identified shortcomings, and to facilitate the calculation of costs of electrical and thermal energy from biomass-based processing pathways. The toolkit was used to compare the Levelized Cost of Energy (LCOE) for electricity and/or heat generation for a 'Bioenergy Case', after the adoption of bioenergy technology, and compared with equivalent costs under a business-as-usual 'Base Case', for selected commercial demand sectors in Sub-Saharan Africa, within a 10 kW to 5 MW scale range. Case Studies of the toolkit's application are described for a smallholder tea factory in Kenya, a wood processing enterprise in Tanzania and an oil palm mill in Ghana, which illustrate its ability to model energy production based on both combustion and anaerobic digestion, under various heat, power and combined heat and power configurations. Sensitivity analysis was carried out to determine the effect on $LCOE_{heat}$ and $LCOE_{electricity}$ of adjustments in key operating parameters, such as biomass feedstock cost, feed-in tariff for export of surplus power to the grid or on-site energy

demand. The versatility of the LCC toolkit enables bioenergy projects to be modelled from different perspectives (biomass feedstock diversification, conversion pathways or business models) and for different users (plant managers, project developers or potential investors), and it can be customised and adapted as prices, legislation and technical aspects evolve with time.

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

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

Bioenergy from renewable resources plays a central role in the transition toward net-zero emission of carbon dioxide and low-energy circular economy. The main objective of this work was to examine the main challenges and opportunities for producing renewable biomass feedstocks and developing realistic bioenergy value chains in the European Union. The main support schemes and regulatory instruments were investigated, linking sustainability issues, certification schemes and smart farming examples for promoting market uptake in a framework of the sustainable energy cropping system.

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

Nano Biotechnology

C.K. Nanditha[a,b], G.S. Vinod Kumar[a] (a. Nano Drug Delivery Systems (NDDS), Bio-Innovation Center (BIC), Rajiv Gandhi Centre for Biotechnology, Thycaud P.O, Thiruvananthapuram, Kerala, 695014, India, b. Research Centre, University of Kerala, Thiruvananthapuram, Kerala, India). **Bioactive peptides laden nano and micro-sized particles enriched ECM inspired dressing for skin regeneration in diabetic wounds. Materials Today Bio, Volume 14(2022): 100235**

Hard to heal wounds such as diabetic wounds is one of the major problems in the healthcare sector. Delayed healing and shortfall of functional restoration at the wound site require upgraded wound management aids. In this study, we report that a nanofibrous mat enriched with bioactive peptides laden nano and microparticles achieve the requirements as an effective diabetic wound dressing. By means of electrospinning method, we fabricated Poly (lactic-co-glycolic acid)/Collagen nano-scale mat and surface functionalised with wound healing peptides, laden Chitosan nano and micro-sized particles, creating an Extracellular Matrix (ECM) -like structure with biomimetic features. The developed dressing displayed good cytocompatibility with Keratinocyte and fibroblast cells and enhanced their in-vitro cell proliferation and migration. Experiments in the streptozotocin-induced diabetic mice model showed that bioactive peptides released from Chitosan particles shorten the inflammatory stage and promote neovascularisation. The supporting nanoscale matrix promotes increased collagen deposition in the wound beds, thereby hastening the complete healing process by substantial tissue re-generation and functional restoration. The results evince that the nano/microparticles enriched nano-scale mat show potential as an effective wound repair dressing for diabetic wounds.

Keywords: Diabetic wound healing, ECM like Wound dressing, Nanofiber functionalization antimicrobial peptide, Wound healing peptide, Chronic wound dressing

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This chapter reviews recent development on various processes and technologies of effluent treatment in textile manufacturing business with the aids of modern biotechnolocial equipments. The various advantages of these biotechnological processes like enzymatic treatment, bioefficient and bioaugmentation routes, dyes and colour removal and recovery have been discussed in this chapter. These processes are quite superior to the conventional effluent, primary, secondary or tertiary filtrations because of some obvious advantages like biological integrations, cellulosic absorption, microbial biotechnology, carbon nanotubes (CNTs) aided nanotechnology and other advanced oxidation processes. The prospects and direction of growth of these biotechnological effluent treatment processes are also discussed.

Keywords: Biotechnology, bioefficient, biological integrations, carbon nanotubes (CNTs), advanced oxidation process

Pintu Pandit[1], Saptarshi Maiti[2], Kunal Singha[1], Subhankar Maity[3], O.L. Shanmugasundaram[4] (1. Department of Textile Design, National Institute of Fashion Technology, Patna, India, 2. Department of Fibres and Textile Processing Technology, Institute of Chemical Technology, Mumbai, India, 3. Department of Textile Technology, Uttar Pradesh Textile Technology Institute, Kanpur, India, 4. Department of Textile Technology, K.S. Rangasamy College of Technology, Tiruchengode, India). **Biotechnological and nano-biotechnological approaches in finishing of textile materials, Applications of Biotechnology for Sustainable Textile Production. The Textile Institute Book Series (2022): 173-186**

Textile finishing is an essential sector in textile processing owing to its advancements in versatile functional applications as well as value addition prospects. The objective of this chapter is to cover the recent developments and the use of biotechnological approaches in textile finishing. Biotechnology is replacing all harsh chemicals from finishing of textile bandit has been discussed in this chapter keeping sustainable development in near future. Modern biotechnology can have a dramatic effect on the world economy and society such as in genetic engineering. This chapter also deals with the application of modern biotechnology used in textile finishing industries.

Keywords: Biotechnology, enzymes, eco-friendly, nano-finishing, textile industry

Biomimicry

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Beautiful and functional—the perfect combination of nature's beauty and engineering functionality–best describes the synergy between biomimicry and additive manufacturing. Nature has proven to be a valuable source of inspiration for design solutions with many success stories, yet critical gaps between biological and engineering domains prevent biomimicry from reaching its full potential. This chapter discusses the latent ability of additive manufacturing for advancing biomimetic research, and the potential contribution of biomimetic structures to the technological advancement of additive manufacturing itself through new products and applications. The current limitation of using natural structures as a source of bioinspiration is that natural structures are not optimally designed for a single function, as frequently required in engineering applications (and as is frequently assumed to be the case). Current biomimetic research focusses on fixed properties or functionalities of natural structures by taking them out of their organismal, ecological, and evolutionary context, and often fail to incorporate an understanding of these biological constraints. Additive manufacturing allows increasingly complex structures to be replicated, modified, enhanced or even designed de novo, thereby allowing researchers to overcome some of the hurdles associated with the current biomimicry approach. The structural complexity and often esthetic properties of natural shapes and forms themselves can, in turn, serve as a toolbox for improving additive manufacturing applications. To illustrate the potential of this synergistic effect for future biomimetic studies, we propose a novel workflow in which additive manufacturing is central and biomimicry inputs are enhanced and refined—a bioenhanced engineering approach.

Keywords: Biomimetic, bioinspiration, bio-inspired, bionic, biological structures, additive manufacturing, 3D-printing, design for additive manufacturing, design optimization, structural biomimicry, optimization

Mohammad Kaiser Ahamed, Hongxu Wang, Paul J. Hazell. (School of Engineering and Information Technology, The University of New South Wales, Canberra, ACT 2600, Australia). From biology to biomimicry: Using nature to build better structures – A review. Construction and Building Materials, Volume 320 (2022): 126195

Nature provides examples of resilient materials and structures with optimised morphologies and topologies to achieve excellent mechanical and structural properties and sustainable options for the construction industry. This paper provides an overview of nature-inspired materials applicable to buildings and civil structures. Current research on bio-inspired novel cementitious composites, bacteria-enhanced materials, building envelopes and facade systems, advanced manufacturing processes, and their applications are discussed. Moreover, this paper provides insights for future research on designing and developing bio-inspired building materials and resilient structures.

Keywords: Biomimicry, Bio-inspired material, Functionally graded material, Sandwich structure, Interlocked structure, Self-healing concrete, Building envelope, 3D printed concrete

Carlos Montana-Hoyos, Mirko Daneluzzo, Raffi Tchakerian, Sayjel Vijay Patel, Renata Lemos Morais. (Dubai Institute of Design and Innovation, DU, United Arab Emirates). .Biomimicry and biodesign for innovation in future space colonization. Biomimicry for Aerospace, Technologies and Applications (2022): 3-39

This chapter explores and proposes potential scenarios for biologically inspired, biologically enhanced, and biohybrid design and technology innovations for the aerospace industry and future colonization of Mars and other planets. First, the goals and current barriers facing the Entrepreneurial Space Industry are discussed to highlight the need for aerospace design and design education within this industry. Next, the middle sections contextualize the main topics of biomimicry and bio-inspired design, bio-enhanced design, and biohybrid design within space colonization through a review of examples and case studies. Design methodologies such as Biomimicry and more recent examples such as Next Nature, Material Ecology, and Biodesign are briefly explained. Hybrid transdisciplinary approaches around nature, culture, and emerging technologies are discussed in view of implications and applications for future space colonization. Finally, we identify future trajectories for this field by presenting faculty and student design research projects at the Dubai Institute of Design and Innovation, in addition to speculative design projects focused on the aerospace industry, and conclude with a consideration of potential applications and implications of the hybrid relationships of biology and nature with design, technology, and innovation for potential future space colonization.

Keywords: Additive manufacturing, Aerospace, Biodesign, Biohybrid, Biomimicry, Future scenariosIn situ resource utilization, Next Nature, Space colonization, Speculative design

Anamarija Frankić. (Department of Ecology, Agriculture and Aquaculture, University of Zadar, Zadar, Croatia). Green Harbors Project: Biomimicry in action. Biomimicry for Materials, Design and Habitats, Innovations and Applications (2022): 529-556

The dynamics and complexities of coupled human-natural systems, and our capacity to manage and protect both, requires inter-disciplinary, holistic education, practice and respectful living with nature. Green Harbors Project (GHP) started at UMass Boston, in 2007, as a response to local needs, specifically addressing degraded environmental health in Boston Harbor, MA, USA, and other urban harbors. The GHP is an organic, educational, research, and outreach project designed to foster transdisciplinary teaching and learning by applying biomimetic solutions for local needs. For example, biomimetic infrastructure and technologies support both human and ecological services and functions in urban harbors providing conditions conducive to life: green cement, green piers and marinas, floating salt marshes and shellfish beds, living shorelines, free energy sources, safe healthy food, and water. The three key goals are to: (1) educate and inspire a new, responsible generation of environmental problem solvers; (2) bring feasible, resilient solutions to local community, and (3) engage industry and businesses in applying biomimetic technologies and solutions in restoring our urban coastal areas. As part of the GHP, our Biomimicry LivingLabs have been initiated in other areas of Massachusetts, at the University of Zadar, Croatia, and Arklow in the Republic of Ireland. At each site, the GHP approach is uniquely and organically designed to integrate practical learning and innovation with professional development, entrepreneurial skill development, and team building that inspires and implements holistic solutions to environmental, social and economic challenges specific for each place. Our projects include biomimetic approach in restoring three keystone costal habitats: salt marshes, oyster reefs (shellfish beds), and eel grass beds. The implementation of the best

practices developed at Biomimicry LivingLabs serve as educational tools for local communities worldwide.

Keywords: Bioelectricity, biomimetic restoration, biomimicry, Green Harbors, oyster reef restoration, coastal restoration, water quality, urban harbors, estuaries, living shorelines

Alex Wolf, Vijal Parikh, Isabella De Lisi. (na2ure, New York City, NY, United States). .The pattern alphabet: Nature's patterns are the language of spatial reasoning and biomimicry. Biomimicry for Materials, Design and Habitats, Innovations and Applications (2022): 57-105

The patternABC (pABC) is a new, iconic system which codifies patterns in nature, or, the way all things natural, build and grow at all scales. Besides being a visual language for nature, the pABC functions practically as a language for spatial skills and biomimicry, a function that, if supported, has potentially sweeping positive implications for our education system and job force. In this chapter, we will explain the following: (1) the origin and structure of the pABC, (2) its connection to the human brain and cognition via spatial thinking and pattern recognition, (3) its role as a language of models for biomimetic problem solving, (4) points educational and professional development at which learners can benefit from the spatial and relational thinking rooted pABC curriculum, and (5) recommendations and implications related to the above premises.

Keywords: Artificial intelligence, biomimicry, bio-design, early childhood education, icons, nature's patterns, pattern recognition, spatial reasoning, STEAM education, systems design

Reuben Sanga, Menard Kilumile, Fatma Mohamed. (Department of Structural and Construction Engineering, University of Dar es Salaam, United Republic of Tanzania). Alternative clay bricks inspired from termite mound biomimicry. Case Studies in Construction Materials, Volume 16 (2022): e00977

As the world is witnessing vast pollution during material production, construction and demolition processes of buildings there is a need to seek for alternative materials that will reduce the environmental impact. The present study borrows inspirations from termite's technique to create a material for constructing a naturally cemented mound structure. The studied termite mound was built from a mix of soil particles and termites saliva containing mucopolysaccharides and cellulase enzyme that digests cellulose into beta-glucose or shorter polysaccharides and oligosaccharides. These polysaccharides are found to be a source of soil stabilization and gluing property. In the process to mimic termites' activities clay bricks were produced from a mix of clay soil and cassava flour in a form of hot cassava paste as a source of polysaccharides at 1.5%, 3%, 4.5% and 6% weight of soil. Brick samples created presented an optimal value at 1.5% cassava flour with compressive strength higher than that of burnt clay bricks at 4.28 MPa.

Keywords: Termite mound, Biomimicry, Clay bricks, Polysaccharides, Cassava paste

Mario Milazzo[1,2], Flavia Libonati[1,3], Shengfei Zhou[1], Kai Guo[1], Markus J. Buehler[1] (1. Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA, United States, 2. The BioRobotics Institute, Scuola Superiore Sant'Anna, Pontedera, Italy, 3. Department of Mechanical, Energy, Management and Transportation Engineering, University of Genoa, Genoa, Italy). .Biomimicry for natural and synthetic composites and use of machine learning in hierarchical design. Biomimicry for Materials, Design and Habitats, Innovations and Applications (2022): 141-182

Humankind has long studied natural systems to understand their complexity and to find motivation and inspiration for improving knowledge and design capabilities for a number of varied applications. These concepts are summarized in a term that has been used as the main keyword in many important research areas: biomimicry. Among all research fields, materials science has been, perhaps, the most influenced by nature. This chapter delivers the basic concepts of hierarchical structures and their universal/diverse features in order to present the most influential natural materials and compounds and their employment in synthetic made-up composites for tissue engineering and industrial applications. Later, we also show how artificial intelligence and machine learning algorithms have contributed to improve the characterization and design of natural and bio-inspired materials, optimizing the computational tools and overcoming the limitations of traditional approaches. We conclude with a deliberation to discuss future opportunities in the field.

Keywords: Biomimicry, materials mechanics, composites, artificial intelligence, machine learning, hierarchical structures, tissue engineering, computational tools, bio-inspired materials, additive manufacturing

Tiffany S. Williams. (NASA John H. Glenn Research Center, Cleveland, OH, United States). Advancing research efforts in biomimicry to develop nature-inspired materials, processes for space exploration and more efficient aircraft. Biomimicry for Aerospace, Technologies and Applications (2022): 385-421

The aerospace industry is constantly evolving, striving for significant improvements in aircraft and spacecraft efficiency. Efforts to replace metal parts with polymer matrix composites have resulted in lower vehicular weight, better efficiency, and reduced emissions in air travel. Lower weight has also led to cost savings for space travel due to lower launch costs. Designing new materials and structures that combine multiple functions into a single structure is a concept that will further reduce mass and boost efficiency; it is just one area of modern developments that can be anticipated in next-generation aerospace systems. Establishing a sustainable presence on the Moon will require advanced technologies and materials that can reliably operate and perform in harsh space environments. To seek innovative solutions for many of these challenges, researchers and engineers have begun to think in unconventional ways to design and fabricate better aerospace materials. Living systems are the best models of efficiency. Nature is very effective and efficient at conserving energy, recovering from damage, withstanding mechanical stresses and impact, and surviving in harsh terrestrial environments. Natural composites such as bones, antlers, and seashells are some of the most damage tolerant materials with respect to their size, density, and composition. This does not infer that human-made materials are inferior to natural composites, as synthetic composites can tolerate loads and temperatures that natural systems cannot survive; however, there are material design improvements that we can observe in nature to help materials perform better and last longer. In this chapter, we discuss different biological examples and principles and illustrate how these models could play a role in designing next-generation aerospace materials. We also discuss existing barriers and advanced fabrication techniques that offer the greatest potential to develop novel, bio-inspired materials.

Keywords: Acoustic absorption, Aerospace, Antiicing, Biomimetic materials, Dust mitigation, Functional surfaces, Multifunctional systems, Polymer matrix composites, Self-assembly, Self-healing materials

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
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13. Annual Review-Public Health
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