ENVIS RESOURCE PARTNER

on

ENVIRONMENTAL BIOTECHNOLOGY

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On

ENVIRONMENTAL BIOTECHBNOLOGY

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BACKGROUND

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

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

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

This is the 38th publication of Abstract Volume of this ENVIS Resource Partner. This contains the abstracts of research papers collected from the various areas of Environmental Biotechnology from different journals published in last six months up to June 2021. In this issue, various topics like Bioenergy, Bioengineering, Bio-degradation, Bio-remediation, Bio-transformation etc. have been covered. We are grateful to the various libraries and their staff for their cooperation extended to us during the collection of the articles.

Abstract Format

The format of the abstract is as follows:

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

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

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

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

GENERAL INFORMATION

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

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

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

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

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

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

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

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

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

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

1. Bacterial Biofertilizer
2. Algal Biofertilizer

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ABBREVIATIONS USED IN ADDRESSES AND CITED JOURNALS

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

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

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

Bioaccumulation

Budiawan Budiawan[a], Heny Suseno[ab], Fitria Afriani[a], Wahyu Retno Prihatiningsih[b] (a. Department of Chemistry, Faculty of Mathematics and Science, Universitas Indonesia, Kampus Baru UI Depok, Jalan Margonda Raya, Kota Depok, 16424, Indonesia, b. Marine Radioecology Group, Center for Radiation Safety Technology and Metrology, National Nuclear Energy Agency, Indonesia) **Bioaccumulation and retention kinetics of trace elements in the horse mussels Modiolus micropterus exposed to different environmental conditions, Volume 87, October 2021, 103692**

Bioaccumulation studies of Zn and 137Cs by the horse mussel (Modiolus micropterus) were conducted in a laboratory that used radiotracer. The study has been carried out on the effect of cesium and zinc concentrations and the effect of sea seawater salinity on the ability of M. micropterus to accumulate these two contaminants. The uptake of Zn and Cs according to the one-compartment model and the experiment was carried out until the steady-state conditions were reached. The concentration factor at steady-state Zn is 31.94–45.54 mL. g−1 and 23.22–33.26 mL. g−1 which are influenced by the concentration and salinity of seawater, respectively. The concentration factor of 137Cs at steady-state conditions due to changes in concentration and salinity is 3.34–7.55 mL. g−1 and 4.23–9.66 mL. g−1, respectively. The release rates of Zn were 30–47 % and 39–49 % at various concentrations and salinity. The depuration rate from concentration reaching 60 % and salinity at ranges 43–52 % was observed within 10 days after exposure. On the other hand, the release rates of 137Cs were 60 % and 43–52 % at various changes in the concentration and salinity of seawater

Keywords: Bioaccumulation, Zinc metal, ^{137}Cs radionuclide, M. micropterus

Weijun Guo[a],Yang Dai[a], Xiaoting Chu[b], Song Cui[c], Yeqing Sun[b], Yi-Fan Li[ad], Hongliang Jia[a] (a. International Joint Research Centre for Persistent Toxic Substances (IJRC-PTS), College of Environmental Science and Engineering, Dalian Maritime University, Dalian 116026, China, b. Institute of Environmental Systems Biology, Dalian Maritime University, Dalian, China, c. IJRC-PTS, School of Water Conservancy and Civil Engineering, Northeast Agricultural University, Harbin, Heilongjiang 150030, China, d. IJRC-PTS, State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, Harbin 150090, China) **Assessment bioaccumulation factor (BAF) of methyl siloxanes in crucian carp (Carassius auratus) around a siloxane production factory, Ecotoxicology and Environmental Safety, Volume 213, 15 April 2021, 111983**

Methyl siloxanes are identified as emerging persistent toxic compounds and the ecological environment risks of these compounds have been caused of great concern worldwide. In this study, the concentrations of methyl siloxanes were reported in dissolved water and crucian carp around a methyl siloxane production factory located in Liaoning Province, Northeast China. D4, D5, D6, D7, L4, L5 and L6 were detectable both in dissolved water and crucian carp. The total concentrations of 7 methyl siloxanes (Σ7MS) were 14 ± 6.3 ng/L in dissolved water and 43 ± 22 ng/g ww in crucian carp, respectively. D5 has the highest concentration both in dissolved water (5.5 ± 3.5 ng/L) and crucian carp (17 ± 11 ng/g ww). Based on the monitoring values, bioaccumulation factor (BAF) of these compounds were calculated. Significant bioaccumulation potential was observed for D4 (BAF = 5900 ± 3500 L/kg) based on the bioaccumulation criteria suggested by USEPA and EU (BAF > 5000 L/kg). To our understanding, this is the first report of BAF values of methyl siloxane in field study, which will provide important support for further assessment of bioaccumulation of these compounds.

Keywords: Methyl siloxane, Bioaccumulation factor, Dissolved water, Fish Methyl, siloxane production factory

Mark A. Cantu, Frank A.P.C. Gobas (School of Resource and Environmental Management, Biological Sciences, Simon Fraser University, Burnaby, British Columbia, V5A 1S6, Canada) Bioaccumulation of dodecamethylcyclohexasiloxane (D6) in fish, Chemosphere Volume 281, October 2021, 130948

To investigate the bioaccumulation behavior of dodecamethylcyclohexasiloxane (D6, CAS number: 540-97-6) in fish, an OECD-305 style dietary bioaccumulation study of D6 in rainbow trout was conducted in the presence of non-metabolizable reference chemicals. The dietary uptake absorption efficiency of D6 was 14 (3 SE) % and lower than that of the reference chemicals which ranged between 22 (2 SE) to 60 (8 SE) %. The concentration of D6 in the body of the fish showed a rapid 40% drop during the first day of the depuration phase, followed by a slower decline during the remainder of the depuration period. The overall depuration rate constant of D6 was 0.016 (0.0026 SE) d^{-1} and significantly greater than those of PCB153 and PCB209, which were not significantly different from zero. During the depuration phase, when fish body weight did not significantly change over time, depuration of D6 appears to be almost entirely due to biotransformation in the body of the fish. The biomagnification factor of D6 in rainbow trout was 0.38 (0.14 SE) kg-lipid kg-lipid^{-1}, indicating a lack of biomagnification. The bioconcentration factor (BCF) of D6 in Rainbow trout was estimated at 1909 (483 SE) L kg^{-1} wet for natural waters of mostly oligotrophic lakes in Northern Canada with an average concentration of total organic carbon of 7.1 mg L^{-1}. Comparing the bioaccumulation profile of D6 to that of 238 similar profiles for 166 unique chemicals indicates that the bioaccumulation capacity of D6 is markedly less than that of many very hydrophobic organochlorines.

Keywords: Bioaccumulation, Bioconcentration, Biomagnification, Siloxanes, Fish, OECD

Golam Kibria[ad], Dayanthi Nugegoda[a], Gavin Rose[b], A.K. Yousuf Haroon[c] (a. School of Science, RMIT University, Australia, b. Kinvara Scientific P/L, Kinvara, NSW 2478, Australia, c. Food and Agriculture Organisation of the UN (FAO), Dhaka, Bangladesh, d. Global Artificial Mussels Pollution Watch Programme, Australia) Climate change impacts on pollutants mobilization and interactive effects of climate change and pollutants on toxicity and bioaccumulation of pollutants in estuarine and marine biota and linkage to seafood security, Marine Pollution Bulletin, Volume 167, June 2021, 112364

This article provides an overview of the impacts of climate change stressors (temperature, ocean acidification, sea-level rise, and hypoxia) on estuarine and marine biota (algae, crustaceans, molluscs, corals, and fish). It also assessed possible/likely interactive impacts (combined impacts of climate change stressors and pollutants) on pollutants mobilization, pollutants toxicity (effects on growth, reproduction, mortality) and pollutants bioaccumulation in estuarine and marine biota. An increase in temperature and extreme events may enhance the release, degradation, transportation, and mobilization of both hydrophobic and hydrophilic pollutants in the estuarine and marine environments. Based on the available pollutants' toxicity trend data and information it reveals that the toxicity of several high-risk pollutants may increase with increasing levels of climate change stressors. It is likely that the interactive effects of climate change and pollutants may enhance the bioaccumulation of pollutants in seafood organisms. There is a paucity of literature relating to realistic interactive effects of climate change and pollutants. Therefore, future research should be directed towards the combined effects of climate change stressors and pollutants on estuarine and marine bota. A sustainable solution for pollution control caused by both greenhouse gas emissions (that cause climate change) and chemical pollutants would be required to safeguard the estuarine and marine biota.

Keywords: Climate change, Pollutants fate and transport, Toxicity/lethality, Bioaccumulation, Estuarine & marine biota, Seafood security

Lei Liu[ab], Jinwu Chen[a], Fang Liu[a], Wencheng Song[ac], Yubing Sun[d] (a. Anhui Province Key Laboratory of Medical Physics and Technology, Institute of Health & Medical Technology, Hefei Institutes of Physical Science, Chinese Academy of Sciences, Hefei, 230031, PR China, b. School of Environment and Chemical Engineering, Anhui Vocational and Technical College, Hefei, 230011, PR China, c. Collaborative Innovation Center of Radiation Medicine of Jiangsu Higher Education Institutions and School for Radiological and Interdisciplinary Sciences, Soochow University, 215123, Suzhou, PR China, d. College of Environmental Science and Engineering, North China Electric Power University, Beijing, 102206, PR China) **Bioaccumulation of uranium by Candida utilis: Investigated by water chemistry and biological effects, Environmental Research, Volume 194, March 2021, 110691**

The bioaccumulation of hexavalent uranium (U(VI)) on Candida utilis (C. utilis) and its biological effects were investigated via batch and biologic techniques. The bioaccumulation mechanism of U(VI) and C. utilis were characterized by SEM, TEM, FT-IR and XPS. The batch results showed that C. utilis had a high adsorption capacity (41.15 mg/g wet cells at pH 5.0) and high equilibrium rate (~100% within 3.5 h). The analysis of intracellular hydrogen peroxides and malondialdehyde suggested that the growth of C. utilis was inhibited under different concentrations of U(VI) due to the abundant production of reactive oxide species. The activity of intracellular antioxidants (e.g., super oxide dismutase and glutathione) was significantly enhanced under U(VI) stress, indicating the anti-toxic effect of C. utilis cells under low U(VI) stress. These results indicated that C. utilis is an ideal biosorbent for removing radionuclides in environmental remediation.

Keywords: Uranium Bioaccumulation, Candida utilis, Antioxidation, Radionuclide

Julien Dron[1], Aude Ratier[14], Annabelle Austruy[1], Gautier Revenko[1], Florence Chaspoul[2], Emmanuel Wafo[3] (1. Institut Écocitoyen pour la Connaissance des Pollutions, Fos-sur-Mer, France, 2. Aix Marseille Université, Avignon Université, CNRS UMR-7263, IRD-237, IMBE, Marseille, France, 3. Aix Marseille Université, INSERM U-1261, SSA, IRBA, MCT, Marseille, France, 4. Université de Lyon, Université Lyon 1, CNRS UMR-5558, LBBE, Villeurbanne, France) **Effects of meteorological conditions and topography on the bioaccumulation of PAHs and metal elements by native lichen (Xanthoria parietina) Journal of Environmental Sciences, Volume 109, November 2021, Pages 193-205**

The bioaccumulation of PAHs and metal elements in the indigenous lichens Xanthoria parietina was monitored during two years at a quarterly frequency, in 3 sites of contrasted anthropic influence. The impact of the meteorological factors (temperature, relative humidity, rainfall, wind speed) was first estimated through principal component analysis, and then by stepwise multilinear regressions to include wind directions. The pollutants levels reflected the proximity of atmospheric emissions, in particular from a large industrial harbor. High humidity and mild temperatures, and in a lower extent low wind speed and rainfall, also favored higher concentration levels. The contributions of these meteorological aspects became minor when including wind direction, especially when approaching major emission sources. The bioaccumulation integration time towards meteorological variations was on a seasonal basis (1–2 months) but the wind direction and thus local emissions also relied on a longer time scale (12 months). This showed that the contribution of meteorological conditions may be prevalent in remote places, while secondary in polluted areas, and should be definitely taken into account regarding long-term lichen biomonitoring and inter-annual comparisons. In the same time, a quadruple sampling in each site revealed a high homogeneity among supporting tree species and topography. The resulting uncertainty, including sampling, preparation and analysis was below 30% when comfortable analytical conditions were achieved. Finally, the occurrence of unexpected events such as a major forest fire, permitted to evaluate that this type of short, although intense, events did not have a strong influence on PAH and metals bioaccumulation by lichen.

Keywords: Indigenous lichen, Biomonitoring Climate, Seasonal impacts, Sampling uncertainties, Integration time

Yueyao Zhou, Linlin Yao, Luqing Pan, Hongdan Wang (Key Laboratory of Mariculture, Ministry of Education, Ocean University of China, Qingdao 266003, China) Bioaccumulation and function analysis of glutathione S-transferase isoforms in Manila clam Ruditapes philippinarum exposed to different kinds of PAHs, Journal of Environmental Sciences, Volume 112, February 2022, Pages 129-139

This study analyzed the function of different glutathione S-transferase (GST) isoforms and detoxification metabolism responses in Manila clam, Ruditapes philippinarum, exposed to 4 kinds of polycyclic aromatic hydrocarbons (PAHs) single, and their mixtures for 15 days under laboratory conditions. 13 kinds of GSTs in R. philippinarum were classified, and the results of tissue distribution indicated that 12 kinds of GSTs (except GST sigma 3) expressed most in digestive glands. We detected the mRNA expression levels of aryl hydrocarbon receptor signaling pathway, and detoxification system in digestive glands of clams exposed to benzo[a]pyrene (BaP), chrysene (CHR), benzo[a]anthracene (BaA), benzo[b]fluoranthene (BbF), and BaP + CHR + BaA + BbF, respectively. Among these genes, we selected GST-sigma, GST-omega and GST-pi as potential indicators to BaP; GST-sigma, GST-A and GST-rho to CHR; GST-pi, GST-sigma, GST-A, GST-rho and GST-microsomal to BaA; GST-theta and GST-mu to BbF; while GST-pi and GST-mu to the mixture of BaP, CHR, BaA and BbF. Additionally, the bioaccumulation of PAHs in tissues increased remarkably over time, and showed an obvious dose-effect. Under the same concentration, the bioaccumulation in single exposure group was higher than that in mixture group, and the bioaccumulation of PAHs in tissues with different concentrations of stress was irregular. The results revealed the metabolic differences and bioaccumulation rules in clams exposed to four kinds of PAHs, and provided more valuable information for the PAHs risk assessment.

Keywords: Ruditapes philippinarum, PAH sbioaccumulation, Glutathione, S-transferasefunction analysis

Xiongyi Miao[a], Yupei Hao[a], Hongwei Liu[b], Zhouqing Xie[b], Dan Miao[d], Xudong He[c] (a. Key Laboratory of Karst Dynamics, MNR&GZAR, Institute of Krast Geology, CAGS, Guilin 541004, China, b. Anhui Province Key Laboratory of Polar Environment and Global Change, Department of Environmental Science and Engineering, University of Science and Technology of China, Hefei 230026, China, c. The Second Engineering Investigation Institute of Guizhou Bureau of Geology and Mineral Exploration and Development, Zunyi 563000, China, d. Department of Chemistry and Environmental Engineering, Wuhan Bioengineering Institute, Wuhan 430415, China) Effects of heavy metals speciations in sediments on their bioaccumulation in wild fish in rivers in Liuzhou—A typical karst catchment in southwest China, Ecotoxicology and Environmental Safety, Volume 214, May 2021, 112099

Although fish are widely confirmed to be susceptible to heavy metals (HMs) contamination in sediments, this bioconversion haven't been detailed. This is especially the case in karst areas, where HMs are less stably retained in the sediments and are more bioavailable. Therefore, we surveyed representative karst rivers in Liuzhou, China, in order to study the relationship between the speciations of seven HMs in the sediments with their bioaccumulation in wild fish. The results showed that the HMs in sediments are all below their permissible exposure limit (PEL), but Cd and Zn are significantly higher than soil basline. Most HMs are in residual fraction, while their exchangeable fractions are present in extremely low proportions. The concentration of Zn, Cr and Cd in some fish are above their maximum recommended limit (MRL). The concentrations of most of the HMs in the fish are significantly correlated with the levels in the sediments and given the higher correlation coefficients for their carbonate-bound phase, this phase can be seen to play a critical role in HMs bioconversion. However, the presence of this phase in low proportions enables other phases, especially oxidizable form, to play a greater role in HMs bioaccumulation. Apart from Do, HMs in the fish samples are significantly correlated with multiple environmental factors, demonstrating environmental fluctuations can manipulate HMs bioconversion from sediments; however, their significance depend heavily on the proportion of particular species. HMs in reducible and oxidizable fraction are more important in regulating, rather than promoting, their bioconversion during

environmental fluctuations. Fluctuations in EC, TDS and pH can increase the impacts of HMs in carbonate-bound fraction on their bioconversion. Given the higher background values of EC and TDS and lower pH values during the monsoon period, careful attention should be paid to the increased bioconversion of HMs in karst rivers during this season.

Keywords: Heavy metals speciations, Heavy metals bioaccumulation, Sediment, Wild fishWaterways of Liuzhou

Bioremediation

Felipe Filgueiras de Almeida, Danúbia Freitas, Fabrício Motteran, Bruna Soares Fernandes, Sávia Gavazza (Department of Civil Engineering, Federal University of Pernambuco (UFPE), Acadêmico Hélio Ramos Avenue, s/n, 50740-530 Recife, PE, Brazil) Bioremediation of polycyclic aromatic hydrocarbons in contaminated mangroves: Understanding the historical and key parameter profiles, Marine Pollution Bulletin, Volume 169, August 2021, 112553

Sensitive biomes, such as coastal ecosystems, have become increasingly susceptible to environmental impacts caused by oil logistics and storing, which, although more efficient nowadays, still cause spills. Thus, bioremediation techniques attract attention owing to their low impact on the environment. Among petroleum-based compounds, polycyclic aromatic hydrocarbons (PAHs) are known for their potential impact and persistence in the environment. Therefore, PAH bioremediation is notably a technique capable of reducing these polluting compounds in the environment. However, there is a lack of understanding of microbial growth process conditions, leading to a less efficient choice of bioremediation methods. This article provides a review of the bioremediation processes in mangroves contaminated with oils and PAHs and an overview of some physicochemical and biological factors. Special attention was given to the lack of approach regarding experiments that have been conducted in situ and that considered the predominance of the anaerobic condition of mangroves.

Keywords: Coastal ecosystem, Polycyclic aromatic hydrocarbons, Mangroves, Oil products, Microorganisms, Biological degradation

Gurpreet Kaur, Magdalena Krol, Satinder Kaur Brar (Department of Civil Engineering, Lassonde School of Engineering, York University, Toronto, Ontario, M3J 1P3, Canada) Geothermal heating: Is it a boon or a bane for bioremediation? Environmental Pollution, Volume 287, 15 October 2021, 117609

There has been a worldwide interest in renewable energy technologies, as a means of decreasing reliance on fossil fuels, minimizing climate change effects, and reducing greenhouse emissions. One such technology is geothermal heating where the constant subsurface temperature is used to cool or heat building interiors via heat pumps. In Canada, the use of geothermal heating has become a popular option for heating and cooling buildings, and it is anticipated that, in the near term, most large buildings will include geothermal heating as part of their climate control strategy. However, little is known about the environmental impacts of geothermal heating on the subsurface environment. The present review will examine the effect of geothermal heating on groundwater flow and remediation efforts, whereby the heat generated by geothermal systems may help with urban pollution. "Geothermal Remediation" could leverage the subsurface heating resulting from geothermal systems to accelerate biodegradation of certain petroleum-based pollutants at brown-field sites, while providing building(s) with sustainable heating and cooling. This idea coincides with the rising momentum towards sustainable and green remediation in Europe and the United States. To ensure that Geothermal Remediation is achievable, the effect of heat on bioremediation needs to be examined. This review provides an insight into what we know about heat effects on bioremediation activities and subsurface transport.

Keywords: Geothermal remediation, Greenhouse emission, Renewable resources, Geothermal heat pumps, Bioremediation

M.Ajona, P.Vasanthi (School of Infrastructure, B S Abdur Rahman Crescent Institute of Science & Technology, India) Bioremediation of petroleum contaminated soils – A review, materialstoday: PROCEEDINGS, Volume 45, Part 7, 2021, Pages 7117-7122

The state-of-the-art methodology and ecologically sound that uses biological processes naturally to thoroughly remove toxic pollutants. The usage of soil, sediments, water, other pollution products employing microorganisms for the degradation of harmful chemicals. The chemical components are also metabolized by microorganisms for production of carbon or methane dioxide, water and biomass. Otherwise, the pollutants may be converted into less toxic or harmless metabolites enzymatically. Both in situ and off field, bioremediation technologies can be adopted. In the event of in situ bioremediation, the polluted material is treated at the site while the contaminated material is extracted to be treated in another location. Bio ventures, landfills, bio areas, manure, bioaugmentations, and bio-stimulation are some examples of bioremediation technologies. Bioremediatory are classified as microorganisms that perform bioremediation functions. Bioremediation and other techniques have been used extensively in past and present to remediate the pollutants of petroleum hydrocarbons in soil. As bioremediation is cost-effective, and leads to the full mineralization, bioremediation is an excellent way of handling these polluted sites. This paper explores bioremediation processes in the soil system, focusing on degradation of petroleum hydrocarbons.

Keywords: Bio remediation, Petroleum contamination, Anaerobic degradation, Hydrocarbon, Microbial strains

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

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

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Leakage of oil and its derivatives into the soil can change the engineering behavior of soil as well as cause environmental disasters. Also, recovering the contaminated sites into their natural condition and making contaminated materials as both environmentally and geotechnically suitable construction materials need the employment of remediation techniques. Bioremediation, as an efficient, low cost and environmental-friendly approach, was used in the case of highly plastic clayey soils. To better understand the change in geotechnical properties of highly plastic fine-grained soil due to crude oil contamination and bioremediation, Atterberg limits, compaction, unconfined compression, direct shear, and consolidation tests were conducted on natural, contaminated, and bioremediated soil samples to investigate the effects of contamination and remediation on fine-grained soil properties. Oil contamination reduced maximum dry density (MDD), optimum moisture content (OMC), unconfined compressive strength (UCS), shear strength, swelling pressure, and coefficient of consolidation of soil. In addition, contamination increased the compression and swelling indices and compressibility of soil. Bioremediation reduced soil contamination by about 50%. Moreover, in comparison with contaminated soil, bioremediation reduced the MDD, UCS, swelling index, free swelling and swelling pressure of soil, and also increased OMC, shear strength, cohesion, internal friction angle, failure strain, porosity, compression index, and settlement. Microstructural analyses showed that oil contamination does not alter the soil structure in terms of chemical compounds, elements, and constituent minerals. While it decreased the specific surface area of the soil, and the bioremediation significantly increased the mentioned parameters. Bioremediation resulted in the formation of quasi-fibrous textures and porous and agglomerated structures. As a result, oil contamination affected the mechanical properties of soil negatively, but bioremediation improved these properties.

Keywords: Oil contamination, Bioremediation, Geotechnical properties, Clay mineralogy, Soil microstructure, Highly plastic soil, Fine-grained clayey soil, Marl

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In this study, the bioremediation capacity of three isolates of Bacillus aryabhattai, Pseudomonas azotoformans and Sphingomonas pseudosanguinis and their consortia at glyphosate added soil medium investigated via the reduction of chemical oxygen demand (COD) and total organic carbon (TOC) parameters in filtrate waters obtained from a designed bioremediation setup. Additionally, mortality assays were performed on the filtrate waters with model organism Daphnia magna. According to the results of the experiments, at the end of the 11 days, the highest COD reduction rate seen in media with S. pseudosanguinis as 92.1% while TOC rate was 69.13% in consortia media. While the mortality rate was 10, 10 and 5% on B, P and S application groups at the

end of the 72th respectively, these rates were 100% in control group at the end of the 48th. According to the results obtained from bioremediation and mortality assessment, these bacteria can reach the high bioremediation rate one by one and in consortia media.

Keywords: Glyphosate remediation, Bacteria, COD, TOC, D. magna

Urška Žvab[a], Danijel Stojković Kukulin[a], Mattia Fanetti[a], Matjaz Valant[ab] (a. University of Nova Gorica, Materials Research Laboratory, 5270, Ajdovščina, Slovenia, b. Institute of Fundamental and Frontier Sciences, University of Electronic Science and Technology of China, Chengdu, 610054, China) **Bioremediation of copper polluted wastewater-like nutrient media and simultaneous synthesis of stable copper nanoparticles by a viable green alga, Journal of Water Process Engineering, Volume 42, August 2021, 102123**

Environmentally benign, algae-mediated biosynthesis of valuable copper-based materials in wastewater, combined with cupric ion (Cu2+) bioremediation, has the potential to reduce the cost of wastewater treatment and generate high quality biosolids. This study investigated the ability of a wild-type strain of Chlamydomonas reinhardtii to bioremediate free Cu2+ in wastewater-like nutrient media during the biosynthesis of copper nanoparticles (Cu NPs). The color of supernatants from treated Cu-polluted media provided a first indication of Cu-based NPs formation in the aqueous phase. Analysis by fluorescein diacetate hydrolysis, observations of cell morphology, and algal regrowth experiments after treatment showed that algal viability was crucial for efficient Cu2+ reduction to Cu NPs. UV–vis absorption spectroscopy demonstrated that sulfur-free medium, which enables sustained hydrogen photoproduction in alga, was not the most efficient in NPs formation. Dark-field scanning transmission electron microscopy (STEM) images overlapped with Cu signal map from energy dispersive X-ray spectrometry (EDS) and high-resolution transmission electron microscopy confirmed the presence of polydisperse, spherical, and well-dispersed sub-10 nm Cu NPs crystallites exclusively in algae-treated heavily Cu-polluted media (10 mg L−1). STEM and EDS also demonstrated the affinity of Cu NPs for carbon-rich (organic) objects. Overall, this study demonstrates the feasibility of Cu2+ bioremediation from the wastewater-like complex nutrient media and the simultaneous biosynthesis of Cu NPs by viable green microalga.

Keywords: Chlamydomonasreinhardtii, Viable microalga, Simulated municipal wastewater, Cupric ion bioremediation, Hydrogen photoproduction, Copper nanoparticle biosynthesis

Lata Rani[ab], Arun Lal Srivastav[c], Jyotsna Kaushal[a] (a. Centre for Water Sciences, Chitkara University Institute of Engineering & Technology, Chitkara University, Punjab, 140 417, India, b. School of Basic Sciences, Chitkara University, Himachal Pradesh, 174 103, India, c. Chitkara University School of Engineering and Technology, Chitkara University, Himachal Pradesh, 174 103, India) **Bioremediation: An effective approach of mercury removal from the aqueous solutions, Chemosphere, Volume 280, October 2021, 130654**

Mercury (Hg(II)) is the 16th rarest element present in the earth's crust. Due to rapid industrialization and urban expansions, the mercury concentration has been elevated in the environment. Hg(II) contamination in the aqueous environment has become a great challenge for human beings. The main source of Hg(II) in the aqueous phase is untreated effluent industries (such as the paper industry). Hg(II) is non-biodegradable in nature and even its trace amount in an aqueous environment can pose chronic threats among the humans (damage to the central nervous system, respiratory system, and cardiovascular system, mutation of DNA), animals, and aquatic creatures. Therefore, the removal of mercury from aqueous solutions is an urgent need of the modern era. The conventional techniques such as ion exchange, precipitation, membrane filtrations are costly and also generate byproducts in the environment. Bioremediation is a sustainable, environmentally sound, and cost-effective

technique to remove Hg(II) from the aqueous solutions. In this process, naturally occurring microorganisms are utilized to remove the Hg(II) from the aqueous solutions. Lentinus edodes, U. lactuca, and Typha domingensis are found to have great potential to remove mercury from water ranged from ~100 mg g−1 to 337 mg g−1.

Keywords: Mercury contamination, Aqueous solutions, Bioremediation, Microbial species, Meroperon

Biotransformation

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Organic pollutants that are introduced into the aquatic ecosystem can transform by various mechanisms. Biotransformation is an important process for predicting the remaining structures of pollutants in the ecosystem, and their toxicity. This study focused on triphenyl phosphate (TPHP), which is a commonly used organophosphate flame retardant and plasticizer. Since TPHP is particularly toxic to aquatic organisms, it is essential to understand its biotransformation in the aquatic environment. In the aquatic ecosystem, based on consideration of the producer-consumer-decomposer relationship, the biotransformation products of TPHP were identified, and their toxicity was predicted. Liquid chromatography-high resolution mass spectrometry was used for target, suspect, and non-target analysis. The obtained biotransformation products were estimated for toxicity based on the prediction model. As a result, 29 kinds of TPHP biotransformation products were identified in the aquatic ecosystem. Diphenyl phosphate was detected as a common biotransformation product through a hydrolysis reaction. In addition, products were identified by the biotransformation mechanisms of green algae, daphnid, fish, and microorganism. Most of the biotransformation products were observed to be less toxic than the parent compound due to detoxification except some products (hydroquinone, beta-lyase products, palmitoyl/stearyl conjugated products). Since various species exist in a close relationship with each other in an ecosystem, an integrated approach for not only single species but also various connected species is essential.

Keyword: Biotransformation, triphenyl phosphate, aquatic ecosystem, target/suspect/non-target analysis, toxicity prediction

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Pharmaceutically active compounds (PhACs) have been shown to accumulate in aquatic and riparian food-webs. Yet, our understanding of how temperature, a key environmental factor in nature, affects uptake, biotransformation, and the subsequent accumulation of PhACs in aquatic organisms is limited. In this study, we tested to what extent bioconcentration of an anxiolytic drugs (temazepam and oxazepam) is affected by two temperature regimes (10 and 20 °C) and how the temperature affects the temazepam biotransformation and subsequent accumulation of its metabolite (oxazepam) in aquatic organisms. We used European perch (Perca fluviatilis) and dragonfly larvae (Sympetrum sp.), which represent predator and prey species of high ecological relevance in food chains of boreal and temperate aquatic ecosystems. Experimental organisms were exposed to target pharmaceuticals at a range of concentrations (0.2–6 μg L−1) to study concentration dependent differences in bioconcentration and biotransformation. We found that the bioconcentration of temazepam in perch was significantly reduced at higher temperatures. Also, temperature had a strong effect on temazepam biotransformation in the fish, with the production and subsequent accumulation of its metabolite (oxazepam) being two-fold higher at 20 °C compared to 10 °C. In contrast, we found no temperature dependency for temazepam bioconcentration in dragonfly larvae and no detectable biotransformation of the parent compound that would result in measurable concentrations of oxazepam in this organism. Our results highlight that while organisms may share the same aquatic ecosystem, their exposure to PhACs may change differently across temperature gradients in the environment.

Keywords: Aquatic invertebrate, Benzodiazepine, Drug, Fish, Dragonfly, Temazepam

José Gilmar da Silva do Nascimento[a], Ester Viana Alencar Silva[a], André Bezerrados Santos[a], Marcos Erick Rodriguesda Silva[b], Paulo Igor MilenFirmino[a] (a. Department of Hydraulic and Environmental Engineering, Federal University of Ceará, Fortaleza, Ceará, Brazil, b. Department of Civil Construction, Federal Institute of Education, Science and Technology of Ceará, Fortaleza, Ceará, Brazil) **Microaeration improves the removal/biotransformation of organic micropollutants in anaerobic wastewater treatment systems, Environmental Research, Volume 198, July 2021, 111313**

This work assessed the effect of increasing microaeration flow rates (1–6 mL min−1 at 28 °C and 1 atm, equivalent to 0.025–0.152 L O2 L−1 feed) on the removal/biotransformation of seven organic micropollutants (OMPs) (three hormones, one xenoestrogen, and three pharmaceuticals), at 200 μg L−1 each, in a lab-scale upflow anaerobic sludge blanket reactor operated at a hydraulic retention time (HRT) of 7.4 h. Additionally, the operational stability of the system and the evolution of its microbial community under microaerobic conditions were evaluated. Microaeration was demonstrated to be an effective strategy to improve the limited removal/biotransformation of the evaluated OMPs in short-HRT anaerobic wastewater treatment systems. The rise in the airflow rate considerably increased the removal efficiencies of all OMPs. However, there seems to be a saturation limit for the biochemical reactions. Then, the best results were obtained with 4 mL air min−1 (0.101 L O2 L−1 feed) (~90%) because, above this flow rate, the efficiency increase was negligible. The long-term exposure to microaerobic conditions (249 days) led the microbiota to a gradual evolution. Consequently, there was some enrichment with species potentially associated with the biotransformation of OMPs, which may explain the better performance at the end of the microaerobic term even with the lowest airflow rate tested.

Keywords: Microaerobic biotransformation, Pharmaceuticals, Hormones, Bisphenol A, Biological treatment

Ting He[ab], Jianguo Bao[a], Yifei Leng[c], Daniel Snow[d], Shuqiong Kong[a], Tong Wang[a], Xu Li[b] (a. School of Environmental Studies, China University of Geosciences, No. 388 Lumo Road, Wuhan, Hubei 430074, China, b. Department of Civil and Environmental Engineering, University of Nebraska-Lincoln, 900 N 16th St., W150D Nebraska Hall, Lincoln, NE 68588-0531, USA, c. School of Civil Engineering, Architecture and Environment, Hubei University of Technology, Wuhan 430068, China, d. Water Sciences Laboratory, University of Nebraska-Lincoln, Lincoln, NE 68583, USA) **Biotransformation of doxycycline by Brevundimonas naejangsanensis and Sphingobacterium mizutaii strains, Journal of Hazardous Materials, Volume 411, 5 June 2021, 125126**

The fate of doxycycline (DC), a second generation tetracycline antibiotic, in the environment has drawn increasing attention in recent years due to its wide usage. Little is known about the biodegradability of DC in the environment. The objective of this study was to characterize the biotransformation of DC by pure bacterial strains with respect to reaction kinetics under different environmental conditions and biotransformation products. Two bacterial strains, Brevundimonas naejangsanensis DD1 and Sphingobacterium mizutaii DD2, were isolated from chicken litter and characterized for their biotransformation capability of DC. Results show both strains rely on cometabolism to biotransform DC with tryptone as primary growth substrate. DD2 had higher biotransformation kinetics than DD1. The two strains prefer similar pHs (7 and 8) and temperature (30 °C), however, they exhibited opposite responses to increasing background tryptone concentration. While hydrolysis converted DC to its isomer or epimer, the two bacterial strains converted DC to various biotransformation products through a series of demethylation, dehydration, decarbonylation and deamination. Findings from the study can be used to better predict the fate of DC in the environment.

Keywords: Doxycycline, Biotransformation, Kinetic, Transformation products

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Toxicokinetic (TK) models refer to the process of contaminant bioaccumulation as a balance between rate of uptake from different sources (e.g., water or food), and rate of elimination via different processes such as excretion, growth and/or biotransformation. Biotransformation can considerably modify the fate of chemicals in an organism, especially their bioavailability, residence time, and toxicity. Invertebrate models generally neglect this process as they assume a low metabolic activity. However, some species such as Gammarus sp. amphipods are able to metabolize a vast range of organic compounds. Some recent TK models include biotransformation, but they prove limited for estimating related parameters by giving negative values and/or large uncertainties for biotransformation rate(s). Here we propose a generic TK model accounting for biotransformation using a Bayesian framework for simultaneously estimating the parameters. We illustrated the added value of our method by fitting this generic TK model to 22 published datasets of several benthic invertebrate species exposed to different chemicals. All parameters are estimated simultaneously for all datasets and showed narrow estimates. Furthermore, the median model predictions and their 95% credibility intervals showed that the model confidently fitted the data. In most cases the uncertainties around biotransformation rate(s) were reduced in comparison to the original studies. From a methodology standpoint, this paper reflects that Bayesian inference has real added value for simultaneously estimating all TK parameters for parent chemicals and their metabolite(s) based on all available data, while accounting for different types of data and the correlation between parameters. Bayesian inference was able to overcome the limits of previous methods, since no parameters were fixed and no irrelevant negative values were obtained. Moreover, the 95% credibility intervals around model predictions, which are core uncertainties for Environmental Risk Assessment, were easily acquired.

Keywords: Invertebrate, Biotransformation, Bayesian inference, Toxicokinetic model, Bioaccumulation

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While heterotrophic microorganisms constitute the major fraction of activated sludge biomass, the role of heterotrophs in the biotransformation of organic micropollutants (OMPs) has not been fully elucidated. Yet, such knowledge is essential, particularly when conceiving novel wastewater treatment plants based on a two-stage process including an A-stage under heterotrophic conditions and a B-stage based on anammox activity. Biotransformation of OMPs in activated sludge is thought to mostly occur cometabolically thanks to the action of low specificity enzymes involved in the metabolism of the primary substrates. For a better understanding of the process, it is important to determine such enzymatic activities and the underlying mechanisms involved in OMPs biotransformation. This task has proven to be difficult due to the lack of information about the enzymatic processes and the complexity of the biological systems present in activated sludge. In this paper, a continuous aerobic heterotrophic reactor following 20 OMPs at environmental concentrations was operated to (i) assess the potential of heterotrophs during the cometabolic biotransformation of OMPs, (ii) identify biotransformation reactions catalyzed by aerobic heterotrophs and (iii) predict possible heterotrophic enzymatic activities responsible for such biotransformations. Contradicting previous reports on the dominant role of nitrifiers in OMPs removal during activated sludge treatment, the heterotrophic population proved its capacity to biotransform the OMPs to extents equivalent to reported values in nitrifying activated sludge plants. Besides, 12 transformation products potentially formed through the activity of several enzymes present in heterotrophs, including monooxygenases, dioxygenases, hydrolases and transferases, were identified.

Keywords: Cometabolism, Enzymes, Heterotrophs, Pharmaceuticals, Transformation products, Wastewater

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Micropollutants are ubiquitously found in natural surface waters and pose a potential risk to aquatic organisms. Stream biofilms, consisting of bacteria, algae and other microorganisms potentially contribute to bioremediating aquatic environments by biotransforming xenobiotic substances. When investigating the potential of stream biofilms to remove micropollutants from the water column, it is important to distinguish between different fate processes, such as biotransformation, passive sorption and active bioaccumulation. However, due to the complex nature of the biofilm community and its extracellular matrix, this task is often difficult. In this study, we combined biotransformation experiments involving natural stream biofilms collected up- and downstream of wastewater treatment plant outfalls with the QuEChERS extraction method to distinguish between the different fate processes. The QuEChERS extraction proved to be a suitable method for a broad range of micropollutants (> 80% of the investigated compounds). We found that 31 out of 63 compounds were biotransformed by the biofilms, with the majority being substitution-type biotransformations, and that downstream biofilms have an increased biotransformation potential towards specific wastewater-relevant micropollutants. Overall, using the experimental and analytical strategy developed, stream biofilms were demonstrated to have a broad inherent micropollutant biotransformation potential, and to thus contribute to bioremediation and improving ecosystem health.

Keywords: Periphyton, Bioremediation, Sorption, Organic contaminants, Microbial ecotoxicology, Biofilm extraction

Mansi Kikani[a], Gopal Bhojani[bc], Chanchpara Amit[ac], Anil Kumar Madhava[ac] (a. Analytical and Environmental Science Division & Centralized Instrument Facility, CSIR-Central Salt & Marine Chemicals Research Institute, Bhavnagar 364 002, Gujarat, India, b. Applied Biotechnology and Phycology Division, CSIR-Central Salt & Marine Chemicals Research Institute, Bhavnagar 364 002, Gujarat, India, c. Academy of Scientific and Innovative Research, Ghaziabad 201 002, Uttar Pradesh, India) **Chemo-metrically formulated consortium with selectively screened bacterial strains for ameliorated biotransformation and detoxification of 1,4-dioxane, Journal of Hazardous Materials, Volume 413, 5 July 2021, 125456**

The biotransformation of 1,4-dioxane, a endrocrine disrupting chemical was achieved using different bacterial strains and their consortia. Three different bacterial isolates were screened on their ability to grow with 50 mg/L 1,4-dioxane in the basal mineral medium. Then the isolates were tested for its efficiency to biotransform 1000 mg/L 1,4-dioxane at varying period of time; 24–120 h. The isolates were distinguished by their morphological features and 16 S rRNA gene sequencing was done to evaluate the phylogenetic relationships. The isolates were identified as Bacillus marisflavi strain MGA, Aeromonas hydrophila strain AG and Shewanella putrefaciens strain AG. The degree of biotransformation was escalated by constructing a bacterial consortium using statistical tool; response-mixture matrix under the design of experiments. The fully grown bacterial strains were used as ingredients in different proportions to formulate the consortium. The biotransformation was analyzed for functional attenuation using spectroscopic techniques and reduction in 1,4-dioxane level was confirmed using mass spectrometry. The precise quantification of biotransformation using mass spectral profile revealed that the consortium removed 31%, 61% and 85% of 1000 mg/L 1,4-dioxane within 96, 120 and 144 h respectively. The activities of inducible laccase were elucidated during biotransformation of 1,4-dioxane. Bio-toxicity of treated and untreated 1,4-dioxane on brine shrimp; Artemia salina showed that the biotransformed products were less toxic. Therefore, this report would be first of its kind to report the biotransformation and detoxification of 1,4-dioxane by a statistically designed bacterial consortium.

Keywords: 1,4-dioxane, Artemia salina, Biotransformation, Chemo-metric, Consortium

Biomarker

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Background
High-risk coronary atherosclerosis features evaluated coronary CT angiography (CCTA) were suggested to have a prognostic role. The present study aimed to evaluate the association of circulating biomarkers with high-risk plaque features assessed by CCTA.
Methods
A consecutive cohort of subjects who underwent CCTA because of suspected CAD was screened for inclusion in the CAPIRE study. Based on risk factors (RF) burden patients were defined as having a low clinical risk (0–1 RF with the exclusion of patients with diabetes mellitus as single RF) or an high clinical risk (≥3 RFs). In all patients, measurement of inflammatory biomarkers and CCTA analysis focused on high-risk plaque features were performed. Univariate and multivariate logistic regression analysis were used to evaluate the relationship between clinical and biological variables with CCTA advanced plaque features.
Results
528 patients were enrolled in CAPIRE study. Older age and male sex appeared to be predictors of qualitative high-risk plaque features and associated with the presence of elevated total, non-calcified and low-attenuation plaque volume. Among circulating biomarkers only hs-CRP was found to be associated with qualitative high-risk plaque features (OR 2.02, $p = 0.004$ and 2.02, $p = 0.012$ for LAP and RI > 1.1, respectively) with borderline association with LAP-Vol (OR 1.52, $p = 0.076$); HbA1c and PTX-3 resulted to be significantly associated with quantitative high-risk plaque features (OR 1.71, $p = 0.003$ and 1.04, $p = 0.002$ for LAP-Vol, respectively).
Conclusions
Our results support the association between inflammatory biomarkers (hs-CRP, PTX- 3), HbA1c and high-risk atherosclerotic features detected by CCTA. Male sex and older age are significant predictors of high-risk atherosclerosis.

Keywords: Coronary atherosclerosis, Coronary plaque, Cardiac computed tomography, Inflammation, Cardiovascular prevention, High-risk plaque features

James C. McPartland (Professor of Child Psychiatry and Psychology, Yale Child Study Center, 230 South Frontage Road, New Haven, CT 06520, United States) Refining biomarker evaluation in ASD, European Neuropsychopharmacology, Volume 48, July 2021, Pages 34-36

This commentary reflects on reasonable biomarker expectations in ASD by addressing three key questions: What is a biomarker? What is required for a biomarker in ASD? How can biomarkers be useful in ASD? In addressing these queries, a path forward emerges based on clear definition of the objective for any given ASD biomarker and evaluation of each biomarker relative to current best practices.

Keywords: Autism spectrum disorder, Biomarkers, Clinical trials, Endpoints

Dawn L. DeMeo MD, MPH (Channing Division of Network Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA) Sex and Gender Omic Biomarkers in Men and Women With COPD: Considerations for Precision Medicine, CHEST, Volume 160, Issue 1, July 2021, Pages 104-113

Sex and gender differences in lung health and disease are imperative to consider and study if precision pulmonary medicine is to be achieved. The development of reliable COPD biomarkers has been elusive, and the translation of biomarkers to clinical care has been limited. Useful and effective biomarkers must be developed with attention to clinical heterogeneity of COPD; inherent heterogeneity exists related to grouping women and men together in the studies of COPD. Considering sex and gender differences and influences related to -omics may represent progress in susceptibility, diagnostic, prognostic, and therapeutic biomarker development and clinical innovation to improve the lung health of men and women.

Keywords: biomarkers, COPD, gender-omics, precision medicine, sex

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Advances in the field of cancer biology and molecular techniques have led to a better understanding of the molecular underpinnings driving cancer development and outcomes. Simultaneously, advances in imaging have allowed for improved sensitivity in initial staging, radiotherapy planning and follow-up of numerous cancers. These two phenomena have led to the development of biomarkers that can guide therapy in multiple malignancies. In bladder cancer, there is extensive ongoing research into the identification of biomarkers that can help tailor personalised approaches for treatment based on the intrinsic tumour biology. However, the delivery of bladder cancer radiotherapy as part of trimodality therapy currently has a paucity of biomarkers to guide treatment. Here we summarise the existing literature and ongoing investigations into potential predictive and prognostic molecular and imaging biomarkers that may one day guide selection for utilisation of radiotherapy as part of trimodality therapy, guide selection of the radiosensitising agent, guide radiation dose and target, and guide surveillance for recurrence after trimodality therapy.

Keywords: Biomarkers, bladder cancer, genomics, radiotherapy, trimodality therapy

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The evaluation of biomarkers for response and resistance to immune checkpoint blockade is currently an active and rapidly evolving area of research.
There are multiple molecular and physiologic mechanisms through which head and neck cancers may develop therapeutic resistance to immunotherapy.
Proposed biomarkers undergoing investigation include tumor mutational burden (TMB), PD-L1 expression, and DNA mismatch repair deficiency.
A highly precise predictive biomarker for immunotherapy response has yet to be identified.

Keywords: Immunotherapy, Checkpoint blockade, Anti-PD-1, Biomarkers, Response

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Alcoholic hepatitis (AH) is a clinical syndrome of jaundice, abdominal pain, and anorexia due to prolonged heavy alcohol intake, and is associated with alterations in gene expression, cytokines, immune response, and the gut microbiome.
Although liver biopsy can confirm the diagnosis and rule out other causes of liver disease, it is neither safe nor cost-effective to perform a liver biopsy on all patients presenting with AH.
Current validated prognostic scoring systems in AH include the model for end-stage liver disease score, the Maddrey modified discriminant function, Glasgow alcoholic hepatitis score, and Lille score, which help guide the clinician as to whether the patient should be treated with corticosteroids.

There are novel biomarkers being studied that use changes in microRNA expression, alterations in the microbiome, and cytokine dysregulation, to diagnose and prognosticate in AH, but larger studies are needed before these biomarkers will become available in the clinical setting.
It is important to determine whether there is underlying fibrosis in patients with alcohol associated liver disease (ALD) and validated laboratory (FibroSure/FibroTest or Enhanced Liver Fibrosis test) and imaging (vibration-controlled transient elastography) methodologies can help quantify fibrosis in ALD.

Keywords: Biomarker, Alcoholic hepatitis, Cytokines, Fibrosis, Maddrey's, microRNA, Microbiome, Extracellular vesicles

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The momentum of cardiovascular drug development has slowed dramatically. Use of validated cardiac biomarkers in clinical trials could accelerate development of much-needed therapies, but biomarkers have been used less for cardiovascular drug development than in therapeutic areas such as oncology. Moreover, there are inconsistences in biomarker use in clinical trials, such as sample type, collection times, analytical methods, and storage for future research. With these needs in mind, participants in a Cardiac Safety Research Consortium Think Tank proposed the development of international guidance in this area, together with improved quality assurance and analytical methods, to determine what biomarkers can reliably show. Participants recommended

the development of systematic methods for sample collection, and the archiving of samples in all cardiovascular clinical trials (including creation of a biobank or repository). The academic and regulatory communities also agreed to work together to ensure that published information is fully and clearly expressed.

Keywords: biobanking, biomarker, clinical trials

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There are currently no validated biomarkers for anorexia nervosa (AN), though recent literature suggests an increased research interest in this area. Biomarkers are objective, measurable indicators of illness that can be used to assist with diagnosis, risk assessment, and tracking of illness state. Related to biomarkers are endophenotypes, which are quantifiable phenomena that are distinct from symptoms and which link genes to manifest illness. In this scoping review, we sought to provide a summary of recent research conducted in the pursuit of biomarkers and endophenotypes for AN. The findings indicate that a number of possible biomarkers which can assess the presence or severity of AN independently of weight status, including psychophysical (e.g., eye-tracking) and biological (e.g., immune, endocrine, metabolomic, neurobiological) markers, are currently under investigation. However, this research is still in early phases and lacking in replication studies. Endophenotype research has largely been confined to the study of several neurocognitive features, with mixed evidence to support their classification as possible endophenotypes for the disorder. The study of biomarkers and endophenotypes in AN involves significant challenges due to confounding factors of illness-related sequalae, such as starvation. Future research in these areas must prioritise direct evaluation of the sensitivity, specificity and test-retest reliability of proposed biomarkers and enhanced control of confounding physical consequences of AN in the study of biomarkers and endophenotypes.

Keywords: Biomarker, Endophenotype, Phenotype, Anorexia nervosa, Marker, Eating disorders

Biofertilizer

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For a biofertilizer to promote plant growth after application, cell survival during storage must be ensured, while the carrier formulation and packaging are important factors during storage. This study aimed to optimize the ratio of rubber wood ash (RWA), decanter cake (DCC), rice husk ash (RHA), and spent coffee grounds (SCG) as a mixed carrier of biofertilizer of purple non-sulfur bacteria (PNSB), Rhodopseudomonas palustris and Rubrivivax gelatinosus. Different packaging materials, and different sealing methods were investigated. The phytotoxicity of PNSB biofertilizers in a solid form, and their effectiveness to enhance rice (Oryza sativa L.) seedling growth in paddy soil were also investigated in comparison with a liquid form. A mixed carrier of RWA,

DCC, RHA and SCG at a ratio of 3:4:2:1 most effectively maintained viability. After 6-month storage at 25 ± 3 °C, PNSB population of a mixed carrier containing R. palustris at roughly 10 log CFU/g in nylon-linear low density polyethylene (nylon-LLDPE) bags that were vacuum sealed at 500 W decreased by only 3 log cycles compared with 7 log cycles in the control. The PNSB biofertilizers, each genus and a mixed culture at 1: 1, either in solid or liquid form at their optimal dilutions showed no phytotoxicity. However, the mixed carrier itself as a control was slightly toxic. At these optimal dilutions, all PNSB biofertilizers in both liquid and solid formulations significantly increased rice growth in paddy soil compared with controls. A suitable mix of agro-industrial waste and suitable packing prolonged the shelf-life and potency of PNSB biofertilizers.

Keywords: Biofertilizer shelf-life, Inoculum carrier, Phototrophic bacteria, Rhizobacteria, Rhizosphere

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Presently, the global biofertilizer market is expanding due to the rising acceptance of efficient soil nutrient management practices such as the application of biofertilizers amongst farmers. Biofertilizers are preferred to chemical fertilizers because they are cost-effective, ecologically friendly, and guarantee sustainable agricultural production. However, the biofertilizer industry is underdeveloped in many African countries due to several challenges; thus, the full adoption and benefits of biofertilizer are yet to be fully realized compared to the developed nations. Therefore, the present review describes the production, usage, challenges as well as the strategies and opportunities for the development of biofertilizer in Africa. The findings show that inadequate biofertilizer research, lack of technology development, and ineffective regulatory framework have largely contributed to the challenges of biofertilizer development in Africa. Although there is evidence of some form of regulations in some African nations, effective biofertilizer regulations and quality control management championed by the government would further promote the production of quality biofertilizers and usage amongst African farmers. Adequate and effective extension programs, agromarket development, as well as agricultural and research institution development, could improve the production and adoption of biofertilizers in Africa. To achieve increased commercial production and optimal application of biofertilizer amongst farmers in Africa, a deliberate intervention by African government through biofertilizer policy, funding and the development of efficient quality control system and market strategies is essential. More so, government and private sector participation in sustainable investment and technical support will lead to substantial biofertilizer commercialization and adoption in Africa.

Keywords: Africa, Biofertilizer technology, Formulation, Government policies, Rules and regulations, Strategy

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Biofertilizer can improve soil quality, especially the microbiome composition, which potentially affect soil nitrogen (N) cycling. However, little is known about the responses of nitrous oxide (N2O) emission and ammonia (NH3) volatilization from biochar-amended paddy soil to the biofertilizer application. Therefore, we conducted a soil column experiment using four 240 kg N ha−1 (equivalent to 1.7 g N pot−1) treatments consisting of biofertilizer (3 t ha−1, equivalent to 21.2 g pot−1), biochar (7.5 t ha−1, equivalent to 63.6 g pot−1), and a mixture of biofertilizer and biochar at the same rate and a control (CK). The results showed that the N2O emissions and NH3 volatilizations were equivalent to 0.15–0.28% and 18.0–31.5% of rice seasonal N applied to the four treatments, respectively. Two treatments with biofertilizer and biochar individual amendment significantly increased ($P < 0.05$) the N2O emissions to same degree by 30.2%, while co-application of biochar and biofertilizer further increased the N2O emission by 74.4% compared to the control. The higher N2O emission was likely attributed to the increased gene copies of AOA, nirK, and nirS. Applying biofertilizer significantly increased ($P < 0.05$) NH3 volatilization by 24.7% relative to the control, while applying biochar had no influence on NH3 volatilization. Co-application of biofertilizer and biochar significantly decreased ($P < 0.05$) NH3 volatilization by 12.3% compared to the control. Overall, the net global warming potential based on NH3 and N2O in current study increased by 13.0–26.0% in both the individual- and co-application of biofertilizer and biochar. Interestingly, both individual- and co-applications of biofertilizer and biochar increased the rice grain yield by 16.5–38.3%. Therefore, applications of biofertilizer and biochar did not increase the GHGI. Particularly, the co-applying of them significantly lowered ($P < 0.05$) the GHGI by 15.2%. In conclusion, biofertilizer and biochar should be co-applied to achieve the goals of environment protection and food security.

Keywords: Atmospheric environment, Biochar, Global climate change, Nitrogen management, Soil quality

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The accumulation of cadmium (Cd) in Oryza sativa L., the world's most significant staple crop, is a health threat to millions of people. The objective of this study was to evaluate the effectiveness of commercially available biofertilizers (with high (BF2) and low organic matter (OM) content (BF1)) on Cd accumulation in two types of soils and to determine the bacterial community responses by high-throughput sequencing. The study was conducted in the form of pot experiment in greenhouse in 2018. Four treatments were set: BF1, BF2, organic fertilizer (OF), and control (CK) and the amendments were applied before the rice cultivation. The results showed that the addition of biofertilizers immobilized or mobilized Cd in soils, depending on the soil type and the OM content in biofertilizers. The exogenous OM in biofertilizers was the driving factor for the difference in pH and Cd accumulation in rice grains. The application of biofertilizers with high OM content was effective in reducing Cd accumulation in the rice grains (19.7% lower than CK) by significantly increasing soil pH (from 6.02 to 6.67) in acid silt loam soil (TZ). The consumption of acid fermentation products by soil chemoorganotrophs and the complexation of organic anions in the biofertilizer treatment tended to buffer the pH drop in the drainage and decrease the Cd availability. However, in the weak acid silty clay loam soil (SX), the addition of biofertilizer with high OM significantly increased Cd accumulation in rice grains (21.9% higher than CK), probably owing to the release of acid substances, resulting from the significant increase of the predominant bacteria Chloroflexi. The addition of biofertilizer with low OM content did not significantly change Cd accumulation in rice grains or affect the soil microbial structures in both soils. In conclusion, the effects of

biofertilizer on rice Cd accumulation were related to the OM content and soil bacterial community. Biofertilizers with high organic matter may not be suitable for amendments in the paddy soils with high clay content to reduce Cd accumulation in rice grains.

Keywords: Biofertilizer, Heavy metals, Cadmium, Rice, Soil predominant microbes, High-throughput sequencing

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The present study was carried out to elucidate the effects of organic manures (FYM, vermicompost and forest litter) and biofertilizers (Azotobacter chroococcum and Pseudomonas fluorescens) on plant growth, yield and fruits quality of strawberry (Fragaria ananassa Duch. cv. Chandler) under field conditions. Sixteen treatments (including a control) were used in this study. Among these, treatment T13 (50 % FYM + 50 % Vermicompost + Azotobacter + Pseudomonas) was found most effective to enhance plant growth parameters viz. plant height, plant spread, leaf area per plant, and induced early flowering. Maximum increase in yield per plant and yield per plot were achieved by the application of 50 % FYM + 50 % Vermicompost + Pseudomonas (T12), which was at par of T13. However, fruit quality parameters including ascorbic acid, total sugar, total phenolic content, and antioxidant capacity were found significantly higher in T13. Higher availability of nutrients (Nitrogen, Phosphorus and Potassium) in soil was also recorded in this treatment. Principle component analysis revealed that different treatments (T9 -T13, T15 and T16) showed positive effects on plant growth, yield and fruit quality parameters. Among these, T13 and T15 were found most effective to increase yield and fruit quality parameters. The PCA analysis also revealed that 'Days to flowering' was independent and negatively correlated to other planting value parameters. Similarly, total acid content in fruit did affect other fruit quality parameter, including antioxidant capacity. The combination of manures and biofertilizers has shown potential to increase crop yield and its nutritive properties under field conditions. Therefore, we concluded that the combination of biofertilizers with organic manures (especially, FYM and vermicompost) should be used for sustainably higher production of quality strawberries especially under organic farming system. Such approaches have a higher rationale with small farm or hill agriculture system where farmers are generally resource poor and have low input capacity.

Keywords: Antioxidents, Azotobacter, Biofertilizers, FYM, Pseudomonas fluorescens, Strawberry

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Dairy industry generates copious amount of wastewater from its milk processing unit (1–10 m3 of wastewater per m3 of processed milk) which needs to be treated before getting discharged. The conventional treatment processes are tedious, energy intensive, and an additional burden for the dairy industry. This study attempts to develop an alternative strategy to convert the dairy wastewater into liquid biofertilizer. A tailor-made microbial consortium-based biofilm reactor with 8.64 m3 d−1 processing capacity, within 16 h of hydraulic retention time (HRT) at ambient temperature produced biofertilizer containing 96.01 mg L−1 ammonia from dairy wastewater at a flow rate of 360 L h−1 with associated 73.72% nitrate, 72.46% phosphate, 61.30% Biological Oxygen Demand (BOD) and 57.23% Chemical Oxygen Demand (COD) reduction. A similar system of 10.94 m3 d−1 processing capacity at 456 L h−1 flow rate produced 298.79 mg L−1 ammonia with nitrate, phosphate, BOD and COD reduction of 42.71%, 84.80%, 89.55% and 76.68% respectively. This liquid biofertilizer could enhance grain yield in maize (Zea mays var. Vijay) by 1.19-fold. It increased biomass yield in Sorghum Sudan grass (Sorghum sudanense) by 3.5-folds and Lemongrass (Cymbopogon citratus var. Dhanitri and var. Krishna) by 2.1 and 2.64 folds respectively. It enhanced gel content in Aloe vera (Aloe elongata var. Ghikuari) by 1.63-folds when compared to chemical fertilizer treatment. This single-step dairy wastewater treatment system requires ten times less energy with the development of a value-added product (biofertilizer). It could make the dairy wastewater management a revenue earning (USD 10.28 d−1 for 600 m3 d−1 processing capacity reactor), eco-friendly, zero discharge process preventing the use of freshwater and chemical fertilizer in agriculture, and saving 89.99% carbon dioxide equivalent (CO2 eq.) gas emission leading to environmental protection.

Keywords: Ammonia, Lemongrass, Mung bean, Sorghum Sudan grass, Biofertilizer Dairy wastewater

Jun Li[ab], Lila Otero-Gonzalez[a], Amelia Paraoa Pieter Tack[c], Karel Folens[a], Ivet Ferrer[b], Piet N.L. Lens[d], Gijs Du Laing[a] (a. Laboratory of Analytical Chemistry and Applied Ecochemistry, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000, Ghent, Belgium, b. GEMMA - Group of Environmental Engineering and Microbiology, Department of Civil and Environmental Engineering, Universitat Politecnica de Catalunya·BarcelonaTech, c/ Jordi Girona 1-3, Building D1, 08034, Barcelona, Spain, c. XMI Research Group, Department of Chemistry, Campus Sterre (S12), Ghent University, Krijgslaan 281, 9000, Ghent, Belgium, d. UNESCO-IHE Institute for Water Education, 2601, DA, Delft, the Netherlands) **Valorization of selenium-enriched sludge and duckweed generated from wastewater as micronutrient biofertilizer, Chemosphere, Volume 281, October 2021, 130767**

Selenium (Se) is an essential trace element for humans and animals with a narrow window between deficiency and toxicity levels. Application of conventional chemical Se fertilizers to increase the Se content of crops in Se deficient areas could result in environmental contamination due to the fast leaching of inorganic Se. Slow-release Se-enriched biofertilizers produced from wastewater treatment may therefore be beneficial. In this study, the potential of Se-enriched biomaterials (sludge and duckweed) as slow-release Se biofertilizers was evaluated through pot experiments with and without planted green beans (Phaseolus vulgaris). The Se concentration in the bean tissues was 1.1–3.1 times higher when soils were amended with Se-enriched sludge as compared to Se-enriched duckweed. The results proved that the Se released from Se-enriched biomaterials was efficiently transformed to health-beneficial selenoamino acids (e.g., Se-methionine, 76–89%) after being taken up by beans. The Se-enriched sludge, containing mainly elemental Se, is considered as the preferred slow-release Se biofertilizer and an effective Se source to produce Se-enriched crops for Se-deficient populations, as shown by the higher Se bioavailability and lower organic carbon content. This study could offer a theoretical reference to choose an environmental-friendly and sustainable alternative to conventional mineral Se fertilizers for biofortification, avoiding the problem of Se losses by leaching from chemical Se fertilizers while recovering resources from wastewater. This could contribute to the driver for a future circular economy.

Keywords: Biofortification, Green beans, Resource recovery, Se-enriched biomaterials, Selenium bioavailability

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The recovery of valuable materials from waste fits the principle of circular economy and sustainable use of resources, but contaminants in the waste are still a major obstacle. This works proposes a novel approach to recover high-purity phosphorus (P) and nitrogen (N) from digestate of municipal solid waste based on the combination of two independent membrane processes: electrodialytic (ED) process to extract P, and gas permeable membranes (GPM) for N extraction. A laboratory ED cell was adapted to accommodate a GPM. The length of waste compartment (10 cm; 15 cm), current intensity (50 mA; 75 mA) and operation time (9 days; 12 days) were the variables tested. 81% of P in the waste was successfully extracted to the anolyte when an electric current of 75 mA was applied for 9 days, and 74% of NH4+ was extracted into an acid-trapping solution. The two purified nutrient solutions were subsequently used in the synthesis of a biofertilizer (secondary struvite) through precipitation, achieving an efficiency of 99.5%. The properties of the secondary struvite synthesized using N and P recovered from the waste were similar to secondary struvite formed using synthetic chemicals but the costs were higher due to the need to neutralize the acid-trapping solution, highlighting the need to further tune the process and make it economically more competitive. The high recycling rates of P and N achieved are encouraging and widen the possibility of replacing synthetic fertilizers, manufactured from finite sources, by secondary biofertilizers produced using nutrients extracted from wastes.

Keywords: Phosphorus, Nitrogen, Struvite, Nutrient recycling, Waste valorization, Seawater

Biocomposting

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The use of agro-biowaste compost fertilizers in agriculture is beneficial from technical, financial, and environmental perspectives. Nevertheless, the physical, mechanical, and agronomical attributes of agro-biowaste compost fertilizers should be engineered to reduce their storage, handling, and utilization costs and environmental impacts. Pelletizing and drying are promising techniques to achieve these goals. In the present work, the effects of process parameters, including compost particle size/moisture content, pelletizing compression ratio, and drying air temperature/velocity, were investigated on the density, specific crushing energy, and moisture diffusion of agro-biowaste compost pellet. The Taguchi technique was applied to understand the effects of independent parameters on the output responses, while the optimal pellet properties were found using the iterative thresholding method. The soil and plant (sweet basil) response to the optimal biocompost pellet was experimentally evaluated. The farm application of the optimal pellet was also compared with the untreated agro-biowaste compost using the life cycle assessment approach to investigate the potential environmental impact mitigation of the pelletizing and drying processes. Generally, the compost moisture content was the most influential factor on the density and specific crushing energy of the dried pellet, while the moisture diffusion of the wet pellet during the drying process was significantly influenced by the pelletizing compression ratio. The density, specific crushing energy, and moisture diffusion of agro-biowaste compost pellet at the optimal conditions were 1242.49 kg/m3, 0.5054 MJ/t, and 8.2 × 10−8 m2/s, respectively. The optimal biocompost pellet could release 80% of its nitrogen content evenly over 98 days, while this value was 28 days for the chemical urea fertilizer. Besides, the optimal pellet could significantly improve the agronomical attributes of the sweet basil plant compared with the untreated biocompost. The applied strategy could collectively mitigate the weighted environmental impact of farm application of the agro-biowaste compost by more than 63%. This reduction could be attributed to the fact that the pelletizing-drying processes could avoid methane emissions from the untreated agro-biowaste compost during the farm application. Overall, pelletizing-drying of the agro-biowaste compost could be regarded as a promising strategy to improve the environmental and agronomical performance of farm application of organic biofertilizers.

Keywords: Agro-biowaste compost, Pelletizing-drying, Life cycle assessment, Moisture diffusion, Soil and plant response, Specific crushing energy

Biopesticide

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Essential oils (EOs) are promising active ingredients to produce biopesticides, although their physicochemical characteristics are a critical issue to develop commercial formulates. Repellent and toxic activity of EOs against crop and stored product pests has been widely investigated in the last decades; however, no information is available on the occurrence of adverse undesirable behavioral responses (i.e. habituation) toward these repellents in target pest species. In this study, stable EO-based nano-emulsions from commercial fennel (Foeniculum vulgare), mint (Mentha x piperita) and sweet orange (Citrus sinensis) EOs were developed, and their repellence was tested against a major stored product pest, the lesser grain borer Rhyzopetha dominica. Besides, the occurrence of habituation in R. dominica adults following successive exposure to the repellent formulations was evaluated, considering the main characteristics of this kind of non-associative learning. Nanometric droplet size

was achieved for all developed nano-emulsions (<200 nm). All the tested EO-based nano-formulations were repellent to R. dominica, whereas F. vulgare-based nano-emulsions triggered lower repellence both in area choice and arena bioassays. The occurrence of habituation was validated for the strongest repellents, M. piperita and C. sinensis formulations and the decline of R. dominica responses was frequency-dependent. Furthermore, insects completely recovered their responsiveness toward the biopesticides just after 24 h from the end of exposure. The decline of the responsiveness in R. dominica adults was attributable to real learning process, since motor and sensory fatigue were excluded by testing stimulus specificity and dishabituation. The results demonstrated that habituation could occur for repellent EO-based formulations, thus this behavioral process can reduce the effectiveness of these kind of treatments against R. dominica and should be considered to articulate adequate IPM programs against stored product pests.

Keywords: Botanical active substance, Habituation, Non-associative learning, Repellence, Stored product pest

Arnau Sala, Silvana Vittone, Raquel Barrena, Antoni Sánchez, Adriana Artola (GICOM Research Group Department of Chemical, Biological and Environmental Engineering Edifici Q, Carrer de Les Sitges Universitat Autònoma de Barcelona 08193 Bellatera (Cerdanyola Del Vallès), Barcelona, Spain) Scanning agro-industrial wastes as substrates for fungal biopesticide production: Use of Beauveria bassiana and Trichoderma harzianum in solid-state fermentation, Journal of Environmental Management, Volume 295, 1 October 2021, 113113

As a waste valorisation option, agro-industrial residues (rice husk, apple pomace, whisky draff, soy fiber, rice fiber, wheat straw, beer draff, orange peel and potato peel) were tested as feasible substrates for fungal conidia production. Solid-state fermentation tests were conducted at laboratory scale (100 g) with Beauveria bassiana or Trichoderma harzianum which conidia are reported to have biopesticide properties. Conidia concentrations with all substrates were at least two orders of magnitude above inoculum except for both fibers, thus demonstrating the possibilities of the proposed waste recovery option. Highest productions were at least 1 × 109 conidia g−1 dry matter for Beauveria bassiana using rice husk or potato peel and higher than 5 × 109 conidia g−1 dry matter for Trichoderma harzianum using beer draff, potato peel or orange pomace. Principal component analysis has been used to understand which parameters affect the most fungal conidia production for an easier evaluation of other similar wastes, being air-filled porosity and initial pH for Beauveria bassiana and cumulative oxygen consumption, initial moisture and total sugar content for Trichoderma harzianum.

Keywords: Solid-state fermentation, Agro-industrial wastes, Beauveria bassiana, Trichoderma harzianum, Principal component analysis

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Agricultural production plays an important role in the stability of the national economy. Agricultural and sideline products are indispensable in human life. While solving the problems required by human life, they also bring certain hidden dangers to human health, and also causes harm to environment. Pesticides have an irreplaceable position in agricultural production. At the same time as large-scale influx of pesticides into the market, a series of problems have followed. Therefore, the development of green and environmentally sustainable pesticides to effectively control crop diseases has become a major concern of the scientists.

With the rapid development of science and technology, multidisciplinary relations have begun to connect with each other. Chemical pesticides have gradually been replaced by biopesticides. The latter effectively solves the shortcomings of chemical pesticides in use. But there are still problems such as poor product stability, slow drug efficacy and high prices, which limit the development of biological pesticides. In the past, China has invested a lot of money and manpower in biopesticide creation. It has also achieved certain success, such as creating some good living microbial pesticides, avermectins, validamycin and gibberellin.
In recent years, the application of nanotechnology in agriculture has become an innovative and rapidly developing research field. Nanotechnology has been applied to the field of biopesticide, realizing the transition of biopesticide materials from macro to micro scales. Thus, nano biological pesticides are gradually playing an important role in agricultural production.

Keywords: Nano, Biopesticide, Product sales, Environmental safety

Jhones Luizde Oliveira (Institute of Science and Technology, São Paulo State University (UNESP), São Paulo, Brazil) 1 - Nano biopesticides: Present concepts and future perspectives in integrated pest management, Advances in Nano-Fertilizers and Nano-Pesticides in Agriculture, A Smart Delivery System for Crop Improvement, Woodhead Publishing Series in Food Science, Technology and Nutrition 2021, Pages 1-27

In this chapter, the potential of nanotechnology to improve the stability and effectiveness of biopesticides is addressed. Whether in the encapsulation of biomolecules extracted from plants, fungi, bacteria that have a prolonged action or also through the numerous biomaterials synthesized by biogenic processes, generating biocompatible and more efficient biopesticides. In addition to presenting an updated literature approach, it also brings future perspectives for these formulations in integrated pest management. Highlights the need a close and efficient collaboration between the different actors in society (universities, research centers, industrial companies, agricultural producers and government regulatory agencies) for fixation and growth of these biopesticide based in agricultural market.

Keywords: Biopesticides, Nanotechnology, Nanoparticles, Sustainable agriculture, Essential oil, Botanical pesticides, Microorganisms

Tuyelee Das[1], Champa Keya Tudu[1], Samapika Nandy[1], Devendra Kumar Pandey[2], Abhijit Dey[1] (1. Department of Life Sciences, Presidency University, Kolkata, India, 2. Department of Biotechnology, Lovely Faculty of Technology and Sciences, Lovely Professional University, Jalandhar, India) Chapter 18 - Role of fungal metabolites as biopesticides: an emerging trend in sustainable agriculture, Volatiles and Metabolites of Microbes 2021, Pages 385-407

The overpopulation and rapid expansion of urban lifestyles has accelerated global demand of food supply, which has triggered unprecedented destruction of forest land and created a heavy toll on the ecosystem. Each year a large portion of agricultural crops are destroyed by different kind of pest infestations, which ensures the use of chemical pesticides despite their toxic aftereffects. The fungi and fungal metabolites are playing a crucial as well as potential role in the biopesticide industry. The inter- and intraspecific competition, rapid hyphal growth, ability to absorb water and nutrients, and phytoremediation features are critical arsenals of fungal biocontrol agents. A number of secondary metabolites were recognized and certified as biocidal, nematocidal, and weedicidal agents. Here we have provided details of large number of fungal metabolites and fungi and discussed their interesting mechanism of action as biopesticide. This chapter has also highlighted the future-research aspects and commercialization requirements of fungal-biopesticides as an integral part of sustainable agriculture.

Keywords: Fungi, metabolites, biopesticides, pollution, agriculture

Alice Ferreira[a], Lusine Melkonyan[bc], Sofia Carapinha[a], Belina Ribeiro[a], Daniel Figueiredo[d], Gayane Avetisova[bc], Luisa Gouveia[ad] (a. LNEG, National Laboratory of Energy and Geology I.P., Bioenergy and Biorefineries Unit, Estrada do Paço do Lumiar 22, 1649-038 Lisbon, Portugal, b. SPC "Armbiotechnology" NAS RA, 14 Gyurjyan Str., 0056 Yerevan, Armenia, c. Yerevan State University, 1 Alex Manoogian, 0025 Yerevan, Armenia, d. Green CoLab - Green Ocean Technologies and Products Collaborative Laboratory, Centro de Ciências do Mar do Algarve, Universidade do Algarve, Campus Gambelas, Edifício 7, 8005-139, Faro, Portugal) **Biostimulant and biopesticide potential of microalgae growing in piggery wastewater, Environmental Advances, Volume 4, July 2021, 100062**

Pig farming generates highly polluting wastewaters which entail serious environmental issues when not adequately managed. Microalgae systems can be promising for cost, energy and environment-efficient treatment of piggery wastewater (PWW). Aside from clean water, the produced biomass can be used as biostimulants and biopesticides contributing to a more sustainable agriculture.
Three microalgae (Tetradesmus obliquus, Chlorella protothecoides, Chlorella vulgaris) and one cyanobacterium (Synechocystis sp.) were selected after a preliminary screening in diluted wastewater (1:20) to treat PWW. The nutrient removals were 62-79% for COD (chemical oxygen demand), 84-92% for TKN (total Kjeldahl nitrogen), 79-92% for NH4+ and over 96% for PO43−. T. obliquus and C. protothecoides were the most efficient ones.
After treating PWW, the produced biomass, at 0.5 g L−1, was assessed as a biostimulant for seed germination, root/shoot growth, and pigment content for tomato, watercress, cucumber, soybean, wheat, and barley seeds. We observed an overall increase on germination index (GI) of microalgae-treated seeds, owing to the development of longer roots, especially in T. obliquus and C. vulgaris treatments. The microalgae treatments were especially effective in cucumber seeds (75-138% GI increase).
The biopesticide activity against Fusarium oxysporum was also evaluated at 1, 2.5 and 5 g L−1 of microalgae culture. Except for Synechocystis sp., all the microalgae tested inhibited the fungus growth, with T. obliquus and C. vulgaris achieving inhibitions above 40% for all concentrations.

Keywords: Tetradesmus obliquus, Cyanobacteria, Swine wastewater, Germination index, Plant protection

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A new formulation for biological pest control with significant UV protection capability has been developed in this research. The formulation is based on individual encapsulation of fungal conidia in an oil/water Pickering emulsion. The droplets size of the emulsions was tuned to meet the demands of single conidia encapsulation in the oil droplets. The emulsions are stabilized by amine-functionalized TiO2 (titania) nanoparticles (NPs). The droplet size, stability, and structure of the emulsions were investigated at different TiO2 contents and oil/water

phase ratios. Most of the emulsions remained stable for 6 months. The structural properties of the Pickering emulsions were characterized by confocal microscopy and high-resolution cryogenic scanning electron microscopy (cryo-HRSEM). The presence of the TiO2 particles at the interface was confirmed by both confocal microscopy and cryo-HRSEM. Metarhizium brunneum-7 (Mb7) conidia were added to the emulsions. The successful encapsulation of individual conidia in the oil droplets was confirmed by confocal microscopy. The individual encapsulation of the conidia in the emulsions was significantly improved by dispersing the conidia in a 0.02 % Triton X-100 solution prior to emulsification. In addition, the bioassay results have shown, that exposure of the encapsulated conidia to natural UV light did not change their germination rates, however, the unprotected conidia demonstrated a dramatic decrease in their germination rates. These results confirm the UV protection capability of the studied emulsions.

Keywords: Single-cell encapsulation, Pickering emulsions TiO_2, Biopesticides, UV radiation, Conidia, Metarhizium brunneum

Thomas De Bock[ab], Xingchen Zhao[a], Liesbeth Jacxsens[a], Frank Devlieghere[a], Andreja Rajkovic[a], Pieter Spanoghe[c], Monica Höfte[b], Mieke Uyttendaele[a] (a. Research Unit Food Microbiology and Food Preservation, Department of Food Technology, Safety and Health, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Ghent, Belgium, b. Laboratory of Phytopathology, Department of Plants and Crops, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Ghent, Belgium, c. Laboratory of Crop Protection Chemistry, Department of Plants and Crops, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Ghent, Belgium) **Evaluation of B. thuringiensis-based biopesticides in the primary production of fresh produce as a food safety hazard and risk, Food Control, Volume 130, December 2021, 108390**

Background: B. thuringiensis is a naturally occurring insect pathogen, genetically closely related to the human pathogen B. cereus. Commercial B. thuringiensis biopesticides have a long track record of safe use. Still, concerns are raised on the potential for enterotoxin production by biopesticide strains, especially since B. thuringiensis found in salad was a hypothesized cause of a foodborne outbreak in the EU.
Scope and approach: This review uses the basic steps of a risk assessment to collect available knowledge relevant to B. thuringiensis biopesticides and their impact on food safety of fresh produce. Subsequently, some directions for effective risk management strategies are provided, reflecting on various aspects that might impact decision-making on the use of B. thuringiensis as a biopesticide.
Key findings and conclusions: Phylogenetic studies show that B. thuringiensis biopesticide strains are part of another clade compared to highly pathogenic B. cereus group strains. Although they contain enterotoxin genes, their ability to produce these toxins in the human gastrointestinal tract may be more limited. Furthermore, surveys show that it is unlikely to find elevated levels of B. thuringiensis on ready-to-eat fresh produce, higher than the established action limit of 105 CFU/g for presumptive B. cereus on foods. Finally, the B. cereus diarrheal syndrome is generally mild and self-limiting. Therefore, the use of B. thuringiensis biopesticides is expected to pose a low food safety risk.

Keywords: B. thuringiensis, B. cereus, Risk analysis, Fresh produce, Biological control, Food safety

Biodegradation

Lilia S. Lens-Pechakova (Independent Researcher, 06200 Nice, France) Recent studies on enzyme-catalysed recycling and biodegradation of synthetic polymers, Advanced Industrial and Engineering Polymer Research, Available online 24 June 2021 https://doi.org/10.1016/j.aiepr.2021.06.005

Post-consumer plastic waste has reached levels that are dangerous for the environment and for human health, and its management now represents a big challenge. Plastic biodegradation and biorecycling emerges as an addition to the conventional plastic waste recycling methods. This review describes recent studies on enzyme-catalysed synthetic polymers biorecycling and biodegradation. The emphasize lies on the most successful cases as that of enzyme-catalysed depolymerisation of polyethylene terephthalate, using a specially engineered enzyme PET depolymerase, that has recently been developed into industrial technologies as well as on other recent promising discoveries of enzymes that are potentially capable of complete and controlled plastic degradation in mild conditions. The review also discusses polymer qualities that are causing diminished plastic biodegradation, and the protein engineering methods and tools to increase enzyme selectivity, activity and thermostability. Many fields of expertise have been used in the described studies, such as polymer chemistry, microbiology, mutagenesis, protein and process engineering. Applying this innovative interdisciplinary knowledge offers new perspectives for the environmental waste management and leads to a sustainable circular economy.

Keywords: Synthetic polymers, Plastic waste, Biorecycling, Enzyme catalysis, Biodegradation, Protein engineering

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Functional role of mixed-culture microbe in photocatalysis coupled with biodegradation: Total organic carbon removal of ciprofloxacin, Science of The Total Environment, Volume 784, 25 August 2021, 147049

Ciprofloxacin is an extensively used fluoroquinolone antibiotic, which exists in aquatic environment, causing detrimental effects to the aquatic ecosystem and thus, indirectly to humans. Thus, an efficient and rapid removal method for ciprofloxacin is urgently needed. Intimately coupled photocatalysis and biodegradation has proven to be highly efficient, low-cost, and eco-friendly. In this study, cube polyurethane sponges modified with visible light-responsive g-C3N4 and mixed culture microbes were used to increase the ciprofloxacin removal efficiency. Subsequently, 94% of ciprofloxacin was removed by photocatalytic-biodegradation and 12 degradation products and possible degradation pathways were analyzed. Photocatalytic-biodegradation had a 1.57 times higher total organic carbon (TOC) removal rate than photocatalytic degradation. The microbial community structure after 72 h of photocatalytic biodegradation was examined. High microbial richness, evenness, and functional dominant species belong to Proteobacteria, which were closely associated with the utilization of antibiotics, may be majorly responsible for the highly efficient removal degradation process. Additionally, microbes retarded the interaction of photogenerated electrons and holes, which may contribute to the increasing mineralization. The findings demonstrated the potential ability of photocatalytic biodegradation in degrading bio-recalcitrant compounds and provide new insights into photocatalytic coupled with biodegradation for removal of ciprofloxacin.

Keywords: Carbon nitride, Ciprofloxacin, Intimately coupled photocatalysis and biodegradation, Total organic carbon

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Optimization of biotic and abiotic factors liable for biodegradation of chlorpyrifos and their modeling using neural network approaches, Applied Soil Ecology, Volume 166, October 2021, 103990

Chlorpyrifos has a substantial risk to human health besides biodiversity. In the present study, a previously isolated bacterial strain Enterobacter sp. SWLC2 has been used to investigate its biodegradation potential in different soil-slurries systems and to optimize culture conditions to achieve enhanced biodegradation of chlorpyrifos. The optimization results indicate that the maximum (87%) spiked-chlorpyrifos biodegradation occurred in a sandy loam soil-slurry system in aeration mode after 18 days of incubation at the optimal temperature (35 °C) and pH (7). The effect of sources of carbon/nitrogen (organic sugars, organic acids, and amino acids, etc.) on the biodegradation of chlorpyrifos has been investigated and their optimal values are estimated. The neural networks have been designed to find the optimal values of earlier factors in the predictive modeling of degradation of chlorpyrifos.

Keywords: Biodegradation, Chlorpyrifos, Enterobacter sp., Artificial neural network, Soil parameters optimization

Yasser Hamidi[ab], Seyed Ahmad Ataei[a], Amir Sarrafi[a] (a. Department of Chemical Engineering, Faculty of Engineering, Shahid Bahonar University of Kerman, Kerman, 76188-68366, Iran, b. National Iranian Oil Company, Head of Products Engineering of NIOPDC, Kerman, 76136-67355, Iran) **A highly efficient method with low energy and water consumption in biodegradation of total petroleum hydrocarbons of oily sludge, Journal of Environmental Management Volume 293, 1 September 2021, 112911**

The hydrocarbons in petroleum sludge are environmental pollutants. It is crucial to eliminate this type of pollution. In this study, a comprehensive and operational study has been conducted on the total petroleum hydrocarbons (TPH) biodegradation in oily sludge. The experiments were performed in a semi-solid phase by two degrader bacterium, Arthrobacter citreus and Rhodococcus jostii, and they were compared with the slurry phase. Solid samples were prepared in three mixing modes of oily sludge with clay. Experiments were conducted by semi-solid bioreactors and other methods on samples contaminated with petroleum hydrocarbons. The performance of the semi-solid bioreactor for the removal of clay-free oily sludge samples showed the best results, in which biodegradation of TPH was 90.33%. GC analyses were conducted on samples before and after biodegradation. It was observed that the contaminants were decomposed uniformly by the microorganisms, except for a combination with a large peak in 12 min. For the best case, the GC-MS test was performed before and after biodegradation. Compounds with a high concentration in the sludge were significantly reduced. Only one heavy aromatic compound was detected in 51.628 min, which decomposed quite slowly and produced a large peak. It was found that 78.2% of the compounds were removed completely.

Keywords: Oily sludge, Biodegradation, Semi-solid bioreactor, Total petroleum hydrocarbons, Gas chromatography

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Biodegradation greatly affects the physical properties and economic value of oil and gas reserves. Here, the composition of a suite of 27 samples of shale soluble organic matter from typical biodegraded shale profiles in the Upper Triassic Yanchang Formation, Ordos Basin, China, was analyzed using GC/MS/MS and ESI FT-ICR MS technology. The effects of slight to moderate biodegradation on the compositions of saturated hydrocarbons and polar nitrogen, sulfur, oxygen (NSO) compounds were assessed, revealing three key effects as biodegradation increases (1) Chloroform asphalt "A" (i.e. soluble organic matter). and saturated hydrocarbons gradually decrease, aromatic hydrocarbons gradually increase, non-hydrocarbons increase, and there is no regular change in asphaltene content. (2) The relative content of pristane (Pr) and phytane (Ph) to their corresponding n-alkanes increases gradually, indicating the n-alkanes decrease gradually. However, the resistance of the n-alkanes to biodegradation may be related to the carbon number and odd-even distribution. As the carbon number increases, the ability of n-alkanes to resist biodegradation increases, and even carbon number n-alkanes may be more resistant to biodegradation than odd carbon number n-alkanes. (3) No obvious changes in the relevant biodegradation indices of steranes and polar NSO compounds were observed in the entire profile. Hopane biodegradation indices were variable and sometimes contradictory with depth throughout the sediment profile. However, overall the data suggest the hopanes were not affected by biodegradation.
Our results indicate that shale oil can also be biodegraded, and due to the tightness of shale reservoirs, slight to moderate biodegradation is common. Changes in shale oil content in the profile are the result of the primary migration and biodegradation together, with primary migration occurring mainly from the shale to the upper sandstone reservoirs. The above evidence shows that slight to moderate biodegradation has a relatively small impact on shale oil. However, in previous work we have shown that biodegradation has significant impacts on the shale gas content and its geochemical characteristics.

Keywords: Biodegradation, Shale oil, N-alkanes, Polar NSO compounds, Yanchang formation

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High utilization of thermoplastic polymers with low degradation rates as packaging materials generates a large amount of waste. Therefore, it should be replaced by natural polymers that can be degraded by microorganisms. In this paper, chitosan (CTS)/tannic acid (TA) materials in the weight ratios of 80CTS/20TA and 50CTS/50TA were prepared as potential packaging materials. The results showed that these materials were similarly degraded in soil and compost. However, in comparison to 50CTS/50TA, 80CTS/20TA was slightly better degraded in soil. After 14 days of biodegradation, the chemical structure of materials was changed resulting from adhesion of the microorganisms. The smallest changes were observed on 80CTS/20TA film. Bacterial species were collected and identified from materials after the degradation process. Microorganisms with the highest hydrolytic activity were chosen for the degradation study. Biodegradation and hydrolytic activity were observed only in a few strains, which indicate difficulties in material degradation. Soil bacteria degraded the films better than bacteria isolated from the compost. This study showed also that consortia of bacteria added to soil and compost had a positive effect on the biodegradation of the tested materials and increased the biodegradation of these materials in the studied environments.

Keywords: Chitosan, Tannic acid, Biodegradation, Hydrolytic enzyme

Mahmudul Hasan[a], Katherine Alfredo[b], Sudhir Murthy[c], Rumana Riffat[a] (a. Department of Civil & Environmental Engineering, The George Washington University, 800 22nd Street, NW, Washington, DC, 20052, USA, b. Department of Civil & Environmental Engineering, University of South Florida, 4202 E. Fowler Ave, Tampa, FL, 33620, USA, c. NewHUB, Herndon, VA, USA) **Biodegradation of salicylic acid, acetaminophen and ibuprofen by bacteria collected from a full-scale drinking water biofilter, Journal of Environmental Management, Volume 295, 1 October 2021, 113071**

This study examined the biodegradation of two pharmaceuticals-acetaminophen, and ibuprofen, and one natural organic surrogate-salicylic acid, by bacteria seeded from backwash water collected from a full-scale biofiltration plant. The degradation was studied in the presence of oxygen. Complete removal of salicylic acid was observed in 27–66 h depending on the seasonality of the collected backwash water, while 90–92% acetaminophen removal was observed in more than 225 h. Ibuprofen demonstrated poor removal efficiencies with only 50% biodegradation after 230 h. Adenosine tri phosphate (ATP) in the reactor was found to be linked with the biodegradation rate. ATP was found to be correlated with oxygen uptake rate (OUR). ATP also had a correlation with each of extracellular polymeric substances (EPS), protein and polysaccharides. These results highlight the potential for increasing the biodegradation rates to achieve enhanced contaminant removal.

Keywords: Salicylic acid, Acetaminophen, Ibuprofen, Biofiltration, Extracellular polymeric substances, Adenosine tri phosphate

Andrea Aldas-Vargas, Thomas van der Vooren, Huub H.M. Rijnaarts, Nora B. Sutton (Environmental Technology, Wageningen University & Research, P.O. Box 17, 6700, EV, Wageningen, the Netherlands) **Biostimulation is a valuable tool to assess pesticide biodegradation capacity of groundwater microorganisms, Chemosphere, Volume 280, October 2021, 130793**

Groundwater is the main source for drinking water production globally. Groundwater unfortunately can contain micropollutants (MPs) such as pesticides and/or pesticide metabolites. Biological remediation of MPs in groundwater requires an understanding of natural biodegradation capacity and the conditions required to stimulate biodegradation activity. Thus, biostimulation experiments are a valuable tool to assess pesticide biodegradation capacity of field microorganisms. To this end, groundwater samples were collected at a drinking water abstraction aquifer at two locations, five different depths. Biodegradation of the MPs BAM, MCPP and 2,4-D was assessed in microcosms with groundwater samples, either without amendment, or amended with electron acceptor (nitrate or oxygen) and/or carbon substrate (dissolved organic carbon (DOC)). Oxygen + DOC was the most successful amendment resulting in complete biodegradation of 2,4-D in all microcosms after 42 days. DOC was most likely used as a growth substrate that enhanced co-metabolic 2,4-D degradation with oxygen as electron acceptor. Different biodegradation rates were observed per groundwater sample. Overall, microorganisms from the shallow aquifer had faster biodegradation rates than those from the deep aquifer. Higher microbial activity was also observed in terms of CO2 production in the microcosms with shallow groundwater. Our results seem to indicate that shallow groundwater contains more active microorganisms, possibly due to their exposure to higher concentrations of both DOC and MPs. Understanding field biodegradation capacity is a key step towards developing further bioremediation-based technologies. Our results show that biostimulation has real potential as a technology for remediating MPs in aquifers in order to ensure safe drinking production.

Keywords: 2,4-D, Biodegradation, Biostimulation, Degradation capacity, Pesticides

Biosensor

Nikhila P. Nambiar, Christy Paul, Greeshma Girish, Aiswarya Velayudhan, S.D. Baby Sreeja, P.R.Sreenidhi (Department of Electronics and Communication Engineering, Amrita Vishwa Vidyapeetham, Amritapuri 690525, India) Simulation study of micro fluidic device for biosensor application, Materials Today: Proceedings, Volume 46, Part 8, 2021, Pages 3158-3163

The word sensors have got huge importance in the modern world as they detect and analyse the data acquired from the physical world. Nowadays biosensors are used in hospitals as well as in houses for diagnosing medical conditions of a patient. The biosensors are used to detect biological or physicochemical information of a patient. The basic components of the biosensor include a transducer and a receptor. Here in this work, a biosensor model was designed and simulated using the software COMSOL Multiphysics. The flow parameters are identified using a convection micro fluidic device which was extended to the concept for biosensor simulation to know the characteristics of the body fluids. Micro fluids in biosensors will react with the biological components of a patient and the resulting signals are detected by the use transducer. The convection biosensor simulation was performed to find the concentration of adsorbed species in the fluids. The basic model of micro fluidic device with three inlets filled with water was simulated. Convection region of analyte molecule from one inlet and convection region of analyte molecule from two inlets were studied in detail. It was observed that, the flow velocity of the solvent decreases due to more concentration of the solute. The proposed model of biosensor can be used to find out the concentration of urine in blood or vice versa depending on the application like dialysis or blood testing. This can be further used to check the abnormal level of harmful impurities in the blood that affects the body. The study shows that, the convection sensor with one inlet flow is useful for the modelling biosensor. The data obtained from the simulation can be used for the hardware implementation in future.

Keywords: Micro fluidic device, Convection, Analyte, Transducer, Receptor, Biosensor, COMSOL

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Parkinson's disease (PD) is one of the most critical disorders of the elderly and strongly associated with increased disability, and reduced quality of life. PD is a progressive neurodegenerative disease affecting more than six million people worldwide. Evaluation of clinical manifestations, as well as movement disorders by a neurologist and some routine laboratory tests are the most important diagnostic methods for PD. However, routine and old methods have several disadvantages and limitations such as low sensitivity and selectivity, high cost, and need for advanced equipment. Biosensors technology opens up new diagnoses approach for PD with the use of a new platform that allows reliable, repeatable, and multidimensional identification to be made with minimal problem and discomfort for patients. For instance, biosensing systems can provide promising tools for PD treatment and monitoring. Amongst biosensor technology, electrochemical techniques have been at the frontline of this progress, thanks to the developments in material science, such as gold nanoparticles (AuNPs), quantum dots (QDs), and carbon nanotubes (CNTs). This paper evaluates the latest progress in electrochemical and optical biosensors for PD diagnosis.

Keywords: Parkinson's disease (PD), Alpha-synuclein (a-Syn), Biosensors, LOD, Linear range

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It should come as no surprise that G protein-coupled receptors (GPCRs) continue to occupy the focus of drug discovery efforts. Their widespread expression and broad role in signal transduction underline their importance in human physiology. Despite more than 800 GPCRs sharing a common architecture, unique differences govern ligand specificity and pathway selectivity. From the relatively simplified view offered by classical radioligand binding assays and contractility responses in organ baths, the road from ligand binding to biological action has become more and more complex as we learn about the molecular mediators that underly GPCR activation and translate it to physiological outcomes. In particular, the development of biosensors has evolved over the years to dissect the capacity of a given receptor to activate individual pathways. Here, we discuss how recent biosensor development has reinforced the idea that biased signaling may become mainstream in drug discovery programs.

Keywords: Biosensors, GPCR, Bias, BRET, Functional selectivity

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Herein, β-cyclodextrin-capped gold nanoparticle surface designed for tyrosinase (Tyr)-based nanosensor is proposed and demonstrated. Integration of the β-cyclodextrin-capped gold nanoparticles on graphite electrode surface was achieved via drop-casting method, Tyr was immobilized on the modified electrode and then used as drug inhibition platform with catechol as the substrate. All optimization studies that affect biosensor response were conducted, and catechol was detected in the linear range of 1.56 μM-25μM catechol concentration with a limit of detection of 0.42 μM and sensitivity of 2.094 μA.μM−1. cm-2. Tyr inhibition was followed with ibuprofen drug active compound with a 15 min incubation time, and the I50 value was found as 213 μM. The sensor is the first in the literature to use an electrochemical method for β-cyclodextrin-capped gold nanoparticles based Tyr biosensor and ibuprofen inhibition. This sensor presents an easy fabrication method, excellent sensor properties, and ibuprofen inhibition capabilities. As a result, it is proposed that the designed sensor is an ideal marker for detecting Tyr inhibition using electrochemical methods and an ibuprofen-based cosmetic cream formulation could be a viable option in the cosmetic market.

Keywords: Catechol detection, Enzyme inhibition, β cyclodextrin, Gold nanoparticles, Ibuprofen, Tyrosinase

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A sensor is a tool used to directly measure the test compound (analyte) in a sample. Ideally, such a device is capable of continuous and reversible response and should not damage the sample. Nanosensor refers to a system in which at least one of the nanostructures is used to detect gases, chemicals, biological agents, electric fields, light, heat, etc. in its construction. The use of nanomaterials significantly increases the sensitivity of the system. In biosensors, the part of the system used to attach to the analyte and specifically detect it is a biological element (such as a DNA strand, antibody, enzyme, whole cell). The "Nano Biosensors" series reviews various types of biosensors and biochips (including an array of biosensors), emphasizing the role of nanostructures, developed for medical and biological applications. Nano Biosensors Electrochemical sensors are sensors that use the biological element as a diagnostic component and the electrode as a transducer. The use of nanostructures in these systems is usually done to fill the gap between the converter and the bioreceptor, which is at the nanoscale. Given the nature of the biomaterial detection process, electrochemical biosensors are divided into catalytic and propulsion. Common electrochemical techniques common in sensors include potentiometric, chronometry, voltammetry, impedance measurement, and field effect transistor (FET). Simultaneous use of the advantages of nanostructures and electrochemical techniques has led to the emergence of sensors with high sensitivity and decomposition power. The use of nanostructures in these sensors is usually done to fill the gap between the converter and the bioreceptor, which is at the nanoscale. Various types of nanostructures including nanoparticles, nanotubes and nanowires, nanopores, self-adhesive monolayers and nanocomposites can be used to improve the performance and efficiency of sensors in their structure. Simultaneous use of the advantages of nanostructures and electrochemical techniques has led to the emergence of sensors with high sensitivity and decomposition power.

Keywords: Nano biosensors, Electrochemical, Analyte, Nanowires, Nanotubes, Biosensors

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Background: In the near future, sensitive, rapid and economical detection of food allergens will remain a hardship to the health promotion of the community. Biogenic Amines (BAs) are a type of food allergens, and due to the trace level and complexity of BAs, improvement of professional and cost-effective detection techniques has become particularly demanding. Since vegetables, canned and fresh fish, beverages, and fermented foods have high concentrations of BAs and are mainly consumed, the advancement of specific and finely tuned methods for quick diagnosis of BAs are exceedingly urgent.
Scope and approach: In this review, enzyme-based biosensors for BAs detection in foods with different transducers such as chemiluminescent, surface-enhanced raman scattering biosensors electrochemical, and fluorescence biosensors are presented. Nanozymes-based detection of BAs in foods are also discussed with recent applications. Moreover, the latest advances of BAs detection by enzyme-based biosensors and nanozyme-based methods are further tabulated.
Key findings and conclusion: Among modern diagnostic techniques, biosensors are economical, simple, and precise instruments for BAs detection. In the future, studying novel biosensors such as multifunctional nanocomposite biosensors will satisfy the demand for the enhancement of food safety and cost-effective nanozyme-based methods for BAs detection.

Keywords: Biogenic amines**,** Food safety**,** Biosensors**,** Enzyme**,** Nanozymes

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Biosensors for sensitive and specific detection of foodborne and waterborne pathogens are particularly valued for their portability, usability, relatively low cost, and real-time or near real-time response. Their application is widespread in several domains, including environmental monitoring. The main limitation of currently developed biosensors is a lack of sensitivity and specificity in complex matrices. Due to increased interest in biosensor development, we conducted a systematic review, complying with the PRISMA guidelines, covering the period from January 2010 to December 2019. The review is focused on biosensor applications in the identification of foodborne and waterborne microorganisms based on research articles identified in the Pubmed, ScienceDirect, and Scopus search engines. Efforts are still in progress to overcome detection limitations and to provide a rapid detection system which will safeguard water and food quality. The use of biosensors is an essential tool with applicability in the evaluation and monitoring of the environment and food, with great impact in public health.

Keywords: Biosensor, Bacteria, Viruses, Food, Water, Lab on a chip

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Background: There is a demand for easy, rapid and affordable analysis of biological contaminants in foods to guarantee their safety and quality. Most analysis of food contaminants is commonly performed in a limited number of samples in centralized laboratories by an expert technician. Therefore, developing of alternative techniques such as portable biosensors is of great significance.
Scope and approach: This review aims to discuss the recent advances in designing and applying of portable biosensors for the detection of biological food contaminants including bacteria, fungi and the related toxins. Also, the review deals briefly the basic knowledge of various portable biosensors which have been developed for the contaminants detection. Moreover, the developed portable biosensors for different biological contaminants are discussed in details.
Key findings and conclusions: Portable biosensors are tiny, accessible and movable diagnostic devices which provide online detection of biological contaminations. Nanotechnology, microfluidic, electronic and biological design strategies as well as wireless networking capabilities help researchers to design and developed portable biosensors. During the recent years several portable devices with high sensitivity and selectivity have been developed for the monitoring biological food contaminants. These biosensors are based on various principles, such as electrochemical, magnetic and optical properties. Introduction of recent advances of the portable biosensors will help researchers to design or promote novel and advanced portable biosensors for food contaminants detection.

Keywords: Food**,** Biological contaminants**,** Portable biosensors**,** Bacteria**,** Fungi**,** Virus**,** Toxin

Bioengineering

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Plasmodium falciparum pathogenesis is complex and intimately connected to vascular physiology. This is exemplified by cerebral malaria (CM), a neurovascular complication that accounts for most of the malaria deaths worldwide. P. falciparum sequestration in the brain microvasculature is a hallmark of CM and is not replicated in animal models. Numerous aspects of the disease are challenging to fully understand from clinical studies, such as parasite binding tropism or causal pathways in blood–brain barrier breakdown. Recent bioengineering approaches allow for the generation of 3D microvessels and organ-specific vasculature that provide precise control of vessel architecture and flow dynamics, and hold great promise for malaria research. Here, we discuss recent and future applications of bioengineered microvessels in malaria pathogenesis research.

Keywords: cerebral malaria, Plasmodium falciparum, PfEMP1, blood vessels, vascular engineering, 3D microvessels

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Stem cell-based in vitro models of embryonic development have been established over the last decade. Such model systems recapitulate aspects of gametogenesis, early embryonic development, or organogenesis. They enable experimental approaches that have not been possible previously and have the potential to greatly reduce the number of animals required for research. However, each model system has its own limitations, with certain aspects, such as morphogenesis and spatiotemporal control of cell fate decisions, diverging from the in vivo counterpart. Targeted bioengineering approaches to provide defined instructive external signals or to modulate internal cellular signals could overcome some of these limitations. Here, we present the latest technical developments and discuss how bioengineering can further advance the optimization and external control of stem cell-based embryo-like structures (ELSs). In vitro models combined with sophisticated bioengineering tools will enable an even more in-depth analysis of embryonic development in the future.

Keywords: embryonic development, in vitro models, bioengineering, stem cells, microfluidics, 3D matrix, optogenetics, blastoids, gastruloids, organoids

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In this study, we examined the ability of nisin A and a rationally assembled bank of 36 nisin derivative producing Lactococcus lactis strains to inhibit Listeria. A broth-based bioluminescence assay for screening single and combinations of bioengineered nisin derivatives using cell-free supernatants (CFS) from nisin derivative producing strains was developed. In this way, we screened 630 combinations of nisin derivative producing strains, identifying two (CFS from M17Q + N20P and M17Q + S29E) which exhibited enhanced anti-listerial activity when used together compared to when used alone, or to the nisin A producing strain. Minimal inhibitory concentration assays performed with purified peptides revealed than when used singly, the specific activities of M17Q, N20P and S29E (3.75–7.5 μM) against L. innocua were equal to, or less than that of nisin A (MIC of 3.75 μM). Broth-based growth curve assays using purified peptides demonstrated that use of the double peptide combinations and a triple peptide combination (M17Q + N20P + S29E) resulted in an extended lag phase of L. innocua, while kill curve assays confirmed the enhanced bactericidal activity of the combinations in comparison to the single derivative peptides or nisin A. Furthermore, the enhanced activity of the M17Q + N20P combination was maintained in a model food system (frankfurter homogenate) at both chill (4 °C) and abusive (20 °C) temperature conditions, with final cell numbers significantly less (1–2 log10 CFU/ml) than those observed with the derivative peptides alone, or nisin A. To our knowledge, this study is the first investigation that combines bioengineered bacteriocins with the aim of discovering a combination with enhanced antimicrobial activity.

Keywords: Bioengineered, Bacteriocin, Nisin, Listeria, Food, Bioluminescence

Philippe Janssen, Fanny Dommanget, Paul Cavaillé, André Evette (Univ. Grenoble Alpes, INRAE, LESSEM, 2 rue de la Papeterie-BP 76, F-38402 St-Martin-d'Hères, France) **Does soil bioengineering benefits aquatic biodiversity? An empirical study of the relative influence of local and regional drivers on benthic macroinvertebrate assemblages, Ecological Engineering, Volume 168, 1 October 2021, 106287**

Riverine ecosystems form a dendritic network in which landscape and catchment-scale properties influence freshwater community structure. Placed in a restoration framework, this suggests that regional drivers can overrule the benefit of measures aiming at improving local habitat quality. Disentangling the relative influence of local and regional drivers on freshwater communities is thus crucial for ecosystem management and restoration. Along riverbanks, soil bioengineering is often used to both control erosion and improve ecological conditions. Soil bioengineering techniques aim at copying naturally functioning riverbank models and can thus be viewed as riparian ecosystem restoration. Nevertheless, these techniques are mostly designed at the local scale and are implemented in a broad range of rivers. This implies large variations in regional drivers, which may greatly influence the response of freshwater communities to restoration efforts. We studied 37 riverbanks, from civil engineering to soil bioengineering, plus natural willow stands, in the foothills of the Alps and Jura Mountains, and assessed the relative influence of local (terrestrial and aquatic habitat conditions) and regional (water quality, hydrological context and land cover composition) drivers on benthic macroinvertebrate assemblages. Using multivariate GLM and structural equation modelling, we investigated variations in the taxonomic and functional composition and in the diversity of native, exotic, shredder and scraper taxa to both set of drivers. Our results showed that soil bioengineering improved local habitat conditions, with an increase in the vegetation density and in the aquatic habitat quality. These changes directly influenced functional composition but indirectly diversity patterns. Instead, we found that native and shredder species richness increased between civil engineered and soil bioengineered structures, suggesting a positive effect of vegetated riverbanks on other local abiotic factors (i.e.

shade, water temperature, organic matter supply). Our results also showed that macroinvertebrates were more influenced by regional than by local drivers. Thus, the hydrological context best explained the composition of taxa feeding habits and variation in taxa diversity, with larger abundance and richness of scrapers and shredders in small headwater streams. Land cover ranked second in explaining variation in functional composition. Also, the diversity of natives, scrapers and shredders increased as the proportion of predominantly urban landscapes decreased. Finally, the abundance of scraper and native species increased with water quality, while the richness of exotic species decreased. Overall, these results highlight the hierarchical structure of local and regional drivers on freshwater communities. Along river networks, catchment-scale properties and landscape attributes are major drivers of macroinvertebrate assemblages. Soil bioengineering improves habitat quality and as such appears to be a good compromise solution to control erosion and support freshwater communities, even though this nature-based solution cannot solve anthropogenic pressures at larger scales. To improve the efficiency of restoration efforts, integrated approaches accounting for both local and regional drivers remains a priority.

Keywords: Benthic macroinvertebrates, Community structure, Ecological restoration, Exotic species, Riverbank Soil bioengineering

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Though neuroscientists have historically relied upon measurement of established nervous systems, contemporary advances in bioengineering have made it possible to design and build artificial neural tissues with which to investigate normative and diseased states [[1], [2], [3], [4], [5]] however, their potential to display features of learning and memory remains unexplored. Here, we demonstrate response patterns characteristic of habituation, a form of non-associative learning, in 3D bioengineered neural tissues exposed to repetitive injections of current to elicit evoked-potentials (EPs). A return of the evoked response following rest indicated learning was transient and partially reversible. Applying patterned current as massed or distributed pulse trains induced differential expression of immediate early genes (IEG) that are known to facilitate synaptic plasticity and participate in memory formation [6,7]. Our findings represent the first demonstration of a learning response in a bioengineered neural tissue in vitro.

Keywords: Learning, Bioengineering, Evoked-potentials, Synaptic plasticity, Habituation

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In the last decades, soil bioengineering has gained considerable popularity worldwide, especially in hillslope, riverbank, and earth embankment stabilisation works. The use of plants as a building material transfers the plant multifunctionality within engineering structures and meets the demand rising from society for more environmental-friendly approaches to structure design. In addition, soil bioengineering approach complies with public policies, such as EU strategies concerning the green infrastructures, the circular economy and the green deal, as well as the global framework defined by the Global Goals for Sustainable Development.
Despite the widespread use of soil bioengineering techniques and their adherence to the new directions of public policies, however, quantitative and temporal aspects of soil bioengineering approach are not fully considered. Construction criteria typical of civil engineering approaches, such as safety, serviceability and duration, need to be evaluated and fulfilled by bioengineering measures in an analog way as for technical construction, with the additional effort to consider spatial and temporal variability of their properties.
In particular, it must be considered at the same time the dynamic temporal development of vegetation (especially the dynamic of root reinforcement) and the decrease in strength of some additive construction material (e.g. wood decay). A comprehensive design scheme, comparable with the one for conventional engineering structures, is still lacking.
In this paper, knowledge and tools aiming to address the above issues, are reviewed, with particular reference to points associated with the structural stability of soil bioengineering structures for shallow landslide stabilisation. The paper:
-provides the background to the traditional engineering design for slope stabilisation, and the normative state of the art of geotechnical and construction design, as well as the residual risk of slope stabilisation;
-considers the temporal issues associated with the vegetation and the effect of soil bioengineering structures on the stability of natural, man-made, and anthropogenically influenced slopes;
-develops a decision framework for soil bioengineering applications that explicitly considers quantitative and temporal aspects of soil bioengineering approach, highlighting critical parameters governing the design with vegetation against shallow slope instability;
-critically debates the issues of the quantifiability of vegetated slopes and the use of permanent and temporary inert material.

Keywords: Soil bioengineering, Slope stabilisation, Geotechnical works, Vegetation, Civil engineering

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Temporal efficiencies of soil bioengineering techniques to mitigate geo-hydrological risks, Ecological Engineering Volume 170, November 2021, 106338

Natural hazards such as landslides, soil erosion and floods are increasingly affecting many regions of the world in relation to ongoing climate change and the abandonment of rural areas. In the last decades, the need to mitigate such phenomena and preserve natural resources, including landscapes, has motivated a number of local and national authorities to promote the use of soil bioengineering techniques. Consequently, these techniques have been increasingly used with variable success rates. This study analysed the efficiencies of different bioengineering structures to mitigate geo-hydrological risks by examining the interventions installed between 2007 and 2013 in the Avellino Province southern Italy. To this end, a specific project consistency analysis and functionality classification were carried out and the causes of inefficiencies were identified. The analysis showed that after a few years, only a small number of the installed bioengineering structures were fully functional and efficient. Overall, the installed structures were generally affected by maintenance issues and in many cases they suffered from design and execution issues, inducing a generally lower degree of efficiency, with most of them

classified as 'not very efficient'. The conclusions of this work are that i) the long-term efficiency of a bioengineering structure is related to its correct design, installation, and maintenance; ii) the design of a bioengineering structure should account for the geological, geotechnical and hydrological characteristics of the area of interest, and iii) maintenance must not affect the short-term efficiency of a structure, but may affect the long-term efficiency.

Keywords: Bioengineering techniques, Land degradation, Landslide, Flood, Soil erosion, Geo-hydrological risks

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Soil bioengineering for riverbank stabilization involves the use of living plant materials to treat unstable or eroding riverbanks. These near-natural structures may harbor a higher plant richness and vegetation cover compared to classical civil engineering structures such as ripraps, but little information exists on vegetation dynamics during secondary succession on stabilized riverbanks. We hypothesized that soil bioengineering, by means of active introduction of early successional Salix shrubs, can foster successional trajectories of riparian plant communities, unlike civil engineering. We sampled three types of riverbank stabilization structures: pure bioengineering structures, mixed structures (combining riprap and bioengineering techniques) and ripraps, across a 14-year sequence on 42 sites located along 23 different streams running through the foothills of the Alps and the Jura Mountains (France and Switzerland). We quantified species richness and density and compared the temporal patterns of four groups of species that normally appear sequentially in natural succession on riverbanks (ruderal, hygrophilous, shade-tolerant, competitive species), as well as non-native species. Plant community composition differed greatly between ripraps and the two types of bioengineered sites, and ligneous species typical of advanced successional stages (Cornus sanguinea, Corylus avellana) spontaneously established in the oldest bioengineered sites. In general, richness of total species was higher in stabilization structures using soil bioengineering (including mixed structures) than in riprapped sites. In particular, the number of shade-tolerant and competitive species in bioengineered sites was double that found at ripraps after 14 years. Yet, richness of shade-tolerant species increased over time only on purely bioengineered sites, and their density there was almost twice that in mixed structures. Neither the type of stabilization structure nor time explained the variability in richness and density of non-native species across sites. Our study showed that along streams running through foothills, where erosion processes are usually intense, vegetation of bioengineered riverbanks exhibits successional dynamics similar to those theoretically found in natural conditions. Bioengineering can therefore foster ecological processes while stabilizing eroding riverbanks along foothill streams, thus satisfying human needs for infrastructure protection with less impact on the riparian ecosystem than riprap structures.

Keywords: Bioengineering, Mixed techniques, Ripraps, Riverbank stabilization, Vegetation succession, Willow fascines

Pollen Biotechnology

Sha Yan[ac], Kai Wang[a], Xiaoying Wang[a], Aiqun Ou[a], Feiran Wang[a], Liming Wu[ab], Xiaofeng Xue[a] (a. Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, Beijing 100093, China, b. Innovation Research Team of Risk Assessment for Bee Products Quality and Safety of the Ministry of Agriculture, Beijing 100093, China, c. College of Food Science and Engineering, Shanxi Agricultural University, Taigu 030801, China) **Effect of fermented bee pollen on metabolic syndrome in high-fat diet-induced mice, Food Science and Human Wellness, Volume 10, Issue 3, May 2021, Pages 345-355**

Bee pollen has potential in preventing metabolic syndrome (MetS). The present study aimed to investigate the effect of yeast-fermented wall-broken bee pollen (YB) intervention on ICR mice with MetS induced with a high-fat (HF) diet. After YB intervention in mice for 16 weeks, the effect on alleviating MetS was evaluated based on MetS serum parameters, hepatic oxidant status markers and gut microbial populations. The results of animal experiment showed that YB intervention attenuated MetS. Based on multivariate statistical analysis results, YB treatment significantly increased glutathione S-transferase (GST) and catalase (CAT) activities and decreased the malondialdehyde (MDA) level in the liver. Further investigation showed that YB restored the Nrf-2-Keap-1 pathway to alleviate oxidative stress. Additionally, gut microbial community analysis revealed that YB restored the increase in the Firmicutes to Bacteroidetes (F/B) ratio (6.94 for the HF group and 3.74 for HF + YB group) and improved Lactobacillus and Lactococcus abundance induced by the HF diet. Overall, YB improved function and prevented MetS by modulating the gut microbiota and alleviating oxidative stress.

Keywords: Bee pollen, fermentation, Gut microbial community, Metabolic syndrome

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Knowledge gap on the reproductive biology of orphan crops is a major challenge to their cultivar development and genetic improvement. This study described the reproductive organs and phenology, assessed receptivity of stigma versus anther dehiscence, and examined pollen viability and germination in Kersting's groundnut. Experiments were conducted on nine morphotypes in a randomized complete block design with three replications in a screenhouse. Phenological observations were made on 1026 flower buds. Anther dehiscence was determined through microscopic observations while receptivity of the stigma was assessed using the hydrogen peroxide test. Pollen viability was assayed using histochemical staining. In vitro germination and pollen tube growth were assessed for up to 72h. Flowers were bisexual and incompletely protogynous, and spontaneous self-pollination was favoured by style bending. Flowering and fruiting were classified into six developmental stages each. Timing of all stages differed significantly ($P<0.001$) among morphotypes. The stigma was receptive 1-2 days before anther dehiscence and remained so until each flower wilted. Anthesis started 3 days from young bud

appearance and lasted between 2–4 days depending on the morphotype. Pollen viability rates were very high (88–98%) and differed among morphotypes (P<0.001). Pollen germination rates were low (8–37%) and varied among morphotypes and anthesis stages (P<0.05). Pollen tube growth varied significantly among morphotypes, anthesis stages and incubation time. The morphotype ZHLA-2 exhibited the highest reproductive vigour and could be recommended as pollen donor for hybridization. The study provides information on the best time and stage for emasculation and is expected to help breeders optimise a hybridisation protocol.

Keywords: Style movement, Protogyny, Forced self-pollination, Anther dehiscence, Stigma receptivity, Pollen tube growth

Xiang Zhou[1], Jun Lu[23], Yuqin Zhang[4], Jingzhe Guo[1], Wenwei Lin[14], Jaimie M. Van Norman[1], Yuan Qin[5], Xiaoyue Zhu[4], ZhenbiaoYang[16] (1. Department of Botany and Plant Sciences and Institute for Integrative Genome Biology, University of California, Riverside, Riverside, CA 92521, USA, 2. Shanghai Center for Plant Stress Biology, Chinese Academy of Sciences, Shanghai, China, 3. National Key Laboratory of Plant Molecular Genetics, Institute of Plant Physiology and Ecology, Shanghai Institutes for Biological Sciences, Shanghai 200032, People's Republic of China, 4. FAFU-UCR Joint Center for Horticultural Biology and Metabolomics, Haixia Institute of Science and Technology, Fujian Agriculture and Forestry University, Fuzhou, Fujian 350002, China, 5. Fujian Provincial Key Laboratory of Haixia Applied Plant Systems Biology, Center for Genomics and Biotechnology, College of Agriculture, Fujian Agriculture and Forestry University, Fuzhou 350002, China) **Membrane receptor-mediated mechano-transduction maintains cell integrity during pollen tube growth within the pistil, Developmental Cell, Volume 56, Issue 7, 5 April 2021, Pages 1030-1042.e6**

Invasive or penetrative growth is critical for developmental and reproductive processes (e.g., pollen tube penetration of pistils) and disease progression (e.g., cancer metastasis and fungal hyphae invasion). The invading or penetrating cells experience drastic changes in mechanical pressure from the surroundings and must balance growth with cell integrity. Here, we show that Arabidopsis pollen tubes sense and/or respond to mechanical changes via a cell-surface receptor kinase Buddha's Paper Seal 1 (BUPS1) while emerging from compressing female tissues. BUPS1-defective pollen tubes fail to maintain cell integrity after emergence from these tissues. The mechano-transduction function of BUPS1 is established by using a microfluidic channel device mimicking the mechanical features of the in vivo growth path. BUPS1-based mechano-transduction activates Rho-like GTPase from Plant 1 (ROP1) GTPase to promote exocytosis that facilitates secretion of BUPS1's ligands for mechanical signal amplification and cell wall rigidification in pollen tubes. These findings uncover a membrane receptor-based mechano-transduction system for cells to cope with the physical challenges during invasive or penetrative growth.

Keywords: pollen tubes, invasive growth, cell wall integrity, ROP1 GTPase, pectin, RALF, CrRLK1L, TipChips, mechanosensing

Xinjian Zou[a], Ling Li[a], Fanglei Liao[ab], Wenrong Chen[ab] (a. College of Chemistry and Life Sciences, Zhejiang Normal University, Jinhua, 321004, China, b. Zhejiang Provincial Key Laboratory of Biotechnology on Specialty Economic Plants, Zhejiang Normal University, Jinhua, 321004, China) **iTRAQ-based quantitative proteomic analysis reveals NtGNL1-dependent regulatory network underlying endosome trafficking for pollen tube polar growth, Plant Physiology and Biochemistry, Volume 161, April 2021, Pages 200-209**

Endosome trafficking has been reported to play an essential role in pollen tube polar growth and NtGNL1 (Nicotiana tabacum GNOM-LIKE 1) regulates the polar growth through endosome trafficking. However, the regulation network and detailed molecular mechanisms underlying endosome trafficking remain unclear. Here,

comparative proteomic analysis was carried out to survey the overall effect of NtGNL1 on pollen tube polar growth and NtGNL1-dependent endosome trafficking. With multiple comparative systems (RNAi, Wild type, and BFA or wortmannin treatments), 481 distinct proteins were identified including 43 common DEPs (differentially expressed proteins), of which 16 significant DEPs were common among RNAi, BFA, and wortmannin treated pollen tubes, indicating their close relation to the endosome trafficking. GO annotation indicates that the vesicle trafficking of gnl1HE pollen tubes differs from that of the BFA and wortmannin treated pollen tubes in the COPII-coated vesicle budding process. KEGG pathway analysis suggests that the Pentose phosphate pathway is critical for the NtGNL1-dependent endosome trafficking. Yeast two-hybrid further confirmed that the NtGNL1-Sec7 domain interacted strongly with VPS32.2, TCTP, PIS2, and PDIL2-1, suggesting that the core functional region of NtGNL1 is the Sec7 domain. Therefore, NtGNL1 likely functions via its Sec7 binding with these proteins to affect endosome trafficking. Our results provide a clear outline of proteins involving in NtGNL1-dependent endosome trafficking and valuable clues for understanding the regulatory mechanism of NtGNL1 guided pollen tube polar growth.

Keywords: Endosome trafficking, iTRAQ, NtGNL1, Polar growth, COPII-Coated vesicle, Pentose phosphate pathway

Jianfeng Liu, Jianying Liu, Xingzheng Zhang, Heng Wei, Jiahua Ren, Cheng Peng, Yunqing Cheng (Jilin Provincial Key Laboratory of Plant Resource Science and Green Production, Jilin Normal University, Siping, Jilin Province, 136000, China) **Pollen tube in hazel grows intermittently: Role of Ca2+ and expression of auto-inhibited Ca2+ pump, Scientia Horticulturae, Volume 282, 10 May 2021, 110032**

Owing to the absence of the ovary when the female inflorescence blooms, hazel pollen tubes show an obvious intermittent growth pattern, which has an important impact on the number of fruits per cluster and yield, but little is known about the mechanisms governing this process. Spray treatments of Ca2+ and Ca2+-ATPase activator 5-aminolevulinic acid (ALA) in field experiment showed that Ca2+ treatments inhibited pistillate inflorescence drop and produced more fruits, while the effects of ALA treatments was just opposite to that of calcium treatments. Highly accumulated Ca2+ was observed at the rear part of the stigma and in the ovary primordial cell layers. Under in vitro culture conditions, pollen germination ratio and tube length were promoted and inhibited by Ca2+ and ALA, respectively. ALA treatment reduced the Ca2+ concentration in pollen tube, which was not conducive to the formation of a tip-focused Ca2+ gradient in pollen tube. The hazel genome encoded 17 Ca2+-ATPases, including 14 auto-inhibited Ca2+-ATPases and three ER-type Ca2+-ATPases. Hazel Ca2+-ATPase family proteins, including 11 common transmembrane domains, were highly conserved. Of 17 Ca2+-ATPases, qRT-PCR analysis showed that ChACA1 and ChECA2 were highly expressed in pollen tubes. In the range of 0–1.3 mM Ca2+, Ca2+ fluorescence intensity in pollen tubes, expression of ChACA1 continued to rise simultaneously, and they reached their maximum at 1.3 mM Ca2+, then declined at 1.6 mM Ca2+, which was consistent and inconsistent with changing trends of pollen tube length and ChECA2 respectively. Analysis of enzyme activity in pollen tubes showed that Ca2+-ATPase activity was promoted by both Ca2+ and ALA treatments significantly. Our findings suggested that ChACA1 may act as a key regulator of pollen germination and pollen tube development in hazel, and provide new insight into the mechanisms of unique pollen tube intermittent growth in hazel.

Keywords: Hazel, Ca2+-ATPase, Pollen tube, Intermittent growth, qRT-PCR

Rita Végh[a], Mariann Csóka[a], Csilla Sörös[b], László Sipos[c] (a. Hungarian University of Agriculture and Life Sciences, Institute of Food Science and Technology, Department of Nutrition, 1118 Budapest, Somlói út 14-16., Hungary, b. Hungarian University of Agriculture and Life Sciences, Institute of Food Science and Technology, Department of Food Chemistry and Analytical Chemistry, 1118 Budapest, Villányi út 29-43., Hungary, c. Hungarian University of Agriculture and Life Sciences, Institute of Food Science and Technology, Department of Postharvest, Commercial and Sensory Science, 1118 Budapest, Villányi út 29-43., Hungary) **Food safety hazards of bee pollen – A review, Trends in Food Science & Technology, Volume 114, August 2021, Pages 490-509**

Background: Bee pollen is a natural apicultural product that is becoming popular among health-conscious consumers due to its wide variety of nutrients and bioactive substances. However, only a limited number of countries have established requirements for the quality and safety of the product so far.
Scope and approach: In this review, recent findings on the food safety risks of bee pollen and data about the concentration of toxic substances detected in the products are summarized. Pollen loads may become contaminated from the environment with pesticides, heavy metals, metalloids and mycotoxin-producing molds. In addition, pollen of certain plant species initially contain hepatotoxic pyrrolizidine alkaloids in relatively large concentrations. Allergens and pollen grains from genetically modified plants may also be present in these products. Based on literature data, a risk assessment was conducted for the most common pesticide active substances (chlorpyrifos, fluvalinate, carbendazim, thiacloprid), toxicologically important elements (arsenic, cadmium, mercury, lead), common mycotoxins (aflatoxin-B1, ochratoxin-A, fumonisins, zearalenone, deoxynivalenol, T-2 toxin) and pyrrolizidine alkaloids.
Key Findings and Conclusions: Our results suggest that pesticide residues usually do not pose a chronic risk to consumers, but the estimated acute exposure values can be close to the acute reference dose (ARfD). Arsenic, cadmium, lead and pyrrolizidine alkaloid content of bee pollen potentially pose a health risk to consumers, therefore it is recommended to set a maximum limit for these substances and monitor their concentration in commercially available products. Since scientific data regarding the mercury and mycotoxin content of bee pollen is incomplete, further studies are needed in order to summarize the food safety hazards of bee pollen pollutants.

Keywords: Bee pollen, Apiculture, Pesticide residue, Heavy metal, Fungi, Mycotoxin, Pyrrolizidine alkaloid, Allergenic, Risk assessment, Food safety, Margin of exposure

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Manganese (Mn) serves as an essential cofactor for many enzymes in various compartments of a plant cell. Allocation of Mn among various organelles thus plays a central role in Mn homeostasis to support metabolic processes. We report the identification of a Golgi-localized Mn transporter (named PML3) that is essential for rapid cell elongation in young tissues such as emerging leaves and the pollen tube. In particular, the pollen tube defect in the pml3 loss-of-function mutant caused severe reduction in seed yield, a critical agronomic trait. Further analysis suggested that a loss of pectin deposition in the pollen tube might cause the pollen tube to burst and slow its elongation, leading to decreased male fertility. As the Golgi apparatus serves as the major hub for

biosynthesis and modification of cell-wall components, PML3 may function in Mn homeostasis of this organelle, thereby controlling metabolic and/or trafficking processes required for pectin deposition in rapidly elongating cells.

Key words: manganese transport, Golgi, pollen tube, cell wall

Yao Yang[ab], Qianwen Zhang[c], Junwen Zhang[a], Anqi Chen[b], Yanxin Chen[a], Shengyu Li[a], Mingde Ye[a], Xuan Xuan[c], Xiaokun Li[ab], Huacheng He[a], Jiang Wu[b] (a. College of Chemistry and Materials Engineering, Wenzhou University, Wenzhou, Zhejiang 325035, PR China, b. School of Pharmaceutical Sciences, Wenzhou Medical University, Wenzhou, Zhejiang 325035, PR China, c. Department of Dermatology, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, Zhejiang 325000, PR China) Natural pollen extract for photothermal therapy, Materials & Design, Volume 202, April 2021, 109573

Herein, we discovered that the sunflower sporopollenin exine capsule (SEC) is an effective photothermal agent. In vitro study finds that the spikes on the surface of the sunflower SEC and its structural integrity are the two key factors to determine the photothermal effect. In vivo melanoma mouse model proves that the sunflower SEC can effectively inhibit tumor growth by inducing cell apoptosis and reducing cell proliferation through the near-infra red light triggered photothermal therapy. The in vivo biosafety of the SEC is also validated. In consideration of its safety, uniform size distribution and abundant availability, the sunflower SEC will be a promising photothermal agent candidate for clinical translational application.

Keywords: Pollen, Photothermal, NIR, Melanoma, Extract

Biotechnology Policy Issue

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The OECD Council Recommendation on Recombinant DNA Safety Considerations is a legal instrument which has been in force since 1986. It outlines the safety assessment practices that countries should have in place for agricultural and environmental biotechnology. This article suggests possible updates to make it suitable for the modern era.

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

Agricultural Biotechnology

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The application of biological control agents for the management of plant pathogens and pests requires sustainable methods that can increase the global rates of food production and food safety. This strategy has contributed to minimizing various detrimental effects of agrochemicals that not only contaminate our environment, but also present many potential health hazards as well as contributing to climate change. Recent advancement in biotechnology have led to the isolation of novel microorganisms, characterization of their gene products and subsequent cloning in plants with a view to increasing their tolerance to both biotic and abiotic stresses. In addition to improving intimate interactions between microbes and plants, these technological advancements have also allowed manipulation of modes of action of different biological control agents toward enhancing their biocontrol potentials. Therefore, this review emphasizes already existing and recent advancements in molecular techniques that have been adopted in the management of plant diseases and pests for enhanced food security and improved agricultural productivity for providing safe food and a healthy environment.

Keywords: Biological control agents, CRISPR/Cas9, Genome editing, Genome sequencing, Insertional mutagenesis, Plant growth regulation, RNA-interference, Systemic induced resistance, Transposons

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Endophytes are emerging as integral components of plant microbiomes. Some of them play pivotal roles in plant development and plant responses to pathogens and abiotic stresses, whereas others produce useful and/or interesting secondary metabolites. The appreciation of their abilities to affect plant phenotypes and produce useful compounds via genetic and molecular interactions has paved the way for these abilities to be exploited for health and welfare of plants, humans and ecosystems. Here we comprehensively review current and potential applications of endophytes in the agricultural, pharmaceutical, and industrial sectors. In addition, we briefly discuss the research objectives that should be focused upon in the coming years in order for endophytes and their metabolites to be fully harnessed for potential use in diverse areas.

Keywords: Agriculture, Applications, Biotechnology, Endophytes, Medicine

Antoine L. Harfouche[1], Vasiliki Petousi[2], Richard Meilan[3], Jeremy Sweet[4], Tomasz Twardowski[5], Arie Altman[67] (1. Department for Innovation in Biological, Agro-food and Forest systems, University of Tuscia, Via S. Camillo de Lellis, Viterbo 01100, Italy, 2. Department of Sociology, University of Crete, Gallos Campus, 74100 Rethymno, Greece, 3. Department of Forestry and Natural Resources, Purdue University, 715 West State Street, West Lafayette, IN 47907, USA, 4. Sweet Environmental Consultants, 6 Green Street, Willingham, CB24 5JA Cambridge, UK, 5. Institute of Bioorganic Chemistry, Polish Academy of Sciences, Zygmunta Noskowskiego Street 12/14, 61-704 Poznan, Poland, 6. The Robert H. Smith Institute of Plant Sciences and Genetics in Agriculture, The Hebrew University of Jerusalem, Faculty of Agricultural, Food, and Environmental Quality Sciences, PO Box 12, Rehovot 76100, Israel, 7. The Lester and Sally Entin Faculty of Humanities, Unit of Culture Research, Tel Aviv University, PO Box 39040, Tel Aviv 6997801, Israel) **Promoting Ethically Responsible Use of Agricultural Biotechnology, Trends in Plant Science, Volume 26, Issue 6, June 2021, Pages 546-559**

Growing global demands for food, bioenergy, and specialty products, along with the threat posed by various environmental changes, present substantial challenges for agricultural production. Agricultural biotechnology offers a promising avenue for meeting these challenges; however, ethical and sociocultural concerns must first be addressed, to ensure widespread public trust and uptake. To be effective, we need to develop solutions that are ethically responsible, socially responsive, relevant to people of different cultural and social backgrounds, and conveyed to the public in a convincing and straightforward manner. Here, we highlight how ethical approaches, principled decision-making strategies, citizen-stakeholder participation, effective science communication, and bioethics education should be used to guide responsible use of agricultural biotechnology.

Keywords: bioethics education, ethical reasoning, plant biotechnology, public and political engagement, responsible research and innovation, science communication

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

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

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

Bioenergy

Elina Mäki, Lotta Kannari, Ilkka Hannula, Jari Shemeikka (VTT Technical Research Centre of Finland, P.O. Box 1000, VTT, FI-02044, Finland) Decarbonization of a district heating system with a combination of solar heat and bioenergy: A techno-economic case study in the Northern European context, Renewable Energy, Volume 175, September 2021, Pages 1174-1199

We study the role of solar heat in decarbonization of a Nordic district heating (DH) network, where most of the annual heat demand is satisfied with bioenergy. We use actual data from a Finnish municipality to create a dynamic model of the heating system with Apros® simulation software. With the help of modelling, we examine various decarbonization scenarios for the existing heating system, using different combinations solar thermal collectors, thermal energy storage (TES) and limitations on how and when solar heat can access the system. According to results, zero emissions during the summer can be achieved with annual solar share of 13.2% and at 44 €/MWh levelized cost of heat (LCoH), if the integration is supported by TES and a careful planning of solar heat integration. Our results show that a simple approach of pursuing for a maximal solar share does not necessarily lead to a reduction in carbon emission or in LCoH. In fact, aiming at higher solar shares of 15–25% in our case system, actually increase greenhouse gas emissions compared to the base case. This highlights the importance of focusing on emissions reductions instead of simple addition of renewable energy when DH utilities plan for solar heat investments.

Keywords: Solar heat, Biomass, Bioenergy, District heating, Flexibility, Energy production

Peng Liu[ab], Ao Li[a], Youmei Wang[ac], Qiuming Cai[a], Haizhong Yu[b], Yuqi Li[b], Hao Peng[ab], Qian Li[ab], Yanting Wang[ab], Xiaoyang Wei[a], Ran Zhang[ab], Yuanyuan Tu[ab], Tao Xia[ac], Liangcai Peng[ab] (a. Biomass & Bioenergy Research Centre, College of Plant Science & Technology, Huazhong Agricultural University, Wuhan, 430070, China, b. Laboratory of Biomass Engineering & Nanomaterial Application in Automobiles, College of Food Science & Chemical Engineering, Hubei University of Arts & Science, Xiangyang, China, c. College of Life Science & Technology, Huazhong Agricultural University, Wuhan, 430070, China) Distinct Miscanthus lignocellulose improves fungus secreting cellulases and xylanases for consistently enhanced biomass saccharification of diverse bioenergy crops, Renewable Energy, Volume 174, August 2021, Pages 799-809

Bioenergy crops provide enormous renewable biomass resources convertible for biofuel production, but lignocellulose recalcitrance fundamentally determines its enzymatic saccharification at high cost and low efficiency. In this study, total 30 diverse Miscanthus lignocellulose substrates were incubated with T. reesei strain to secret lignocellulose-degradation enzymes, and their major wall polymers features (cellulose crystallinity, hemicellulose arabinose and lignin H-monomer) were meanwhile examined with distinct impacts on the enzyme activities. Using characteristic Miscanthus (Msi62) de-lignin residue as inducing substrate with the reesei strain, this study detected that the Msi62-induced enzymes were of consistently higher enhancements on enzymatic saccharification of various lignocellulose residues examined in 17 grassy and woody bioenergy crops, particularly for the hemicellulose hydrolyses, compared to other two reesei-secreted cellulases and three commercial enzymes. Notably, based on SDS-gel protein separation profiling and LC-MS/MS analysis, the Msi62-induced enzymes consist of distinct cellulases (CBHI, BG, EGII) compositions and high-activity xylanases. Therefore, this study has demonstrated an applicable approach to achieve the optimal cellulases and xylanases cocktails that enable for low-costly and high-efficient enzymatic saccharification of diverse lignocellulose sources, providing a potential strategy for large-scale biofuel production in all major bioenergy crops.

Keywords: Cellulases, Xylanases, Biomass saccharification, Trichoderma reesei, Miscanthus, Bioenergy crops

Muhammad Nurariffudin Mohd Idris[a], Haslenda Hashim[a], Sylvain Leduc[b], Ping Yowargana[b], Florian Kraxner[b], Kok Sin Woon[c] (a. Process Systems Engineering Centre (PROSPECT), School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310, UTM Johor Bahru, Skudai, Johor, Malaysia, b. Ecosystems Services and Management (ESM), International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, A-2361, Laxenburg, Austria, c. School of Energy and Chemical Engineering, Xiamen University Malaysia, Jalan Sunsuria, Bandar Sunsuria, 43900, Sepang, Selangor, Malaysia) **Deploying bioenergy for decarbonizing Malaysian energy sectors and alleviating renewable energy poverty, Energy, Volume 232, 1 October 2021, 120967**

Due to the capital cost of co-firing being lower than other biomass technologies, the transformation of coal plants into co-firing facilities can potentially minimize the bioenergy cost needed to meet energy decarbonization targets. This study analyzes the impact of the co-deployment of co-firing and dedicated biomass technologies in contributing to the bioenergy cost reduction for country-level energy systems using a spatio-temporal techno-economic optimization model. Malaysia is used as a case in the analysis. Different scenarios were developed to assess the robustness of the cost reduction potential under the impact of incremental CO2 reduction targets and supply chain cost parameter variations. Our results suggest that the multi-sectoral deployment of bioenergy in energy systems is key to meeting decarbonization targets at the national scale. By also considering co-firing in the biomass technological pathway, up to 27% of bioenergy cost reduction can be enabled in the baseline case. The decrease in the supply chain cost parameter values further enhances the cost reduction potential; bioenergy costs can be reduced up to threefold. The findings have shown that developing countries such as Malaysia can benefit from the use of their rich agricultural resources to cost-effectively alleviate renewable energy poverty.

Keywords: Bioenergy, Renewable energy, Decarbonization, Spatial analysis, Optimization, Oil palm biomass

Zigong Cai[a], Fei Ye[a], Zefei Xie[a], Li Zhang[b], Ting Cui[b] (a. South China University of Technology, Guangzhou, 510640, PR China, b. Guangdong University of Finance and Economics, Guangzhou, 510640, PR China) **The choice of cooperation mode in the bioenergy supply chain with random biomass feedstock yield, Journal of Cleaner Production, Volume 311, 15 August 2021, 127587**

A successful cooperation mode between bioenergy producers and farmers can effectively promote the supply of biomass feedstock, which plays an important role in the bioenergy industry. In this study, we examine two prevailing cooperation modes in bioenergy supply chain, namely contract farming (CF) and land as shares (LS). This study assesses how each cooperation mode influences the planting acreage, the feedstock quality and the profits of supply chain participants. Under CF, the farmer and the bioenergy producer sign a contract in which the bioenergy producer purchases all feedstock produced by the farmer. Under LS, the farmer converts their land use rights into company shares, so that the bioenergy producer will share part of sales revenue with the farmer. First, we find that the optimal planting scale of biomass feedstock under LS is larger than that under CF when the bioenergy market size is sufficiently large. If the market size is relatively small, the supply quantity of biomass feedstock under LS depends on the marginal value of feedstock quality. Second, when the bioenergy market is sufficiently large, the farmer and the bioenergy producer under LS can achieve a win-win situation, which improves the reliability of the bioenergy supply chain. Third, we extend our model to the case where the government implements subsidies for biomass feedstock. We find that when the subsidy is high enough, the biomass feedstock quantity under LS will be larger. In addition, government subsidy does not necessarily improve the profit of all supply chain participants and excessive government subsidy may adversely affect the reliability of the bioenergy supply chain.

Keywords: Bioenergy supply chain, Contract farming, Land as shares, Government subsidy

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orldwide modern-bioenergy is getting more attention in terms of policy-support and deployment, however in Pakistan, this resource is not being used to its fullest. Though traditional biomass is being used by most of the rural population, but the use of modern biomass as an energy source is dismally low, which is a result of poor policymaking and its implementation. During the 1970s the first initiative was taken for the development of small scale (household/community level) bioenergy projects in Pakistan. Later, policies were enacted to utilize the bioenergy resources, especially bagasse-powered bioenergy generation. This study reviewed the policies for their effectiveness in the development of bioenergy in Pakistan. Policies are compared for different aspects, including regulatory, fiscal, political and institutional. Furthermore, effectiveness is compared in terms of energy security, environmental impact, economic impact, and energy equity. The comparison has been made based on a total of 26 parameters. Finally, the study presents the challenges and recommendations for policy-making, in Pakistan, for maximum utilization of bioenergy.

Keywords: Bioenergy, Bioenergy policy, Bioenergy policy evaluation, Pakistan

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As climate change is likely to alter regional water availability via shifted precipitation patterns that affect agricultural practices, the analysis of the effectiveness of bioenergy promotion policies and efficiency of bioenergy development requires a thorough consideration of the interrelationships among water, agriculture, and renewable energy development in the context of climate change. We propose a stochastic, price-endogenous mathematical programming with recourse model by linking a well-established water resource model to a bioenergy production framework to investigate the aggregate economic and environmental effect of bioenergy production. This study theoretically analyzes the optimal resource allocation and production conditions of the model, and empirically tests the goodness of the proposed model with observed data. The results show that the proposed framework is likely to reflect the actual bioenergy production in the face of climate-induced impacts, and at small to moderate climate impacts the bioenergy production is likely to be more influenced by the energy and emission prices than by climate-induced yield changes. In addition, while the reduction in precipitation would not result in significant effects on bioenergy production, a substantial change in land use and cropping decisions might occur.

Keywords: Efficiency, Optimal resource allocation, Policy analysis, Renewable energy, Uncertainty

Andrew Welfle, Ali Alawadhi (School of Mechanical, Aerospace and Civil Engineering, The University of Manchester, Oxford Road, Manchester, Greater Manchester, M13 9PL, United Kingdom) **Bioenergy opportunities, barriers and challenges in the Arabian Peninsula – Resource modelling, surveys & interviews, Biomass and Bioenergy, Volume 150, July 2021, 106083**

The link between energy and climate change is fundamental - energy accounting for two-thirds of global greenhouse gas emissions. Of all countries, those of the Arabian Peninsula are synonymous with energy and the supply and use of fossil fuels. However driven by commitments to international climate change agreements the Gulf Cooperation Council (GCC) countries have been developing alternative energy strategies with targets for renewables. This paper presents the outputs of biomass resource modelling analyses that identify bioenergy opportunities across the region. Municipal wastes are found to represent a leading opportunity for bioenergy with a combined 19.35 Mtpa of resource across the GCC currently being sent to landfill that could otherwise be used for energy. The research finds that up to 22.5% of GCC country electricity could be generated from bioenergy technologies fuelled by indigenous biomass resources. Interviews were undertaken with Director-level GCC individuals from industry and government and a survey was facilitated to gain an understanding of perceptions of bioenergy and the potential barriers to its greater deployment. There was majority support for renewable technologies and for bioenergy, however a majority of respondents were found to be 'not willing' or 'unsure' when asked if they would be willing to take any individual actions such as recycling to support bioenergy schemes. High availability of cheap fossil fuels, stimulated by fossil fuel subsidies is identified as the greatest barrier to renewables. The GCC's commitment to international climate and sustainability targets represents an opportunity to develop a strategy to phase out fossil fuels.

Keywords: Bioenergy, Resource, Perceptions, Opportunities, Barriers, Middle east, GCC, Arabia

Mohd Alsaleh, A.S. Abdul-Rahim, Mansur Muhammad Abdulwakil (a. School of Business and Economics, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia) The importance of worldwide governance indicators for transitions toward sustainable bioenergy industry, Journal of Environmental Management, Volume 294, 15 September 2021, 112960

his study examined the impact of worldwide governance indicators on the sustainability of the bioenergy industry in selected European countries for the period 1996–2018. Applying the Fixed Effect (FE) Model, the results reveal that the bioenergy industry can significantly grow by improving the quality of worldwide governance indicators in European countries, especially in Western European Countries (WEC). Government effectiveness, rule of law, regulatory quality, and voice and accountability are found to be increasing the growth of the bioenergy industry. Precisely, the results further show that the magnitude of the effect of government effectiveness, voice and accountability, and Gross Domestic Product (GDP) on bioenergy output is higher in Western European Countries (WEC) as compared to the Central and Eastern European Countries (CEEC). Also, the findings further elaborate that the significant positive impact of regulatory quality and rule of law on bioenergy output is higher in CEEC countries compared to the WEC countries. The finding implies that the growth of the bioenergy industry in European countries can be effectively increased by improving the practice and quality of worldwide governance indicators. The study recommends for European countries to increase the efficiency of worldwide governance in their bioenergy industry to increase the sustainability of bioenergy production and reduce Dioxide Carbon (CO2) emissions. Policymakers in these countries should also invest more in worldwide governance to increase its effectiveness and transparency in the bioenergy industry. The authorities should equally emphasize the effectiveness and transparency of worldwide governance indicators to attain bioenergy security and lessen the dependence on fossil fuels.

Keywords: Worldwide governance, Bioenergy industry, Sustainability, European countries

Nano Biotechnology

Muhammad Bilal[a], Clara Dourado Fernandes[bc], Tahir Mehmood[d], Fareeha Nadeem[d], Qudsia Tabassam[e], Luiz Fernando Romanholo Ferreira[bc] (a. School of Life Science and Food Engineering, Huaiyin Institute of Technology, Huaian 223003, China, b. Graduate Program in Process Engineering, Tiradentes University, Murilo Dantas Avenue, 300, Farolândia, 49032-490 Aracaju, Sergipe, Brazil, c. Waste and Effluent Treatment Laboratory, Institute of Technology and Research (ITP), Tiradentes University (UNIT), Murilo Dantas Avenue, 300, Farolândia, 49032-490 Aracaju, Sergipe, Brazil, d. Institute of Biochemistry and Biotechnology, University of Veterinary and Animal Sciences-UVAS, Lahore 54000, Pakistan, e. Institute of Chemistry, University of Sargodha, Sargodha 4010, Pakistan) **Immobilized lipases-based nano-biocatalytic systems — A versatile platform with incredible biotechnological potential, International Journal of Biological Macromolecules, Volume 175, 1 April 2021, Pages 108-122**

Lipases belong to α/β hydrolases that cause hydrolytic catalysis of triacylglycerols to release monoacylglycerols, diacylglycerols, and glycerol with free fatty acids. Lipases have a common active site that contains three amino acid residues in a conserved Gly-X-Ser-X-Gly motif: a nucleophilic serine residue, an acidic aspartic or glutamic acid residue, and a basic histidine residue. Lipase plays a significant role in numerous industrial and biotechnological processes, including paper, food, oleochemical and pharmaceutical applications. However, its instability and aqueous solubility make application expensive and relatively challenging. Immobilization has been considered as a promising approach to improve enzyme stability, reusability, and survival under extreme temperature and pH environments. Innumerable supporting material in the form of natural polymers and nanostructured materials is a crucial aspect in the procedure of lipase immobilization used to afford biocompatibility, stability in physio-chemical belongings, and profuse binding positions for enzymes. This review outlines the unique structural and functional properties of a large number of polymers and nanomaterials as robust support matrices for lipase immobilization. Given these supporting materials, the applications of immobilized lipases in different industries, such as biodiesel production, polymer synthesis, additives, detergent, textile, and food industry are also discussed.

Keywords: Lipases, Enzyme immobilization, Nanostructured carriers, Cosmetics, Textile, Detergent, Food industry, Organic synthesis

Rima Kumari[a], Devendra Pratap Singh[b] (a. Department of Botany, Langat Singh College (A constituent College of BRA Bihar University), Muzaffarpur, Bihar, India, b. Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow, India) **Chapter 21 - Nano-Biotechnological Approach of Plant Genetic Engineering, Policy Issues in Genetically Modified Crops, A Global Perspective 2021, Pages 481-494**

Genetic engineering of plants has province role in augmenting agricultural productivity and ensuring food security via inducing desired genetic changes in plant. However, delivery of desired biomolecule in plant system through conventional genetic engineering have some key challenges. Current emerging trends of plant nanotechnology have created great opportunity to overcome these drawbacks and nanoparticle assisted delivery of specific genes (i.e., DNA, RNA) and protein is an advanced scope in plant genetic engineering. It is proven as highly efficient approach for successful delivery of specific genes in plant system, as it has strong efficacy to pass on/ traverse rigid and multi-layered plant cell wall structure, as well as having broad compatibility with various plant species. Nanotechnology inferred devices (i.e., nanocapsules, nanotubes, nanofibers, nano-sheets), used as nano-vector/ nanocarriers for efficient delivery of active ingredients to specific target sites in plants and induce genetic transformation in plant in desired way. Recently, nanoparticle mediated delivery of important

biomolecules (DNA, RNA and protein) into plant system without using ballistic force externally has been successfully documented by various nanotechnologist, via using different nanomaterial, that is, single walled carbon nanotube (SWCNTs), mesoporous silicon based nanotube NPs (MSNs), polymeric nanotubes DNA nanostructures, peptide-based nanomaterials etc. Recently, solar rechargeable antimicrobial nanofibrous membranes (RNMs) were developed by nano-biotechnological researchers that can efficiently produce some specific reactive oxygen species (ROS) to resist against micro pathogens, so on acts efficiently in improving plant resistance against different biotic and abiotic stress. The nano-mediated biomolecule delivery exhibit several advantages; i.e., high extensibility/ transmissibility through cell wall, efficient compatibility of nano-carriers with plant biomolecules refers them for efficient delivery of intact DNA into plant, as well as acts as promising material for delivery of plasmid DNA into intact plants, immature plant tissues and protoplasts, executed in less time. In recent decade, nano-technologists have great concern on exploring nanomaterial -based genetic delivery strategies for different genetic cargos by using novel nano-genetic tools. The previous reports are promising tool to enforce further exploration of nanomaterial as genetic engineering tool to transient plant biomolecule delivery platform. Present chapter is an attempt to document foreseen and co-ordinated interdisciplinary researches on role of nanotechnology in bio cargo delivery in plant system, addressing the advances, scopes and applicability of nano-based genetic methods, its limitations and further research perspectives for ensuring their safer use in future food security and sustainability in agriculture.

Keywords: genetic engineering, nanomaterial, carbon nanotube, antimicrobial nanofibrous membrane, biomolecule delivery, agriculture

Hassan Karimi-Maleh[abc], Seyed Jafar Mousavi[b], Majid Mahdavian[b], Mouj Khaleghi[d], Sajjad Bordbar[e], Mehmet Lütfi Yola[f], Rozhin Darabi[g], Mei Liu[h] (a. School of Resources and Environment, University of Electronics Science and Technology of China (UESTC), 611731, China, b. Department of Chemical Engineering and Energy, Quchan University of Technology, Quchan, Iran, c. Department of Chemistry, University of Johannesburg, P.O. Box 17011, Doornfontein Campus, Johannesburg, 2028, South Africa, d. Department of biology, Faculty of Science, Shahid Bahonar University of Kerman, Kerman, Iran, e. Department of Metals, Institute of Materials Science and Engineering, Graduate University of Advanced Technology, Kerman, Iran, f. Hasan Kalyoncu University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Gaziantep, Turkey, g. Department of Analytical Chemistry, Faculty of Chemistry, University of Kashan, Kashan, Islamic Republic of Iran, h. School of Petrochemical Engineering, Liaoning Petrochemical University, Fushun, 113001, Liaoning, China) **Effects of silver nanoparticles added into polyurea coating on sulfate-reducing bacteria activity and electrochemical properties; an environmental nano-biotechnology investigation, Environmental Research, Volume 198, July 2021, 111251**

In the present work, Ag nanoparticles were added to polyurea coating in order to improve its antibacterial and electrochemical properties in sulfide-reducing bacteria-containing media. To this end, Ag nano-powder was mixed with two component polyuria, and then the antibacterial behavior of the nanocomposite coating was studied in sulfate-reducing bacteria (SRB)-containing medium. The results revealed the inhibitory effects of nanocomposite coating on the formation of SRB biofilms on the samples. Moreover, the SRB population decreased in contact with the Ag nanoparticles-mixed coating over 7 days. Investigation of the growth and activity of the bacteria represented the effective antibacterial properties of Ag nanoparticles in the polyurea matrix. Furthermore, EIS (electrochemical impedance spectroscopy) measurements indicated that the corrosion properties of the nanocomposite coating improved considerably over 7 days. The coating resistance increased 2 times by adding Ag nanoparticles after 1 day and 3.3 times after 7 days. In accordance with the same results, the charge transfer resistance increased 1.5 times and 1.1 times by adding Ag nanoparticles after 1 day and 7 days, respectively. The improvement in the protective properties of the nanocomposite coating are reflected in the increase in both film and charge transfer resistance.

Keywords: Polyurea, Ag nanoparticles, Antibacterial effect, Corrosion

Mona Sadat Mirtaleb[a], Mahvash Khodabandeh Shahraky[a], Elena Ekrami[a], Amirhossein Mirtaleb[b] (a. Department of Bioprocess Engineering, National Institute of Genetic Engineering and Biotechnology, Tehran, Iran, b. Department of Materials Science & Engineering, Faculty of Engineering & Technology, Tarbiat Modares University, PO Box: 14115-143, Tehran, Iran) **Advances in biological nano-phospholipid vesicles for transdermal delivery: A review on applications, Journal of Drug Delivery Science and Technology Volume 61, February 2021, 102331**

Many biological molecules have been passed through the skin to treat diseases. In recent decades, the use of phospholipid nanocarriers has been considered as a tool to increase the quality of transdermal drug delivery. Among phospholipid nanocarriers, liposomes have been recognized for their ability to deliver drugs. These nanocarriers are designed to facilitate the passage of drug molecules through the skin. By changing the structure of liposomes and using materials in the process of preparing them, more stable liposomes with unique properties can be formed. Engineered liposomes are designed to enhance the features of conventional ones. In addition to preserving the biological properties of the drug molecules, these nanocarriers make it easier for the drug molecules to pass through the skin layers. In this review article, studies on modified liposomes in dermal and transdermal delivery of drug molecules are presented.

Keywords: Transdermal delivery, Lipid vesicular system, Liposomes, Nanocarrier, Hyalurosome

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Nano-fiber composites have shown promising potential in biomedical and biotechnological applications. Herein, novel nano-fiber composites constituting a blend of polyvinyl alcohol (PVA) and chitosan (CS) along with different weight ratios of nano-bioactive glass (BG) were prepared by electrospinning. Nano-fibers incorporating 10% (by wt.) of BG were uniform, dense and defect-free with a diameter of 20–125 nm. The model osteoporotic drug (Risedronate sodium) was blended with the electrospinning forming solution and the in-vitro drug release was further studied. About 30% of the drug was released after only 30 min and the release pattern was sustained over 96 h. Drug release took place through a two-stage intra-particle diffusion mechanism. BG-incorporated nano-fibers markedly retarded the drug release profile relative to their BG-free counterparts. They also enhanced the drug release efficiency by releasing 93 ± 4% of the drug. The developed nano-fiber composites can be potentially used as drug-delivery vehicles due to their efficiency and sustained drug release capacity.

Keywords: Nano-fibers, Release kinetics, Nanocomposites, Chitosan/polyvinyl alcohol, Bioactive glass, Electrospinning process

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Trachyspermum ammi and Nigella sativa are mostly used as traditional medicinal plants to cure different diseases. It was observed that both extracts showed significant antibacterial activity against gram-negative bacteria and which may be extended to the SARS-CoV-2, leading to the absence of the peptidoglycan layer. T. ammi showed the highest percentage inhibition in the antifungal assay compared to N. sativa against Aspergillus flavus. The antioxidant assay was performed. It was observed that T. ammi has more free radical scavenging activity as indicated by low IC50. The cytotoxic assay was performed by following brine shrimp lethality assay, and it was observed that T. ammi has more cytotoxicity. The results are that both N. sativa and T. ammi are the origins of active pharmaceutical ingredients and have several pharmacological effects. Furthermore, both essential antibacterial agents were identified and can, therefore, be used as an antibiotic. They have now shown important antioxidant and cytotoxic potential, such that their potential in herbal medicine and cancer genetics can now unravel. In the future, the bioactive molecules responsible for biological processes will be separated. Besides, the nano-formulations in nano-biotechnology may also be analyzed with these extracts.

Keywords: Nigella sativa, Antimicrobial, Antifungal, Cytotoxic, Cardiovascular disease, SARS-CoV-2

Biomimicry

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Biomimicry consists in imitating nature to solve complex human problems. The hand surgeon usually tries to copy and recreate the structure-to-function and function-to-control relationships of the native tissues after damage. With its exceptional structure and biomechanics, the flexor digitorum superficialis (FDS) has been an important source of inspiration for artificial hand system reconstruction. The present systematic literature review highlights the twenty-two artificial hand system reconstructions derived from the FDS, and presents biomimicry as an alternative approach in clinical research in hand surgery.

Keywords: Flexor digitorum superficialis, Biomimicry, Tendon transfer, Hand Surgery

Name of Journals

1. Acta Biotechnologica
2. Aerobiologia
3. Annual Review-Plant Pathology
4. Annual Review- Ecology and Systematics
5. Annual Review-Biochemistry
6. Annual Review-Biomedical Engineering
7. Annual Review-Biophysics and Biomolecular Structure
8. Annual Review-Microbiology
9. Annual Review-Pharmacology and Toxicology
10. Annual Review-Phytopathology
11. Annual Review-Physiology
12. Annual Review-Plant Physiology
13. Annual Review-Public Health
14. African Journal of Biotechnology
15. Applied and Environmental Microbiology
16. Applied Microbiology & Biotechnology
17. Aquaculture
18. Allergy
19. Australian Journal of Plant Physiology
20. Biocatalysis and Transformation
21. Biocontrol
22. Biocontrol Potential and its exploitation in sustainable Agriculture
23. Biodegradation
24. Biodeterioration & Biodegradation
25. Biodiversity and Conservation
26. Biological Agriculture and Horticulture
27. Biomass and Bioenergy
28. Biomedical and Environmental Sciences
29. Biomedical Engineering
30. Bioresource Technology
31. Bioscience, Biotechnology and Biochemistry
32. Biosensors-and –Bioelectronics
33. Bioseperation
34. Biotechnolgy Letters
35. Biotechnology Advances
36. Biotechnology and Applied Biochemistry
37. Biotechnology and Bioengineering
38. Botanical Review
39. Canadian Journal of Microbiology
40. Cell & Tissue Banking
41. Clinical Microbiology Reviews
42. Critical Reviews in Biotechnology
43. Crop Research Hisar
44. Current Microbiology
45. Current Opinion in Biotechnology
46. Current Science
47. Cytotechnology
48. Ecology and Environmental Corner
49. Ecological Engineering
50. Ecotoxicology
51. Environmental Conservation
52. Environmental Research
53. Environmental Pollution
54. Enzyme and Microbial Techynology
55. Every Man's Science
56. Environmental Imapct Assessment Review
57. Fems Microbiology & Ecology
58. Food & Agricultural Immunology
59. Global Environmental Change
60. Hydrometallurgy
61. Immunological Research
62. Indian Agriculturist
63. Indian Biologist
64. Indian Farming
65. Indian Journal of Agricultural Science
66. Indian Journal of Biotechnology
67. Indian Journal of Ecology
68. Indian Journal of Experimental Biology
69. Indian Journal of Environmental Toxicology
70. Indian Journal of Environmental Health
71. Indian Journal of Plant Physiology
72. International Biodeterioration & Biodegradation
73. International Journal of Biotechnology
74. International Journal of Phytoremediation
75. Journal of Applied Sciences and Environmental Management
76. Journal of Agriculture and Environmental Ethics
77. Journal Biological Control
78. Journal of Bacteriology
79. Journal of Chemical Technology & Biotechnology
80. Journal of Environmental Management
81. Journal of Food Science and Technology-Mysore
82. Journal of Hazardous Materials
83. Journal Indian Association Environment Management
84. Journal Indian Pollution Control
85. Journal of Indian Soil Science

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

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