Advancements in Environmental Biotechnology

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SALICYLIC ACID: AN EFFECTIVE TOOL TO COMBAT MANCOZEB TOXICITY IN PLANTS

Shadma Andleeb Khan, Nida Sultan, Laxmi and Aisha Kamal*

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ABSTRACT

The use of fungicides is the continuous practice in agriculture to protect crops from various fungal diseases. Mancozeb (MZ(2-)], is a fungicide classified in the carbamate pesticide family, It is registered for use on a variety of horticulture and agricultural crops and seed treatment of cotton, potatoes, corn, safflower, sorghum, peanuts, tomatoes, flax, and various cereal grains. The fungicide mancozeb has a considerable deleterious impact on soil microflora, nitrification, ammonification, soil microbial biomass, carbon mineralization, and soil enzymes which may result in harmful effects on nutrient uptake and plant growth. Salicylic acid (SA) is an important signal molecule, regulating oxidative stress response in plants. It was found in many studies that exogenous application of salicylic acid could promote the degradation of pesticides and suppress the accumulation of pesticides in plant tissues. The present chapter covers the aspects of pesticidal response of plants and evaluates the contribution of Salicylic acid in mitigating pesticide-induced stress and increasing the tolerance of plants.

Keywords: Salicylic acid; Mancozeb; Pesticides; Stress

CHAPTER 2

CURRENT TRENDS AND FUTURE PERSPECTIVES OF BIOPLASTICS

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Abstract

Bioplastics are plastics in which all carbon is derived from renewable feedstock's. Bioplastics plays a vital role in our lives because of its uniqueness in properties and extended application in industries, packaging, sports, medicine, perfumes and preservatives, plastics, fuels, toys etc. PHB (Polyhydroxybutyrate) is a polymer belongs to polyesters group of Polyhydroxyalkanoate (PHA), which are used as bio-derived and biodegradable plastics. The use of PHB derived bioplastics are completely safe and do not have any chemicals or toxins. These plastics harmlessly breaks down by microbial consortia using depolymerase enzymes and gets absorbed into the earth. Such advantages of bioplastics are of extreme importance that could markedly increase as more durable versions are developed, and the cost to manufacture these bio-plastics continues to go fall. Moreover, it reduces the growing toxic plastic load on the earth that will be in favour of future generations. The biodegradable plastics market's immense growth will help drive the further evolution of a bio-economy in world.

Keywords: Biodegradable plastic; PHA; PHB; PHB depolymerase enzymes;

CHAPTER 3

BIOCHEMICAL RESPONSE OF THE NITROGEN FIXING CYANOBACTERIUM *NOSTOCMUSCORUM* TO METALLIC NANOPARTICLES: AN APPROACH TOWARDS ENVIRONMENTAL SUSTAINABILITY

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Abstract

Indiscriminate use of nanomaterials and excessive heavy metal discharge into the environment calls for the better understanding of their toxicological effects on the ecosystem. Though these particles have various vital applications in multiple sectors, there is an increasing concern related to the potential hazards of these nanoparticles to the human health and environment. In recent years, many studies are focusing on the toxicity of different nanoparticles including silver nanoparticles. However, the exact mechanisms, as well as the toxicity contribution from its ionic and nano-form, is still very much unknown. For analyzing their toxic effects cyanobacteria is emerging as our model system.Cyanobacteria is known to accumulate heavy metals and act as a sink for many aquatic contaminants. Effect of metallic nanoparticles stress on enzymatic and non-enzymatic antioxidants is also studied as a biomarker for stress. This chapter aims to present and discuss the various applications and (eco) toxicity of silver nanoparticles to understand the use of these nanoparticles in a safe way. A significant conclusion includes the need for a risk-benefit analysis for all applications and eventually restrictions of the uses where a clear benefit cannot be demonstrated. Thus, the understanding of the responses incurred in cyanobacteria during heavy metal and metal nanoparticle stress can be very well used to evaluate their toxic responses in the environment.

Keywords: *Nanoparticle; Cyanobacteria; Biomarker; Sustainability.*

CHAPTER 4

EFFECT OF BRASSINOLIDE AND SALICYLIC ACID ON GROWTH, QUALITY AND QUANTITY OF ESSENTIAL OIL COMPONENTS IN PALMAROSA (*CYMBOPOGON MARTINII*)

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Abstract

Palmarosa (*Cymbopogon martinii* [Roxb.] Wats. Var. motia) is an important aromatic grass, yielding an essential oil which is highly profound and strong rose like odour widely distributed in tropical and subtropical regions. The main components of oil are geraniol and geranyl acetate (Khanuja *et al* 2005). The essential oil from *C. martinii* is widely used as a valuable component for perfumes, cosmetic and pharmaceutical products (Singh K *et al* 1996) and against the action of various bacteria, fungi and microorganisms (Duarte MC *et al* 2005). The essential oil also has some of the important properties such as insect repellent and is also used in aromatherapy, due to these applications, essential oil demand in the domestic and international market has increased, which has stimulated its cultivation. Many factors including age, seasonal variation, nutrition, temperature and phytohormones have an influence on accumulation and metabolism of secondary metabolites. There are numerous reports in the literature concerning the effects of growth regulators which stimulate growth and terpenoid biosynthesis in various aromatic plants, which can result in beneficial changes in quality as well as quantity of terpenoids (Shukla *et al* 1992). Biosynthesis of terpenoids is dependent on primary metabolism e.g. photosynthesis and oxidative pathways for carbon and energy supply (Singh *et al* 1990).

Keywords: Plant growth regulators, BR, SA Essential Oils, Citral, Geraniol

CHAPTER 5

NATURAL BIOACTIVE COMPOUNDS FOR THE MANAGEMENT OF TYPE 2 DEBATES: AN *IN-SILICO* APPROACH

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Abstract

Diabetes Mellitus is one of the utmost potent a metabolic disorder of proteins, fatsand carbohydrate metabolism which is characterized by post prandial and high fasting blood sugar levels. Diabetes mellitus results the production of insulin is less or dysfunction of insulin. Cyanobacteria are reflected good candidates for applications in pharmaceuticals,agriculture, and food industry.There are many activities of cyanobacteria have been reported which is antimalarial, antilarvicidal, anticancer, antioxidants, antibacterial, antiviral, antifungal, algaecides, and cytotoxic activities. Recently, much attention has been given to bioactive compounds that may be beneficial for the prevention of diabetes. Much evidence exists that flavonoids, such as quercetin, anthocyanins, genistein, vitamins, such as vitamin D and C, and EGCG enhance beta-cell function, lead to glucose easiness in animal models and humans, and protect against diabetes. *In silico or computational* techniques play an important role in investigating multi-target directed ligands (MTDLs) with cost and time benefits. Several *in silico* techniques have been evolved, which can be divided into two major application areas, i.e., ligand-based drug design and structure-based drug design. Ligand-based drug design (LBDD) techniques like quantitative structure-activity relationship (QSAR) rely on knowledge of diverse ligands that interact with the biological targets of interest.

Keywords: Diabetes mellitus, Cyanobacteria, Bioactive Compounds, Molecular Docking, *In silico* approach, Drug Designing, T2DM

CHAPTER 6

EFFECT OF PLANT GROWTH REGULATOR GA_3 (GIBBERELLIC ACID) ON ESSENTIAL OIL YIELD IN LEMONGRASS (*CYMBOPOGON FLEXUOSUS*)

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Abstract

In the recent years, there has been a tremendous diversity in the research area of plant growth. Many researchers are studying the behavior of PGRs on Aromatic and Medicinal Plants. One such aromatic plant is the Lemongrass (*Cymbopogon flexuosus*). *Cymbopogon flexuosus* is a species of grass in the *cymbopogon* genus best known by the common name lemongrass. This is a perennial grass, native to Southeast Asia, especially India, and it is cultivated for its essential oil. The essential oil of this plant, which contains the active compound citral and geraniol, is valued for its aroma and for a number of traditional medicinal and household uses. Lemongrass oil has been shown to be an effective insect repellent when applied to stored grain and beans. PGRs are chemical substances that generally function as chemical messengers for intracellular communication and profoundly influence the growth and differentiation in plants. This chapter provides the deep insights on role of PGRs on essential oils yield by modulating the key enzymes involved in terpenoid pathway.

Keywords: Plant growth regulators, GA_3, Essential Oils, Citral, Geraniol

CHAPTER 7

CYANOBACTERIAL STRAIN *PLECTONEMA BORYANUM*AS A POTENT SOURCE OF BIOACTIVE COMPOUND: C-PHYCOCYANIN

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Abstract

Cyanobacteria are prokaryotic micro-organisms that carry out photosynthesis through the oxygen evolution utilization process. They are morphological, physiologically, and structurally different from each other which helps them to adapt to environmental factors. They produce a large number of bioactive compounds. At the commercial level, by modifying the strategies used in culture medium synthesis of bioactive compounds can be enhanced. Also, help in lowering the cost of the manufacturing process. Experiments are carried out by altering the concentration or character of ingredients of media. A better medium supports the faster growth rate and higher cell concentration. Due to one at a time strategy complication and time-consuming process, the classical method is less preferable while the statical approach gives a systematic and efficient method for experimentation. Cyanobacteria have a long history of fossils. They are found all over the world including land and water. They create a symbiotic relationship with fungi, plants, animals, and the man terrestrial ecosystem. They can produce neurotoxic, hepatotoxic, tumor-causing secondary metabolites. Some cyanobacteria create two types of specialized cells- Hetrocyst and Akinetes. Cyanobacteria have a wide range of applications in biotechnology e.g. mariculture, food, feed, fertilizer, medicines, and pollution control. In addition, they produce many secondary metabolites e.g. cyanotoxin, Siderophores, photo-protective protease, antimicrobial agents. *Plectonema boryanum* is a strain of the cyanobacterium that produces C-phycocyanin, a bioactive compound. C-phycocyanin has an assembly of heterodimers composed of α and β subunits called phycobiliprotein monomers and respective chromophores linked via a thioether bond. Phycocyanin is used as a natural protein dye in food, cosmetics, medicines, and pharmaceuticals. It is used in diagnosis as well as microscopy to detect the molecules.

Keywords: Bioactive compounds, phycobiliprotein, media optimization, pigments, biomass

CHAPTER 8
MICROBIAL BIODEGRADATION OF POLYMERS

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Abstract

Biodegradable polymers are a novel and promising alternative to non-biodegradable plastics that find application in mostly every commodity today due to their strength and malleability. The major concern in using non-biodegradable plastics is their degradation as it is highly demanding process and is not possible to eliminate the polymers completely. This possesses a negative impact on the environment. Biodegradable polymers such as Polyhydroxyalkanoates (PHAs) accumulate in bacteria as insoluble granules of which Poly-3-hydroxybutyrates (PHBs) are the most common. The intra- and extra-cellular degradation of PHBs can be achieved easily through biocatalyst PHB depolymerase enzyme which have reported to be isolated from microorganisms such as bacteria, yeast, and fungus. Some common microorganisms as the source of PHB depolymerase are *Pseudomonas lemoigne, Comamonas* sp., *Acidovoraxfaecalis, Aspergillus fumigates*, and *Variovorax paradoxus, Alcaligenes faecalis, Pseudomonas, Pseudomonas strutzeri*. Future studies on finding novel sources of biopolymer degrading enzyme PHB depolymerase will open new arena for efficient polymer degradation. Using enzymes with better catalytic efficiency.

Keywords: Polymers, Polyhydroxyalkanoates, Poly-3-hydroxybutyrate, Poly-3-hydroxybutyrate depolymerase, Biodegrdation

CHAPTER 9

COMBATING BULK AND NANO METAL TOXICITY USING CYANOBACTERIA

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Abstract

Heavy metal toxicity in the ecosystem is a major environmental concern which needs urgent preventive and combating measures. A very common organism found in the aquatic ecosystem is cyanobacterium that tends to accumulate the heavy metals in polluted water bodies. Cyanobacteria ingests the heavy metal ions and either detoxify or metabolize the heavy metals, thus reduce the toxicity from the environment as well as act as a bioindicator to assess the chemical risk to the ecosystem. Cyanobacteria are well adapted to environmental stress conditions and have a robust antioxidant mechanism to fight any reactive oxygen species (ROS) generated due to the biotic or abiotic stress that cause cytotoxicity and oxidative damage. Transcriptome and proteome study of cyanobacteria involved in combating heavy metal toxicity reveals that stress induced proteins are generated that help the organism to adapt to the stress condition. A better understanding of the mechanism employed by cyanobacteria to combat metal toxicity can be delineated through more detailed molecular level study

Keywords: Heavy metal ions, Silver nanoparticles, Abiotic stress, ROS, Cyanobacteria

CHAPTER 10

Role of nitrogen sources in the Production of C-Phycocyanin from Cyanobacteria

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Abstract

Cyanobacteria are gram-negative prokaryotes and also called blue-green algae, blue-green bacteria, or Cyanophyta that carry out photosynthesis to get their energy. They have originated 3.5 billion years ago, They are a significant part of the marine nitrogen cycle and also a primary producer in many areas of the ocean, but are also found in other habitats like freshwater lakes, soil, etc. they do not have flagella therefore they show their motility by gliding. They reproduce asexually. They have four layered cell walls made up of peptidoglycan. They produce a large amount and a large number of secondary metabolites e.g. Microcystis, Anabaena, Nostoc, and Oscillatoria. Some cyanobacteria also produce some toxins as well as bioactive compounds. Also, they have a cholesterol-lowering effect in animals and humans. Cyanobacteria are very helpful to humans as it has a wide range of applications in food, pharma, cosmetic, fuel, fertilizer, and pollution control. Phycobiliproteins, found in cyanobacteria are used as a natural color in food, medicines, and cosmetics. Cyanobacteria used local basic resources like pH, temperature, incubation time, salinity, carbon and nitrogen sources, and amino acids to enhance the production of bioactive components. In cyanobacteria, the main component used for photosynthesis is chlorophyll-a chlorophyll-b and chlorophyll-care absent. In addition, cyanobacteria produce some other metabolites like Cryptophycin, Cyanovirin-N, and Borophycin.

Keywords: Heterotroph, Pharmaceutical, Nitrogen fixation, secondary metabolites, and Phytoplanktons