Title

Smart and sustainable lignin based delivery systems for agro-biotechnology

Abstract

There is an urgent need for developing novel and sustainable systems to allow controlled delivery of agrochemicals over long periods as well as systems that enable provision of water to crops in order to prevent the negative effects of drought on crop yields. In view of the fast depletion of ground water reserves, uncertainty of rains all over the world, coupled with the growing food demand due to exponential growth in human population, efficient use of water available for crops has become highly relevant. In addition since up to 50 % of nitrogen fertilizer is lost while more than 95% of pesticides and herbicides are released into the environment [1-3] there is need to develop technologies that guarantee that these agrochemicals do not contaminate the environment. To address these problems current agrochemical delivery and water storage systems are based on non-biodegradable fossil resources whose persistence in the environment are already causing serious environmental pollution.

Lignin, present in trees (40%), is mostly seen as waste material or by-product is currently under-explored and mainly burned for energy production. Based on these reasons, the major aim of the study is to explore the possibility of producing lignin based biodegradable water and agrochemical controlled release systems using biocatalysts. The increasing global food demand is expected to double by 2050 while the arable land is decreasing due to industrialization, urbanization, desertification, and land degradation. Hence, this favors the increase in the use of water storing and slow release systems, and agrochemicals slow release systems in order to increase productivity per available agriculture land or other artificial environments. To minimize leaching, prevent environmental pollution, reduce the frequency of administering agrochemicals, prevent damage of ecosystems and reducing adverse human health effects, agrochemical biodegradable controlled delivery systems are increasingly recognized as an important strategy to timely deliver agrochemicals upon demand over a long period of time. Based on very promising preliminary experiments, in this thesis, enzymes as biocatalysts will be used to polymerize lignin for the production of agrochemical slow delivery systems. In addition, lignin will be used to immobilize probiotics to fine-tune nutrient supply by solubilizing nutrients such as P and many other bio-stimulants making them available to crops on demand. This in our view will constitute a 100 % biodegradable green biobased product using 100 % renewable green chemistry technology.

Aim of the PHD thesis

Faced with the foreseeable increasing demand for agrochemical controlled release systems, erratic rainfalls affecting crop yields, environmental concerns of fossil-based

solutions, and depletion of fossil based fuels there is a strong need to develop biodegradable and biobased alternatives. Controlled delivery systems are increasingly being recognized as important systems to timely deliver agrochemicals upon demand, apply agrochemicals where they are needed and minimize leaching thereby preventing environmental pollution and reduce the frequency of administering agrochemicals, save manpower and energy, prevent damaging ecosystems and reduce adverse human health effects. The major aim of the PhD thesis is to explore the possibility of enzymatically synthesizing lignin based biodegradable water and agrochemical holding and controlled slow release systems. These will be 100 % biobased agrochemical delivery system produced using 100 % green chemistry technology „enzymes“. In our opinion this development heralds a new era in processing lignin for application in the production of a variety of versatile agrochemical delivery systems

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Scientific Output

Publications:

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Lignin-Based Pesticide Delivery System

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