Abstract for the General Public

Given the growing need for sustainable energy and the limitations of fossil fuels, there is a lot of interest in using biomass to produce bioenergy. Researchers are focusing on finding ways to transform lignocellulosic materials into biofuels, as this is an important area of study. Fortunately, Poland has access to a significant amount of biomass resources, which may be used to produce a lot of bioenergy. Around 46.7 million dry tonnes of lignocellulosic biomass can be obtained annually from sources like waste, agriculture, and forestry residues. To make the most of this potential, Poland is looking to implement advanced policies and distinctive approaches that will enable efficient utilization of lignocellulosic biomass. This, in turn, will drive the development of a bio-based economy in the country by 2030. Shifting towards the production of advanced biofuels and valuable chemicals using renewable lignocellulosic resources, such as agricultural and forestry waste residues, is an attractive alternative to relying solely on crude oil and fossil fuels. However, there are several challenges to overcome. A key obstacle in cost-effective and eco-friendly biofuel production is finding effective ways to remove or reduce the lignin barrier that encloses the cellulose fibers in agricultural residues. Scientists are actively working on developing pre-treatment methods to address this challenge and improve the overall process of biofuel production. Traditional methods for breaking down lignocellulosic structures often involve harsh conditions like high temperature, pressure, and the use of toxic chemicals. However, researchers have discovered that certain fungi can degrade lignin in a more environmentally friendly way. They have been studying how enzymes produced by these fungi can break down lignocellulosic biomass. There are specific enzymes called peroxidases and laccases that have the ability to catalyze the breakdown of lignocellulosic materials. These enzymes, found in white rot fungi, such as lignin peroxidase (LiP), Mn-dependent peroxidase (MnP), and laccase, are incredibly versatile and can be used as biocatalysts in various applications including biofuels production, lignocellulose debasement, and pulp and paper industry. So far, most of the research has focused on using these enzymes individually rather than exploring how they can work together to break down lignocellulose. The main goal of this research project is to develop a new method for breaking down lignin by utilizing ligninolytic enzymes for environmentally friendly processing of lignocellulosic waste materials. The ligninolytic consortium, which mainly comprises three enzymes (Lac, LiP, and MnP), will be used to break down lignin both singly and in different combinations and compare its effectiveness with other approaches like alkali, acid, or high-temperature water pretreatment. By harnessing the power of these ligninolytic enzymes, we hope to find a more sustainable and efficient way to break down lignocellulosic waste materials and contribute to a greener future. In conclusion, developing and using our biotechnological approach to remove lignin from agricultural waste residues brings several benefits. Firstly, it reduces the need for toxic chemicals, making it safer for both humans and the environment. Secondly, it contributes to environmental protection by finding a sustainable solution for waste management.. This achievement is a big step towards achieving self-reliance in the production of biofuels, specifically biobutanol, and advancing environmental biotechnology. Moreover, the pretreatment of lignocellulosic materials aligns well with the United Nations Sustainable Development Goal of "Affordable and Clean Energy." This goal aims to make clean and renewable energy more accessible to all by promoting research and technology related to renewable energy sources. By implementing these advancements, we are not only reducing our reliance on fossil fuels but also creating a cleaner and more sustainable energy future for everyone.