POPULAR SCIENTIFIC SUMMARY

The project concerns the determination of the impact of the chemical composition of monoecious and dioecious hemp straw on the efficiency of waste biomass processing as a raw material for the production of advanced biofuels and biocomposites. The principles of inheritance of the traits determining the high quality of biomass for its further processing will also be initially determined, based on the analysis of newly produced lines and parental varieties.

Hemp is an environmentally friendly plant and due to its very high biomass yield (up to 15 t/ha), it is very well suited for the effective production of advanced biofuels, and also as a natural filler for biodegradable composites. Due to the deep root system and high binding activity of active compounds, hemp is highly useful in the process of natural remediation of degraded lands (e.g. post-mining heaps, sites with a high content of heavy metals). The cultivation of industrial hemp has a positive effect on the structure of the soil, rationally enriching the crop rotation. Hemp plants, which bind about 11 t CO_2 per 1 hectare of cultivation, are also characterized by high resistance to diseases, weed infestation and water deficiency in the soil, being a species friendly to cultivation. The cultivation of hemp for seed purposes and pro-health non-hallucinogenic cannabinoids which has been intensively developed in recent years, causes a dynamic increase in the cultivation area. The above-mentioned cultivation directions focus on the use of panicles as the main raw material. Therefore, after ginning, large amounts of unused biomass remain, which is worth using. An interesting and rational proposal is the acquisition of advanced biofuels and the production of biocomposites.

Hemp biomass consists of three basic components: cellulose, hemicelluloses and lignin, the proportions of which have a significant impact on the possibilities of using this plant in the above-mentioned processes. These proportions depend to a large extent on the proper selection of varieties, the breeding of which is carried out on the basis of the established principles of important traits inheriting. The production of better and better genotypes is an important element of biological progress. As a part of the proposed project, it is planned to obtain new lines of hemp with high suitability for the production of advanced biofuels and biocomposites. It is also planned to initially determine the mechanisms of inheriting the traits that determine the high quantity and quality of biomass.

The processing of hemp biomass into advanced biofuels using fermentation methods may be a problem related to the occurrence of so-called lignocellulosic complex in its structure. It is necessary to carry out the process of alkaline hydrolysis, the key purpose of which is to loosen the compact structure of lignocellulose and to remove lignin. Correctly and effectively carried out process allows to change the proportion of the chemical composition, i.e. increase the content of cellulose and hemicelluloses, and reduce the amount of lignin. Another complicated step is the conversion of cellulose to simple sugars (including glucose), which – metabolized by microorganisms in the fermentation process – will allow for the production of biofuels such as bioethanol or biohydrogen.

Natural fillers used in biocomposites require the use of substances that can be combined with the polymer. The lack of connection between the natural filler and the polymer directly reduces the mechanical strength of biocomposites. The surface unification process of lignocellulosic fillers is mediated by hydroxyl groups, mainly coming from cellulose. Changes in the chemical composition of biomass from various new lines of hemp varieties are of particular importance for the selection of parameters for innovative processes of chemical modification of natural fillers with the use of organosilicon compounds. The selection of appropriate parameters in relation to the chemical composition of the biomass is important for the effectiveness of the modification process and for the appropriate selection of the quality and quantity of raw materials, solvents and the detailed conditions of the process.

The main expected effect of the project will be obtaining new hemp lines with high suitability for the production of biofuels and biocomposites, as well as preliminary analysis of the inheritance of the traits determining the high yield and favorable chemical composition of the biomass. They will allow to achieve high efficiency in the cellulose hydrolysis process and thus obtain the maximum concentration of glucose. The obtained results will significantly contribute to determining the optimal methods of industrial use of hemp waste biomass, presenting the issue in a holistic and interdisciplinary manner. This will have a direct impact on increasing the attractiveness of the cultivation of industrial hemp by developing the possibilities of complete, versatile use of plants, and improving the economics of agricultural production thanks to the management of waste biomass in various industries.

The proposed solutions contribute to the development of a pro-ecological economy in the scope of maximizing the use of natural resources and creating synergy between agriculture and industry, which is a stimulus for the growth of innovation, competitiveness of Polish agriculture and industry, and the creation of a new technologically advanced specialization of the national economy.