PROSPECTS OF USING AGRO-INDUSTRIAL WASTE FOR BIOFUEL PRODUCTION

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Abstract

This review examines the prospects for using agro-industrial waste for biofuel production. Agro-industrial production is a source of various wastes that can have different components and properties. Plant stalks, husks, straw etc. can be used for biofuel production provided that effective methods are used to decompose biomass into its main components and convert them into functional monomers.

Keywords: *biofuels, agro-industrial waste, lignocellulosic biomass*

Introductions. Today, the world is experiencing an increase in the demand for energy resources. Problems associated with the depletion of traditional fuel resources and environmental problems have become a driving force for the study of renewable, environmentally friendly, economical and sustainable alternative energy sources [1]. Therefore, the development of bioenergy is one of the important directions not only of science, but also of industry, as it allows to reduce dependence on fossil fuels, which in turn reduces greenhouse gas emissions [2].

First-generation biofuels are produced from raw materials used as food and feed, such as cereals. Second-generation biofuels are produced from non-food raw materials, such as wood and various lignocellulosic materials. Conventional crops, such as corn and sugarcane, cannot meet the global demand for biofuel production due to their primary value as food and feed [3].

One of the most promising areas in this area is the production of biofuels from plant waste from the agro-industrial complex. Ukraine has quite the necessary conditions for the development of this area of renewable energy. Firstly, the country has a developed agricultural sector, in particular crop production, which is a source of a large amount of various waste and residues. Every year, agriculture in our country generates a significant amount of plant waste: straw, corn stalks, sunflower husks, which can be used as raw materials for fuel. They make up the largest part of the biomass potential but are often disposed of without benefit. In addition, the use of renewable energy sources will contribute to solving several strategic tasks, such as reducing dependence on energy imports, developing the agro-industrial complex, creating new jobs and finally improving the environmental situation in the country.

Materials and methods. A review of literary sources was conducted using information search methods and scientific data analysis to investigate the possibilities of using agro-industrial waste for biofuel production.

Results and discussion. The main components of agro-industrial waste are cellulose, lignin and hemicellulose. Their recycling is a global problem, since the most of such waste is currently incinerated or buried in the soil, causing air and water pollution and global warming [4]. Given the polysaccharide nature, such materials are considered as promising raw materials for meeting energy needs.

One of the main problematic issues related to the use of lignocellulosic raw materials is the development of effective methods for the decomposition of biomass into its main components (cellulose, hemicellulose and lignin) and their conversion into functional monomers, which can subsequently be used for the biofuels production. When developing methods and technologies for processing agro-industrial waste, it should be considered that the qualitative and quantitative content of the main components, namely cellulose, hemicellulose and lignin, may vary depending on the type and origin of the biomass.

In the work [5] it was shown that the yield of monosaccharides from corn and sweet sorghum waste after delignification and enzymatic hydrolysis is higher in comparison with wheat straw by an average of 27%. The total yield of reducing sugars, from the content of cellulose and hemicelluloses in the raw material, from wheat straw was 45.4%, corn stalks 65.9%, sweet sorghum 74.5%.

The authors in study [6] proposed a method for removing lignin and hemicellulose from wheat straw to improve the efficiency of enzymatic hydrolysis, in which the yield of reducing sugars was 81.6%.

Another method of pretreatment of lignocellulosic biomass to increase the yield of sugars was proposed in [7]. The authors carried out sequential pretreatment of sunflower stalk biomass in a combinatorial mode using alkali (NaOH) and the ionic liquid 1-butyl-3-methylimidazolium chloride. Such pretreatment led to an increase in the yield of reducing sugars by 40.41% and 51.3%, compared to autonomous pretreatment using alkali or ionic liquid 1-butyl-3-methylimidazolium chloride, respectively.

Mera A. M. et al. [8] proposed a method for optimizing enzymatic hydrolysis in lignocellulosic bioconversion. The authors showed that the use of soybean protein together with a lactonic sophorolipid biosurfactant allows to increase the yield of sugars from cellulignin obtained from sugarcane bagasse. In particular, the yield of glucose increased by 24.9%, and the yield of xylose by 30.9%.

In the work [9] it is shown that non-traditional plant wastes, such as fruit tree cuttings, hop stems, and castor bean stems, are characterized by a high content of polysaccharides. The total yield of polysaccharides during hydrolysis is 52.8-59.1% depending on the type of raw material.

The efficiency of pretreatment of rice straw biomass was determined by Tunio A. et al. [10] based on the glucose yield after enzymatic saccharification of the raw material. The authors showed that the glucose yield after enzymatic hydrolysis of pretreated rice straw was 51.06 g/l. While using untreated rice straw, the glucose yield after enzymatic hydrolysis was 16.78 g/l.

Agro-industrial waste, in particular oilseed and grain straw, as well as fruit and berry processing waste, can be subjected to biochemical conversion into biofuel after pre-treatment. By changing the conditions of pre-treatment of lignocellulosic raw materials, the number of reagents, the duration of the process, etc., it is possible to increase the cellulose content in the final product, suitable for further conversion into biofuel.

Conclusions. The research analyzed the potential of agro-industrial waste for biofuel production. The approach, which involves biochemical conversion of agro-industrial waste after pre-treatment, is quite promising, as it allows for the effective use of available domestic resources to meet energy needs and reduce dependence on fossil fuels. However, the effectiveness of the implementation of lignocellulosic biomass processing technologies depends on many factors, including the type of raw material, chemical composition of the raw material, methods of pre-treatment, hydrolysis, fermentation. Therefore, further research will be aimed at optimizing all of these processes.

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