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Editorial

Environmentally Friendly Biofuel Production

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1. Introduction

Changes in the environment and climate conditions, as well as economic growth and the increase in energy consumption, have led to an intensification of research on alternative fuels to replace fossil fuels. Currently, the dynamic development of alternative energy sources and the use of waste and biomass for the bioenergy production are possibilities to improve the energy mix. In addition, it is worth reaching for new, less popular prospective solutions as well as various solutions based on the principles of bioeconomy.

Energy production is one of the basic tasks carried out in the economy. Humanity would not be able to function today without electricity or heat. However, with the increases in both energy demand and public awareness, the use of fossil fuels is being abandoned in favor of renewable sources as raw materials for energy production [1].

Plant and animal biomass is widely considered an alternative source of energy to fossil fuels. Although their production and processing require significant amounts of energy, it is estimated that their energy management is less burdensome for the natural environment than the use of crude oil, brown coal or hard coal. This is due to the absorption of carbon dioxide during plant growth, which significantly reduces the overall impact of biomass production on the ecosystem. Biomass can be used in many ways to produce bioenergy. Individual conversion processes are dedicated to bio-raw materials depending on the dominant substances in their chemical composition. The products obtained in this way, such as solid, liquid or gaseous biofuels, can have a major impact on the diversification of energy sources, combating climate change, efforts towards a circular economy and increasing the use of renewable energy sources [2,3].

The most common plant biomass used for solid biofuel production is that with a high content of lignocellulosic compounds, which can be obtained as waste from various processing processes or from energy crops. After drying and crushing, briquettes or pellets are most often produced, which are a convenient form of biofuel intended for combustion in home furnaces. Straw bales are most often used in large combined heat and power plants. One of the most important parameters determining the suitability of biomass for the production of solid biofuels is its high calorific value. It has an impact on reducing the mass of the raw material needed to produce the desired amount of energy. However, other aspects are also important for the process to be effective, such as the content of ash, sulfur, chlorine and other undesirable chemical compounds. Moreover, the moisture content of the biomass intended for combustion is also very significant [4].

Liquid biofuels are used as a substitute or additive to diesel fuel in the form of bioethanol, biomethanol, esters, dimethyl ethers, pure vegetable oils or synthetic hydrocarbons. Fatty Acid Methyl Esters (FAMEs) are most often first-generation biofuels, although they are increasingly produced from waste oils. Nevertheless, if only as a result of legislative changes aimed at moving away from the production of biofuels from food raw materials, the production of second-generation biofuels from lignocellulosic biomass and third-generation biofuels from algae is developing dynamically [5].

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Biogas is produced from organic matter from the processing of biomass in various biological processes in the absence of oxygen. The most widespread and effective technology for producing biogas in industrial conditions is methane fermentation carried out in special reactors under strictly defined conditions. The gas mixture produced in this way consists of about $^{2}/_{3}$ methane and about $^{1}/_{3}$ carbon dioxide. In addition, other compounds may also be present in biogas in various proportions. These are most often small amounts of hydrogen sulfide, ammonia, hydrogen and other gasses. For high efficiency of the fermentation process, the process temperature, the used inoculum, the presence of possible process inhibitors and, above all, the chemical composition of the substrate and the content of dry matter in it are of particular importance. Increasingly, in addition to corn silage, waste is used for biogas production, including primarily that from agriculture and agri-food processing. This allows for rational waste management and bioenergy production at the same time [6].

This Special Issue, entitled "Environmentally Friendly Biofuel Production", aimed to present and disseminate the most recent advances related to bioprocess engineering, sustainable development and the circular economy for environmentally friendly biofuel production.

2. Overview of the Special Issue

The papers collected in this Special Issue addressed various areas of the use of biomass for energy purposes. The topics of interest for publication included the following:

- All aspects of energy crop cultivation and processing harvested biomass into bioenergy.
- Technical and economic aspects of biofuel production efficiency.
- Bioprocess engineering and its application in a circular economy.
- Novel applications of biofuel production according to sustainable development.
- Advanced technologies of waste conversion into biofuels.

In the paper "Analysis of the Energy and Material Use of Manure as a Fertilizer or Substrate for Biogas Production during the Energy Crisis" written by Mazurkiewicz (Contribution #1), the aim of the study was show the differences in profit when using manure directly as fertilizer (after the storage period) or as a substrate for biogas plants with a cogeneration unit, and then using the digestate for fertilization purposes. According to the author, the performed economic, energy and ecological calculations of manure management can be used as guidelines when considering investing in biogas plants. Moreover, it is important in the context of the carbon footprint of dairy production. The results confirmed that biogas plants, as a renewable energy source, fully comply with the idea of sustainable development and should be considered as a possible source of energy diversification in times of energy crisis.

The paper "The Biogas Potential of Oxytree Leaves" (Contribution #2) describes the characteristics of the Oxytree plant in terms of its impact on GHG emissions and its potential use to produce biofuel, i.e., biogas. It was found that the best results were achieved for the harvest of the freshest leaves—on average 430 $m^3 \cdot Mg^{-1}$ biogas and 223 $m^3 \cdot Mg^{-1}$ methane, per dry organic mass. The highest yield of biogas in terms of fresh mass was obtained for leaves fallen and collected after 1 day—123 $m^3 \cdot Mg^{-1}$ (59 $m^3 \cdot Mg^{-1}$ methane). The author summarizes that processing Oxytree leaves through anaerobic digestion will contribute to reducing the carbon footprint of wood biomass production and is an additional source of renewable energy and fertilizer product.

In "Loss of Energy and Economic Potential of a Biogas Plant Fed with Cow Manure due to Storage Time" (Contribution #3), Mazurkiewicz analyzed investments in biogas plants with a cogeneration unit for an average-size dairy farm. According to the author, it has been estimated that for a single farm with 100 cows, without government mechanisms subsidizing investments in renewable energy, the payback period exceeds 15 years, and the return on capital employed is slightly more than 6%.

The increase in waste of animal origin is an important problem that will cause serious environmental problems if not properly treated. In the paper "The Impact of Manure Use for Energy Purposes on the Economic Balance of a Dairy Farm" (Contribution #4), aspects related to emissions were analyzed, among others. Since the carbon footprint is already a standard cost component in many industries, it should be expected that in the near future it will also be an element of the economic balance of dairy farms.

The paper "Influence of the Parameters of Used Biochar on the Dark Fermentation Process" (Contribution #5), written by Kozłowski et al., analyzes the impact of biochar produced under various production conditions on the course of the dark (hydrogen) fermentation process. The research showed that increasing the temperature and holding time during the production of biochar from digestion pulp improved the dynamics of biohydrogen production during the process of dark fermentation.

3. Conclusions

This Special Issue "Environmentally Friendly Biofuel Production" included research about the sustainable use of biomass and waste. The topics covered in this Special Issue were diverse due to its broad scope; however, biogas played a dominant role. When waste is used as a raw material, it has a positive impact on reducing the carbon footprint and acts as a resource. For this reason, a significant increase in interest in processing biomass and waste into biofuels can be expected. The editors of this Special Issue would like to thank all the authors involved in the project and encourage further scientific activity in this area.

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List of Contributions

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