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BIOTECHNOLOGIES IN ENERGETICS

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Abstract

In the modern world, energy is the foundation for the functioning of the basic areas of industry that determine the progress of social production. It is no secret that such energy resources as oil, gas, coal are non-renewable (exhaustible). In addition, of course, with the existing demand for them and use on a large scale, resources tend to run out and their conservation (or energy saving) and replenishment (or energy replacement) are a common problem. Conservation of energy resources implies their efficient use, reduction of wasteful or excessive consumption. As for replenishment, the most obvious solution to this problem is the search and development of new deposits. It is worth considering the option of developing new deposits. It is one thing to find a place, another to equip the field with appropriate technologies. For example, back in 2005, they discovered that the Arctic shelf could become a rich source for Russia's oil production. However, the oil industry does not yet have the necessary drilling equipment for its exploration and development. This scientific work is devoted to the search and consideration of various biotechnologies to solve energy issues that confront a person today.

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Keywords: Energy resources, energy saving, gas, oil

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1. Introduction

In recent years, humankind has been resolutely striving to find alternative sources of energy in order to reduce the emission of harmful substances into the atmosphere, which occurs due to traditional and habitual systems for its production. We are talking about nuclear power plants, coal plants. To search for alternative sources of energy replenishment and not only, one should turn to biotechnology (Fiapshev et al., 2020; Khakimov, 2020). Biotechnology as a complex science solves a number of energy problems. One of the areas of biotechnology is bioenergetics, a discipline that studies the mechanisms of energy conversion in the processes of life of organisms, a discipline about the ways and mechanisms of energy transformation in biological systems (Pipia & Dorogokupets, 2020).

The main advantage of following the methods of biotechnology is obtaining energy using environmentally friendly technologies, because the consumption of energy resources already presented above leads to toxic emissions and causes significant damage to the environment, which creates the threat of the so-called ecological heart attack (Teplitskaya et al., 2021).

Science has made a big breakthrough in the study of biophysics, genetics, biochemistry, that is, the sciences, the synthesis of which is biotechnology. Based on the results achieved in all these areas, it becomes possible to obtain solid, liquid and gaseous fuels on a large scale in an environmentally friendly way. For this reason, special attention is paid to biotechnologies and bioenergy in most countries of the world (Prishchep et al., 2006; Zhiganova, 2019).

The key goal of the development of bioenergy in Russia is the creation of a new direction of the fuel and energy complex (FEC) and a new market sector of demanded bioproducts created on the basis of modern biomass processing technologies, which will solve both social problems and environmental problems (Zaichenko et al., 2020; Zakharov, 2022).

2. Problem Statement

The modern world is heavily dependent on non-renewable energy resources such as oil, gas, and coal for the functioning of basic industries and to facilitate social production. However, the existing demand for these resources coupled with their limited availability has raised concerns regarding their conservation and replenishment. This issue requires immediate attention, as it can have a detrimental effect on our environment and economy.

3. Research Questions

This study prompts the following research inquiries: What are the current practices for the conservation of non-renewable energy resources? What viable options exist for the replenishment of non-renewable energy resources? What are the potential biotechnologies that can be harnessed to solve energy issues?

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4. Purpose of the Study

In recent years, The purpose of this study is to explore various biotechnologies that can provide solutions to the energy issues that confront humanity today. The study will also examine the current state of conservation and replenishment practices for non-renewable energy resources. The research aims to identify and evaluate the viability of different solutions that have the potential to contribute to sustainable energy development in the future. The findings of this study can aid policymakers, industry experts, and researchers in developing practical strategies for addressing energy challenges and promoting sustainable development.

5. Findings

5.1. Biomass

Biomass includes the entire spectrum of plant and animal waste. The term literally means "biological material". The technology of obtaining energy by processing biomass originates in antiquity, as it implies a fermentation production. The energy contained in biomass is produced by photosynthesis. For example, trees contain as much energy as all available non-renewable energy resources.

Biomass sources include:

i. Fallen leaves and peat.
ii. Wood and wood waste.
iii. Waste from production activities.
iv. Special plants and crops.

There are several ways to process biomass:

i. Incineration is the simplest recycling method, the meaning of which is to use the steam from the burning of dry organic waste to run a generator that produces electricity.
ii. Gasification is a processing method, the advantage of which is pure fuel (,) safe for the environment.
iii. Pyrolysis - heating of biomass with the removal of volatile compounds to obtain fuel. The result of pyrolysis is: 1) coal with greater energy intensity and convenient for transportation; 2) biofuel, which is cheaper than oil, suitable for any engine, does not pollute the environment; 3) phenolic oil, used in the manufacture of wood glue, isopene, plastics. In addition, the volatile compounds removed are used for the synthesis of methane and methanol.
iv. Anaerobic fermentation - the essence of which is the processing of waste by anaerobic bacteria. The result of this fermentation is hydrogen and methane, which are used to generate electricity. This method recovers 2/3 of the fuel from biomass.
v. Fermentation - a way of processing almost all existing wastes by yeast-type microorganisms to produce ethanol or other hydrocarbons (Egorova et al., 2018).

Unfortunately, with all the advantages available, the use of biomass processing is not very popular. There are countries in which such an approach to the extraction of energy resources is practiced on an ongoing basis. For example, Brazil and Zimbabwe. In these countries, bio-alcohol is produced from plant

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biomass - sugar cane - that serves as the main fuel for cars. In Brazil, this production has become the largest biotechnology industry. To increase the energy potential of reeds, breeding methods are used.

In Russia, there are quite large reserves of biomass. About a quarter of the world's timber resources and about 45% of the world's peat reserves are concentrated on the territory of Russia. The annual amount of organic waste only from the agro-industrial complex is about 700 million tons with a total gross energy content of about 90 million tons of reference fuel. However, the country does not fully realize it is potential. Moreover, biomasses that could serve as a source of necessary energy resources are idle aimlessly, turning into dangerous storage facilities. Waste wood (at logging sites, woodworking) is also uneconomical. For example, more than 600 million cubic meters of wood waste is generated annually. This mass would make it possible to completely replace other types of fuel for the generation of cheap thermal energy.

All the information provided is aimed at familiarizing with the possibilities of biotechnology for solving environmental problems and creating an environmentally friendly product. Biotechnology products (biofuel, biogas, bio-alcohol) are already in everyday life, cost less than conventional fuel and do not actually require any modification of engines, such as internal combustion or diesel engines. This is also important because it saves consumers money (Higgins et al., 1985).

5.2. Multifaceted Microbes to Produce Renewable Energy Sources from the Biomass

Multifaceted microbes play a very important role in obtaining energy from biomass (figure 1). Microbial biotechnology itself is becoming increasingly visible and in demand for emissions. Today there is a problem of concentration in the territories of the agro-industrial complex, associated with a large amount of waste. In order to solve this problem and even reap the benefits, the risk of microbial growth is of great importance. They take into account and influence various beneficial enzymes that protect against infections and prevent their possible harmful contacts with pathogenic pathogens. At the same time, what was said, the quality of processing waste into fuel is consumed and the consumption of flora is not increased (Glick & Patten, 2022).

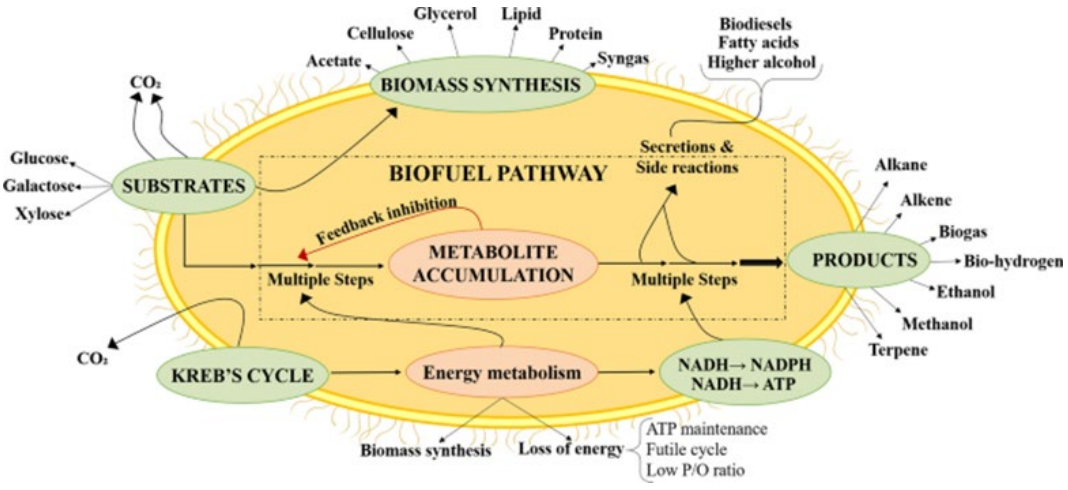

Figure 1. Renewable energy production process by various multifaceted microbes

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Multifaceted microbes play a fundamental role in consolidated biorefining and have proven to be effective also in the production of synthetic energy. We are talking about a type of microbe called Clostridium, which can also be the feedstock for obtaining various biological finished substances and synthesis gas: a combination of hydrogen and carbon dioxide.

In continuation of the topic of obtaining synthetic raw materials, I would like to note that the special value of such microbes also lies in the fact that they can be combined with various types of plants. For example, ordinary algae, when synthesized with these microbes, can be very efficiently processed into oil, and later into automobile, the so-called "green" fuel.

Technologies for obtaining oil from algae have been known for a long time, but the complexity of the process was that they had to be processed for a long time and this made the process unprofitable. In addition, transesterification into biodiesel required additional components, which complicated the processing processes. However, when a group of American scientists began to use multifaceted microbes for the processing of algae in laboratory tests, the process was significantly accelerated several times and now these technologies are becoming more and more widely used (Egorov & Samuilov, 2017).

Of course, the processing of bio-raw materials into oil, the production of synthesis gas, and the disposal of waste from the agricultural sector are far from the only area of application for multifaceted microbes. They have also proven effective in the production of bioethanol, biohydrogen, biodiesel ether and more.

5.3. Metabolic Engineering

Metabolic engineering encompasses numerous studies of the specific features of the metabolism of many unique microbes and organisms. In addition, he is also engaged in the creation of completely new organisms and systems with altered metabolic processes. Metabolic transformations make it possible to obtain waste products from various substrates. Such products have many different applications and are used in various industries, including bioenergy production (Volova, 1999).

Modern progress in these issues has made it possible to accelerate the production of biofuels many times over, such as various gases, acids, alcohols and others. Some studies of microorganisms in metabolic engineering are given in Table 1.

Table 1. Metabolic engineering strategies

Classes	Biofuel	Microorganisms	Carbon source	Metabolic engineering strategy	Yield
Alcohol based products	Ethanol	Synechocystis sp. PCC 6803	Glucose	Double homologous recombination technology was used to integrate the alcohol dehydrogenase II (adh) and pyruvate decarboxylase (pdc) genes from Zymomonas mobilis into the Synechocystis PCC 6803	5.2 mmol OD730 /unit/L/day
	Ethanol	Synechococcus	Glucose	Transformation of	6 mmol

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		sp. PCC 7942		Synechococcus sp. strain PCC 7942 using the bacterium Zymomonas mobilis	OD730/unit/L/day
	Ethanol	Synechocystis PCC 6803	Glucose	Engineering the pathway involving ribulose-1,5-bisphosphate carboxylase/oxygenase	Enhanced by 43.6% for EtOH-rbcSC
Fatty acid based products	Triacylglycerol	Rhodococcus opacus	Glucose	Deletion of acyl-coenzyme A (CoA) synthetases and over-expression of three lipases with lipase-specific foldase	82.9 g/L
Gaseous products	Hydrogen	Escherichia coli	Xylose and Glucose	Deletion in gene ptsG (phosphotransferase system) for as well as ldhA and frdD	0.284 g/L

In metabolic engineering, there are many different criteria for testing. The key among them can be called the choice of a suitable organism and the creation of the most suitable environmental conditions for it. The models of organisms given above are among the most popular and often studied. Thanks to them, various approaches are being developed in genetic engineering, areas of hybrid testing, and so on. All this helps to identify microbes and organisms capable of producing biofuels / positively influencing the utilization of harmful components and substances / increasing the yield and growth productivity of other organisms, and so on (Bykov, 1993).

However, it should be noted that in addition to metabolic engineering, an additional method is also involved in the production of various types of biofuels, which includes the modulation of restoring energy. This term mainly means that the resulting product must be controlled and maintained at all stages of processing, as by-products or emissions often occur when using microbes. Modulation of the restoring energy is carried out by enriching the pool of restorative elements. For example, when constructing biosynthesis using Clostridium microorganisms, additional trace elements are introduced and the pool of ferredoxin and reductase genes is increased. As a result, this approach has several advantages at once: firstly, the biofuel is of better quality and less emission of by-products, and secondly, there is a significant acceleration of the biofuel production process.

6. Conclusion

In conclusion, I would like to note that today the problem of alternative sources of renewable energy is very relevant. Many countries are trying to move away from traditional methods of energy production in the field of green technologies. This is due, first of all, to the issues of protecting the ecology of our planet. Therefore, research in the field of biotechnology will only gain momentum and attract an increasing number of researchers and various government programs.

This scientific work touched upon the role of microorganisms and microbes in various areas of biofuel production and highlighted some of the nuances of its production processes. Even with the large

amount of research and growing interest in this area, there are still many questions to be solved when using microbes. They are mainly related to the fact that synthesis processes require a large amount of resources, capacities, control of the composition of the resulting substances. Researchers are faced with the task of minimizing costs and the amount of emissions, since part of the resulting biomass is wasted (Elinov, 1995).

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