
Perspective for the Development of the Bioplastics Market in Russia: Key Products and Technologies

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Abstract:

The article is devoted to the study of the perspectives for the development of bioplastics market in Russia as one of the most important markets for the direction of effective processing of agricultural products using modern biotechnologies.

Using the method of collection and evaluation of "large data", a study of the global market of bioplastics was conducted, the largest drivers of the market were identified and the dynamics in the market, as well as changes in the economic climate affecting both the industry itself and its dependent sectors.

By collecting expert opinions, as well as evaluating analytically further scenarios for the development of bioplastics market in Russia, the main priorities of market development were identified, starting from possible products and ending with the scientific and practical tasks that producers of biopolymers are facing today.

Keywords: Market development forecast, bioplastics market, key biotechnologies, biotechnologies development, bioplastics, biopolymer, biodegradable polymer.

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1. Introduction

The production and use of synthetic polymer materials contradicts the principles of resource-saving, since synthetic plastics are produced on the basis of non-renewable hydrocarbon raw materials, and also causes an increase in ecological risks associated with environmental pollution problems due to their inefficient utilization. World production volumes of synthetic polymers, mainly represented by various polyolefins, are huge (about 300 million tons per year) and continue to grow. At the same time, the share of all plastic materials that are recycled in the world is about 15% (Volova, 2014; Thevenon *et al.*, 2014), while most of the waste products of plastics are buried or burned.

In response to the emerging ecological and energy threats, a number of preventive measures have already been taken in many countries, including bans and restrictions on the use and disposal of plastic bags. A striking example of the world trend in reducing the pressure of the chemical industry on the ecology is the final document of the UN Conference on Sustainable Development RIO+20, in which the transition to the rational use of chemicals throughout the product life cycle by 2020 is identified among the main priorities for state leaders focused on sustainable development (The Future..., 2012). In the current situation, bioplastics obtained from renewable raw materials became an alternative to synthetic plastics. A significant role in the development of biopolymers production technologies is played not only by the concomitant ecological benefits, but also by the bioplastics properties: biocompatibility and biodegradability for implants and surgical threads, reduced resilience of tires with biopolymer components, etc.

The urgency of the development of the bioplastics market in Russia today is beyond doubt, as evidenced by the current strategic documents. So, in the Comprehensive Program for the Development of Biotechnologies in the Russian Federation for the Period to 2020 and the State Coordination Program "BIO-2020", among the development priorities, "biocompatible materials" for biopharmaceuticals and medicine and "production of biodegradable polymers" for industry and bioenergetics are indicated (VP-P8-2322..., 2012; State coordination..., 2012). Separately, in the documents the need to finalize the technical regulations of the Customs Union "On Packaging Safety" is indicated in order to stimulate the introduction of biodegradable materials. In addition, in the S&T Foresight Study for the Russian Agricultural Sector Until 2030 (2017), approved by the Ministry of Agriculture of the Russian Federation, the market of biopolymers appears among promising emerging markets.

At the same time, in the document the projected volumes of the global market of biopolymers of renewable raw materials (20 milliard dollars by 2030) are indicated, as well as the expected contribution of Russia to the global market of bioplastics: 7.5% under "local growth" scenario and 10% in the case of "global breakthrough" scenario (S&T Foresight Study, 2017). The Forecast of scientific and technological

development of Russia for the period until 2030 (Alekseeva, 2013) also presupposes the development of technologies for obtaining biopolymers based on organic raw materials.

However, there is no planning system in Russia that determines the future characteristics of this and other markets, and also the tasks that should be solved for their effective growth. This is the aim of the project of developing a forecast for implementation of the priority of scientific and technological development, defined in paragraph 20g of the Strategy of scientific and technological development of the Russian Federation (agreement No. 14.601.21.0016, project ID: RFMEFI60117X0016) (2014), within which the present work was carried out.

The purpose of this study is to identify the main trends in the development of the bioplastics market in Russia, as well as the most promising areas of application of the market products, taking into account the experience of foreign biopolymers manufacturers. On the way to achieving this goal, the research tasks were defined, namely: to compile lists of the most promising products and services of the market and technologies required for its successful development.

2. Methodology

To compile a list of promising market products, as well as the technologies necessary for its effective growth, the following working methods were used:

- analysis of open sources, analytical and strategic documents;
- analysis of “large” data, taking into account key Russian and foreign analytical and forecast documents, news and other open Russian and foreign sources;
- interviews with experts in the field of effective processing of biomass;
- questioning of experts in two stages.

All the obtained results were analyzed and summarized for the purpose of forecasting the development of the Russian biopolymers market

3. Discussion and Research Results

Theme 1: Drivers of the market, backgrounds: World production of plastics in 2016 was 280 million tons, 29% of which were produced in China, 19% were produced in the EU countries and 18% were produced in the NAFTA countries. At the same time, most of the plastics then, as now, were used for packaging products: in 2016 only the European demand for plastic packaging products amounted to about 20 million tons (about 40% of the total demand of Europe for plastic) (Plastics..., 2017).

The use of synthetic plastics is criticized mainly because of the issues of their utilization: one of the critical ecological problems is the plastic pollution of the

ocean. Plastics are 60-80% of all marine garbage (Derraik, 2002), and according to existing mathematical models, scientists estimate the total weight of plastics that pollute the hydrosphere at 268,940 tons (Eriksen *et al.*, 2014) or more (van Sebille *et al.*, 2015), which is approximately 5.25 trillion plastic waste units, excluding garbage on the seabed or on the beaches. In early 2018, a great response was caused by the researchers of Greenpeace, who reported the discovery of microplastic particles in Antarctic waters (Microplastics..., 2017). It reflected both in the adoption of new laws (more than 40 countries established legislative restrictions and bans on the use of plastic bags in their territories: in Denmark since 1994 there is a tax on free distribution of plastic bags in stores, in Singapore, Bangladesh and Taiwan since 2003 there is a complete ban on the use of plastic bags, in Kenya there is an imprisonment for the import and sale of plastic bags (Odula, 2017), and in a set of social initiatives: this year United Nations dedicated World Environment Day to the problem of plastic pollution, as well as under the auspices of UNEP announced a global company to combat marine litter (CleanSeas, n/d). Large foreign supermarkets (Tesco, ASDA, Lidl, etc.) also show ecological responsibility and already refuse disposable plastic bags. In Russia, the main initiator of reducing the use of plastic is Greenpeace. At the same time, experts in the field of biotechnology, interviewed during the work on this project, name transition from traditional plastics to bioplastics (materials based on polymers from biological raw materials) as one of the ways to solve the problem of plastic contamination.

Theme 2: State of the world bioplastics market today: Today bioplastics make only about one percent of 320 million tons of plastic produced every year. According to the latest data collected by the European Bioplastics in cooperation with the Nova-Institute (Bioplastics market data 2017), the global production capacity of the market by 2022 should reach 2.44 million tons (in 2017 it was 2.05 million tons). According to the BCC Research report, the production of bioplastics by 2020 may increase by 271% compared to 2015 (A budding market, 2017).

The existing global bioplastics market is the market for large players. A key market share consists of a dozen of companies, including BASF SE, Dow DuPont, FMC Biopolymer AS, Plantic Technologies Ltd, Archer Daniels Midland, NatureWorks LLC, Novamont SpA, Danimer Scientific, Total Corbion and Galatea Bio Tech. The main bioplastics production is situated in Asia and South America, followed by Europe and North America (Figure 1) (Global biopolymers market, 2018).

In terms of actual bioplastics production, Asia is the undisputed leader (more than 50% of all bioplastics that have entered the market). However, the EU countries occupy the first place in the field of research and development. In part, a number of legislative measures, including European directives 94/62/EU of December 20, 1994 on packaging and packaging waste and 2000/53/EU of September 18, 2000 on the restriction of the use of chemicals, have had a positive effect on the development of the biopolymer market in Europe.

Figure 1. World production of bioplastics in 2017 by regions (Bioplastics market data 2017)

Global production capacities of bioplastics in 2017 (by region)



Theme 3: Promising products of the market: Today, innovative biodegradable biopolymers, such as PLA (polylactic acid) (Nampoothiri *et al.*, 2010) and PHAs (polyhydroxyalkanoates) (Mohapatraa *et al.*, 2017) are the main growth drivers of the bioplastics market. PHAs are an important group of polymers that enter the market in increasing volumes: the projected growth in PHAs production capacity is estimated as 300% after the next 5 years. The growth in world production of PLA is also projected to be impressive; it will be 50% more by 2022 compared to 2017.

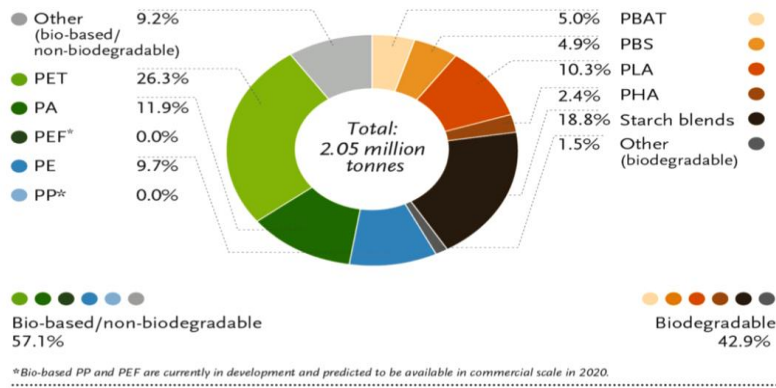
At the same time, most of the biopolymers market (more than 56% of the market or 1.2 million tonnes per year) currently consists of non-biodegradable plant-based plastics, such as bio-PE (bio-polyethylene) (Fasciotti, 2017), bio-PET (bio-polyethylene terephthalate) (Chen *et al.*, 2016), bio-PA (polyamides) (Negrell *et al.*, 2016), as shown in Figure 2. PEF (polyethylenefuranoate), a new polymer (van den Oever *et al.*, 2017) is expected to enter the market in 2020. PEF is comparable to bio-PET, but, unlike the latter, 100% consists of biological raw materials.

Dupont, ADM, Corbion, as well as Avantium and BASF have already shown their interest in the production of PEF. It is expected that in 2022 bio-PP (bio-polypropylene) and its derivatives will also enter the world market on a commercial scale; the growth potential of these products will be very high due to the broad PP applications and the high characteristics of new bioplastics of this class (Hu *et al.*, 2018).

Bio-PUR (bio-polyurethanes) based on biomass is another important group of biopolymers that already have a well-developed market and are produced on a large scale (Noreen *et al.*, 2016). This kind of bioplastics is versatile, which opens up a multitude of emerging markets for its producers. Figure 2. shows the structure of world bioplastics production in 2017 (Rebelo *et al.*, 2017).

Figure 2. Structure of world bioplastics production in 2017 (Bioplastics market data 2017)

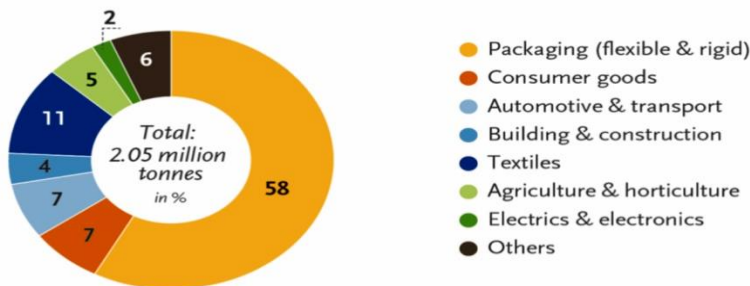
Global production capacities of bioplastics in 2017 (by material type)



Theme 4: Fields of application: Today, bioplastics are widely used in a growing number of markets, from the packaging of food and consumer electronics to the agriculture, auto, textile and construction industries (Figure 3). In this case, packaging remains the largest area of modern bioplastics application (about 60% of the total bioplastics market in 2017).

Figure 3. Segments of the world bioplastics market in 2017 (Bioplastics market data 2017)

Global production capacities of bioplastics in 2017 (by market segment)



Also medicine and pharmacology are increasingly interested in using materials based on bioplastics of a new generation, which opens new opportunities for development to the biopolymers market. Today, modern biocompatible and highly ecological surgical and disposable medical materials, components of drug delivery systems, sutures and dressings, matrices for cellular and tissue engineering, elements for transplantology and much more are produced on the basis of biopolymers (Overview of the biotechnology, 2014; Pattanashetti *et al.*, 2017).

In the final list of key products and services of the market were included the following items:

- biodegradable polymers based on natural components of plant, animal and algal biomass (cellulose, starch, collagen, chitin, etc.);
- polymers and their components produced in result of microbiological synthesis (polymers based on lactic acid, glycolic acid, polyhydroxyalkanoates, etc.);
- bioplastics for medicine and pharmacology (surgical and disposable medical materials, components of drug delivery systems, sutures and dressings, elements for transplantology, etc.);
- bioplastics for household needs (disposable tableware, clothing, technical textiles and fabrics);
- biodegradable packaging, bioplastics for agriculture (seed coaters, degradable films, etc.).

Theme 5: Competences and perspectives: In Russia, biopolymers are not currently produced on a significant scale. The most obvious barriers to the development of the industry in the country are: the limited paying capacity of enterprises and potential consumers, the lack of attention to the ecological problems on the part of the legislature, as well as the unwillingness of investors and enterprises to invest money in the development of new technologies with a long payback period. However, in recent years in Russia there have been manufacturing enterprises engaged in obtaining biodegradable packaging. They are: EuroBalt Company LLC, Tiko-Plastik CJSC, DAR PF, Artplast LLC, Pagoda National Company CJSC, Belavi LLC.

Studies aimed at studying the processes of biopolymers synthesis in Russia have not been properly developed up to the present moment; nevertheless, scientific competences that allow working effectively on the development of the industry are significant and concentrated in following scientific centres: V.A. Kargin Polymer Research Institute, Karpov Institute of Physical Chemistry, N.M. Emanuel Institute of Biochemical Physics RAS, Siberian Federal University, Institute of Biophysics, Siberian Branch of the Russian Academy of Sciences, Federal Research Centre “Fundamental Foundations of Biotechnology” of the Russian Academy of Sciences, K.G. Scriabin Institute of Biochemistry and Physiology of Microorganisms RAS and others.

One of the promising directions of growth of the Russian bioplastics market is use of plant and animal subproducts and wastes products of the market. This is due to the agricultural sphere widely developed in the country. The most promising products of the market are biodegradable and biocompatible biopolymers for use in medicine and pharmacology. Today in Russia, most of the market for biopolymers of medical purpose is imported products. Meanwhile, the demand for such materials and medical products remains high and will only grow in the future. For example, the country’s need for endoprosthesis of large joints is estimated at 300-400 thousand

operations per year, whereas in fact no more than 100 thousand such operations are actually performed (Overview of the biotechnology, 2014). The Russian pharmacological industry is also almost entirely dependent on imported raw materials, which is one of the decisive reasons for its low competitiveness.

Theme 6: Key technologies: The determination of key technologies for the biopolymers production proceeded from the directions of using the products of these technologies and their basic properties. Consideration was given to the availability of relevant competencies in the country, the successful market experience, the specifics of its development, and the expert opinions collected during the study. The final list of key technologies of the direction, thus, included:

- Technologies for obtaining biodegradable and biocompatible polymers for medicine and pharmacology and products based on them.
- Technologies for production of polymer materials with bioadditives for the production of decomposable packaging, household and agricultural products.
- Technologies for creating new strains producing biopolymers or their precursors.
- Technologies for sorting agricultural and fishery wastes, as well as MSW.

4. Conclusion

The purpose of this work was to outline the general perspectives for the growth of the bioplastics market in Russia, identifying the main prerequisites for its development in the country in the short and long term. It was shown that the bioplastics market is one of the most important emerging in Russia new markets, based on the principles of effective processing of agricultural products using modern biotechnologies. At the same time, the main drivers of market development are: the need to reduce ecological risks associated with the problem of recycling synthetic plastics, the transition to resource-saving technologies in the country, as well as the need of the country's significant industries in the market products.

The study included the identification of the main areas of bioplastics application in the world, the review of existing technologies and already used materials, the search for Russian competencies that contribute to the development of the market and the definition of future applications of domestic products of the industry. As a result of the work, key products were identified that could ensure the effective development of the Russian biopolymers market due to their growing demand by consumer industries, as well as key technologies necessary for the production of these products.

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