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Research Article

Bioplastics / Biopolymers: How Aware Are We?

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Abstract

Today, polymers have found a wide range of uses from kitchen utensils to artificial heart valves, thanks to their lightness, easy shaping, corrosion resistance, and cheapness. A large number of polymers are used in the packaging of food, textiles, and machinery, and they are an important part of solid waste disposed of in landfills. In addition, microplastics, which are small particles under 5 mm, pose a major problem in the pollution of rivers, lakes, seas, and oceans and increase our carbon footprint. Many strategies are being developed in parallel with the Green Deal to reduce both all the negative effects caused by polymers and our carbon footprint. According to the European Green Deal, reducing waste, compensating for carbon footprint emissions, and protecting resources and sustainability are key priorities for the EU now and in the future. Reusability and biodegradable polymer production are important parts of these strategies. The scientific works demonstrated the opportunity for renewable, biodegradable biopolymers to replace their synthetic counterparts in a variety of /application. Biopolymer is a type of polymer and a biodegradable chemical compound that is produced by living beings in the ecosphere. Biopolymers obtained from natural materials (e.g. alginate, zein, gelatin, agar, and chitin/chitosan) are highly abundant but underexploited renewable biomasses. Besides their natural biological and structural functions, the biopolymers can be tailored to new biomaterials with novel functionalities. The roles of biopolymers in obtaining environmentally friendly materials are very important for the future of the world.
So, are we aware of plastic pollution and ways to reduce it? Is there enough awareness in academia, industry, and society for biopolymers that are so important for a sustainable environment? In this study, the answers to these questions are researched and discussed.

Keywords: Biopolymer, Bioplastic, Green Deal, Sustainable Environment, Pollution.

Biyoplastikler / Biyopolimerler: Ne Kadar Farkındayız?

Öz

Günümüzde polimerler, hafiflikleri, kolay şekillendirilmeleri, korozyona dayanıklılıkları ve ucuz olmaları nedeniyle mutfak gereçlerinden yapay kalp kapakçıklarına kadar geniş bir kullanım alanı bulmuştur. Gıda, tekstil ve makinelerin paketlenmesinde çok sayıda polimer kullanılmaktadır ve bunlar çöplüklere atılan katı atıkların önemli bir bölümünü oluşturmaktadır. Ayrıca 5 mm'nin altında küçük parçacıklar olan mikroplastikler nehirlerin, göllerin, denizlerin ve okyanusların kirlenmesinde büyük sorun teşkil etmekte ve karbon ayak izimizi arttırmaktadır. Hem polimerlerin neden olduğu tüm olumsuz etkileri hem de karbon ayak izimizi azaltmak için Yeşil Mutabakata paralel olarak birçok strateji geliştiriliyor. Avrupa Yeşil Mutabakatına göre, atıkları azaltmak, karbon ayak izi emisyonlarını telafi etmek ve kaynakları ve sürdürülebilirliği korumak AB için şimdi ve gelecekte temel önceliklerdir. Yeniden kullanılabilirlik ve biyolojik olarak parçalanabilen polimer üretimi bu stratejilerin önemli parçalarıdır. Bilimsel çalışmalar, yenilenebilir, biyolojik olarak parçalanabilen biyopolimerlerin çeşitli uygulamalarda sentetik muadillerinin yerini alma fırsatını göstermiştir. Biyopolimer, ekosferde canlılar tarafından üretilen bir tür polimer ve biyolojik olarak parçalanabilen bir kimyasal bileşiktir. Doğal malzemelerden (örneğin aljinat, zein, jelatin, agar ve kitin/kitosan) elde edilen biyopolimerler oldukça boldur ancak yeterince kullanılmamış yenilenebilir biyokütlelerdir. Doğal biyolojik ve yapısal işlevlerinin yanı sıra biyopolimerler, yeni işlevselliklere sahip yeni biyomalzemelere uyarlanabilir. Biyopolimerlerin çevre dostu malzemeler elde etmedeki rolleri dünyanın geleceği için oldukça önemlidir.
Peki, plastik kirliliğinin ve bunu azaltmanın yollarının farkında mıyız? Sürdürülebilir bir çevre için bu kadar önemli olan biyopolimerler için akademi, endüstri ve toplumda yeterli farkındalık var mı? Bu çalışmada bu soruların cevapları araştırılmakta ve tartışılmaktadır.

Anahtar Kelimeler: Biyopolimer, Biyoplastik, Yeşil Mutabakat, Sürdürülebilir Çevre, Çevre Kirliliği.

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1. Introduction

It can be said that the meeting of the modern world with plastics started in the 1400s after Christopher Columbus encountered a ball made of natural rubber in Haiti. Charles Goodyear had added sulfur to natural rubber, making its properties incredibly change. After the first synthetic polymer was obtained in the early 1900s, the properties of its molecules were discovered in the 1920s, and nylon was indented in 1928. Since the early 1950s, many different types of polymeric materials have been developed [1].

Today, plastics have an important place of our lives. It has found a wide range of usage for many reasons such as lightness, easy formability, mixing ability with different additives and changing properties easily, and having good corrosion resistance. Except the naturals, polymers can also be classified as thermoplastics and thermosets. A thermoset cannot be reprocessed due to its cross-links, so it is not recyclable. However, a thermoplastic material can be reprocessed and recycled by heating it to the appropriate temperature. Polymeric materials find a wide range of uses, from kitchenware to car bumpers, from chairs to artificial heart valves. But especially a large amount of polymeric material is used in packaging (food, textile, machinery, etc.) processes. The disappearance of plastics in nature begins after 450 years.

In the EU, around 25.8 million tonnes of plastic waste are produced in every year. The collected plastic waste is less than 30% of all generated plastic in total [2]. Only 6% of plastic products are demanded in Europe as recycled plastics. Around 5 to 13 million tons of plastics, 1.5 to 4% of global plastic production worldwide, are transported to the oceans. It is estimated that 150 000 to 500 000 tonnes of this amount originates from the European Union [3,4]. This ratio is frightfully increased by the increasing amount of plastic waste produced each year. The most important factor on this increase is the increase in the amount of 'single-use' plastics which are used to produce small packaging, bags, disposable cups, etc.

Plastic wastes are important part of solid waste disposed to solid waste landfills. Most of these wastes are packaging plastics. In this environment, they can remain intact for many years, which causes the landfill to be filled prematurely. Reuse in manufacturing, incineration for energy generation, biodegradation in compost or in soil in natural environment can be counted as disposal processes of plastic wastes. However, large quantities of plastic (millions of tons per year), especially packaging plastics, are still being thrown into landfill, where they take up a large amount of space and contribute to capacity shortages. Plastic packaging parts are represented about 8% of the overall refuse in the landfills [5].

Microplastics can be defined as tiny fragments below 5 mm in size. Their leakage and pollution are also increasing day by day and are almost a part of the food chain in the oceans. Approximately 75000 to 300000 tons of microplastic emissions are estimated in the European Union per year [6].

As explained above, plastics and microplastics represent one of the biggest environmental and health problems in the world and Europe. To reduce all negativities caused by plastics, Europe needs a sustainable and innovative plastic strategy. For this purpose, EU has developed "A European Strategy for Plastics in a Circular Economy" [7]. Reusability and nature-degradable plastic production are an important part of this strategy. Actions on compostable and biodegradable plastics are included in this strategy, also.

In the ASTM document D883-00, "Standard Terminology Relating to Plastics" necessary definitions are made related to degradable plastic materials [8]:

-Biodegradable plastic: A degradable plastic in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi, and algae.

Biodegradation of organic materials is the result of the activities of microorganisms such as fungi, yeasts, actinomycetes, and bacteria. Fungi and bacteria represent a wide range of possibilities [5]. Biodegradable plastics, "Green plastics", typically can be produced in various forms such as film and fibers, and are compatible with extrusion and moulding which are easy-to-apply production forms. Except some application area like starch-based loose-fill packaging market, Green plastics comprise less than 1% of today's plastics [9].

For a more livable world, biodegradable plastics should be recognized and used. Although research on green plastics is increasing day by day, their use is not at the desired level. Most people and most manufacturers either have no knowledge of these plastics or know very little.

For this reason, the FutureBio project idea is developed, supported by the Turkish National Agency with project number 2021-1-TR01-KA220-HED-000032160 within the scope of Strategic Partnerships in the Field of Higher Education. FutureBio aims:

For society

-To raise social awareness that plastic pollution is an issue that needs urgent and immediate action

-To give information about biodegradable and compostable products

-To obtain awareness about biodegradable and compostable products

- To raise awareness of young people, especially at secondary and higher education levels

- To increase the usage of bio bags by replacing and selling plastic bags throughout the country and Europe.

For academics

-To give information about biodegradable and compostable products

-To obtain awareness about biodegradable and compostable products

- Encourage and guide the development of biodegradable and compostable materials and products

-To guide them to prioritize these issues in their academic career planning

-To increase the competencies of trainers for vocational education

For manufacturers

-To give information about biodegradable and compostable products and their usage areas

-To obtain awareness about biodegradable and compostable products' advantageous

- Encourage and guide the manufacturing of biodegradable and compostable products

-To help the people who are working/will work in these manufacturers to gain the right professional knowledge and competence

The project outputs and the events to be organized in line with the European strategies within the scope of the FutureBio idea can be summarized as follows:

- To prepare a curriculum and training materials for both higher education and companies related to green polymers

-To prepare a guide on the usability of methods and machines instead of today's plastic material for the production of biodegradable plastics

-To prepare dissemination materials for raising social awareness (leaflet, website, social media platforms, etc)

-To prepare dissemination activities for raising social awareness

-To contribute to the training and development of the academic staff of the project partners in applications and products in different fields

-To contribute to the training and development of the employees of companies engaged in applications and products in different fields

-To prepare webinars for academics and employees

- Creating a value chain extending from the laboratory to the industry, from industry to the environment and the economy.

Despite the importance of biopolymeric/biodegradable materials in technology and the impact on our life the knowledge and implications related to them seem not so common. This is why a short survey was created to guide the project idea and to analyze the initial needs. A total of 347 people from Turkey, Romania, Italy, Denmark, and the other EU countries answered the survey. In this study, the results of the survey study are given and the general awareness level about biopolymeric/biodegradable materials is discussed.

2. Material and Method

The survey prepared to measure the level of knowledge at basic level and awareness about bioplastics/biopolymers consists of a total of 13 questions and two parts. No personal data was requested from those who filled out the survey and the syrvey was filled on a voluntary basis. A permission was obtained from Pamukale University Social and Human Sciences Research and Publication Ethics Committee for the survey application.

The first part of the survey prepared for university students, academicians and industrial workers was included the following information:

1. the country of the participants,

2. the last school level from which he/she graduated,

3. whether they are students, academics, scientists or industrial workers

4. working area

The second part of survey was included following questions related to bioplastics/biopolymers basic knowledge:

1. Your level of knowledge on Polymers / Plastics

2. Do you use plastic bags while shopping?

3. Do you separate plastic waste for recycling?

4. Your level of knowledge on biopolymers

5. Do you know the difference between biopolymer and conventional plastics / polymers?

6. Do you want to take online courses related Biopolymer?

7. Do you want to attend a seminar related Biopolymer?

8. If there is a social media account about Biopolymer, would you follow it?

9. Would you like to do a scientific study after you have enough information about biopolymers?

After completing the questionnaire prepared and filled using Google Forms, analysis was made for each question.3. Results and Discussion

The survey was filled by a total of 347 participants from Turkey, Romania, Italy, Denmark, and the other EU countries answered the survey (Figure 1).

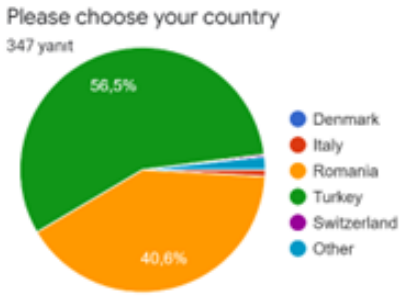

Figure 1. Distribution of respondents by country

As can be seen in Figure 2, 43.8% of the respondents have a high school degree, 20.7% have a bachelor degree, 11.2% have a master's degree, and 24.2% have a PhD.

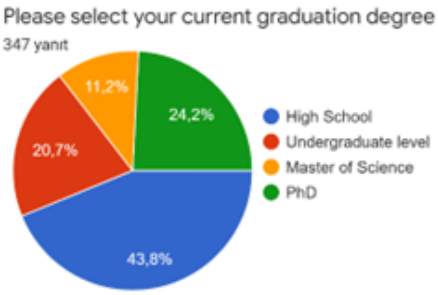

Figure 2. Distribution of respondents by graduation degree

The rate of students, academic staff/scientists, and industrial workers who responded to the survey were 52.2%, 31.8%, and 16%, respectively (Figure 3).

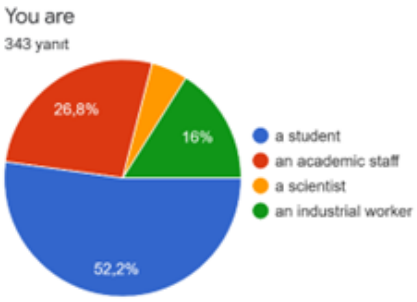

Figure 3. The rate of students, academic staff/scientists, and industrial workers who responded to the survey

As can be seen in Figure 4, fields of study of participants are engineering (159), educational sciences (66), social sciences (22), economic and administrative sciences (41), Science and Mathematics (24), architecture (7), Medicine and health sciences (9) and other professional branches (19). Thus, an awareness study was carried out in a wide range of professional groups.

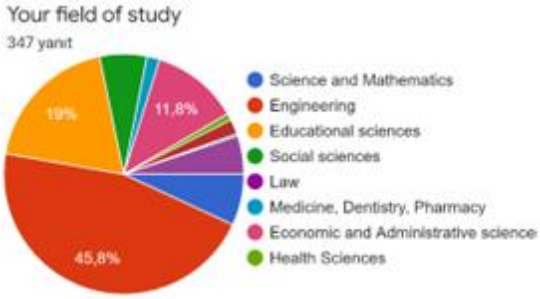

Figure 4. Fields of study of respondents

The level of knowledge on polymer/plastic materials question showed that only 10.1% of the participants have good knowledge of plymeric materials (Figure 5).

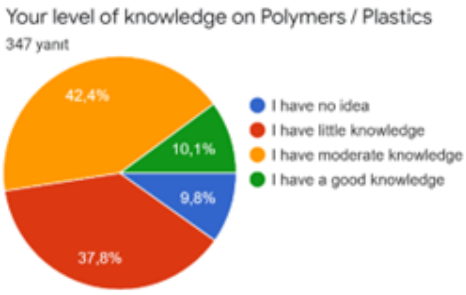

Figure 5. The level of knowledge on polymer/plastic materials of respondents

Only 10.1% of respondents answered that they do not use plastic bags in shopping, while the remaining participants stated that they rarely use plastic bags (Figure 6).

Figure 6. The level of plastic bags using

Only 11.8% of the participants gave a negative answer to the question about the separate of plastic wastes for recycling. While 16.4% of the respondents seldom sorted garbage, the remaining participants stated that they usually sorted the garbage for recycling (Figure 7).

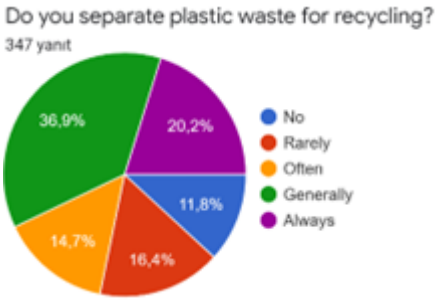

Figure 7. Separation rate of plastic wastes

Figure 8 shows that the level of knowledge on biopolymer materials. It can be seen that only 6.4% of the participants have good knowledge.

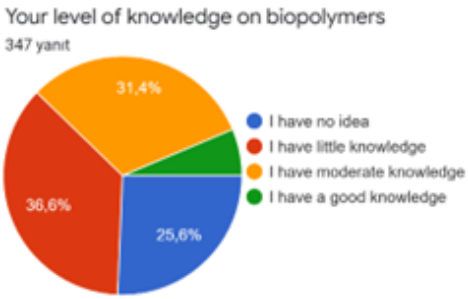

Figure 8. The level of biopolymer materials knowledge

The results showed that only 37.8 % of the participants know enough about biodegredable polymers and only 13.8% of them know the difference between traditional plastics and biodegredable polymers very well (Figure 9).

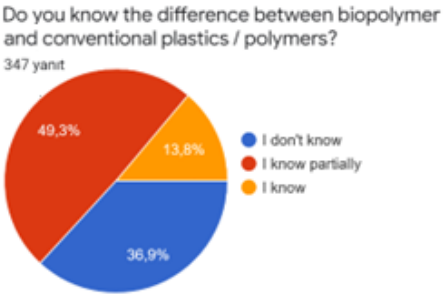

Figure 9. The level of knowledge between biodegredable polymers and traditional plastics

The respondents except 17% of the participants stated that if there are courses and seminars related to biodegredable polymers, they can participate in these (Figure 10 and Figure 11).

Figure 10. Responders' willingness to join online courses related biopolymer

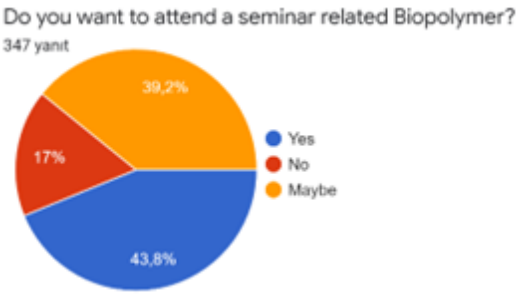

Figure 11. Responders' willingness to join seminars related biopolymer

Approximately 57,1% of the responders seem to be able to follow the issue effectively if sufficient awareness is created (Figure 12).

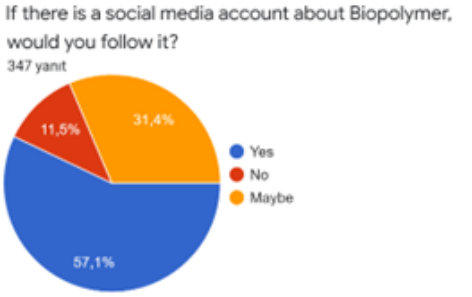

Figure 12. Responders' willingness to follow social media accounts related biopolymer

Figure 13 shows that the responders' answered ,48,4% rate, if they will have enough information on biopolymers, they would like to do scientific study.

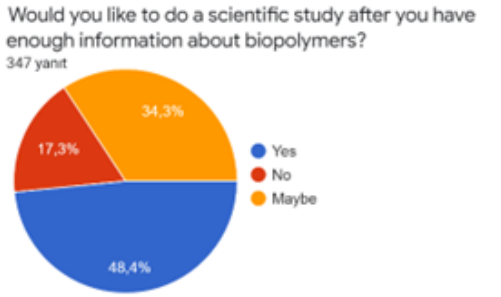

Figure 13. Willingness to do scientific work on biopolymer after having sufficient knowledge

4. Conclusions and Recommendations

Polymeric waste is frightfully increased with 'single-use' plastics each year. For reducing this rate, reusability and naturedegradable polymer production are important. According to the European Green Deal Communication [10], reducing wastes, compensating carbon footprint emissions, saving resources, and sustainability are key priorities for the Europe now and in the future. For a more liveable and green world, biopolymers should be developed and used.

The preliminary studies carried out within the scope of the FutureBio project supported by the Turkish National Agency show that the knowledge and awareness of all segments of the society about biopolymer is not at the desired level. For this reason, information and awareness studies should be carried out in especially in universities, industrial institutions, employees in these institutions, and in every part of the society.

In the efforts to increase awareness and knowledge level, digital training materials, whose importance has become more evident with the Covid-19 pandemic, should also be used. In order to attract the attention of the Z generation, educational materials and social media platforms containing high-performance and interesting digital technology should be prepared, and more importance should be given to environmental activities.

5. Acknowledge

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