FUTUREbio

Project Sustainability and Exploitation Plan

Project Acronym:	FutureBio
Project full title:	Let's use biodegradable plastic for the future
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Version	Date	Author (Partner/Person)	The revision reason
0.1	14.12.2023	Arzum IŞITAN (PAU)	first draft that forms the plan

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1. Introduction

The modern world has met with plastic and polymeric materials for the first time in the 1400s after Columbus encountered a natural rubber ball in Haiti. Today, polymers have found a wide range of applications thanks to their lightness, easy formability, and wide range of uses, from kitchenware to artificial heart valves. Many polymers are used in the packaging of food, textiles, and machinery, and they are important parts of solid waste disposed of in landfills.

According to EU reports, PM packaging parts represent about 8% of the overall refuse in the fills. Besides, microplastics which are tiny fragments below 5 mm in size, are a big problem for leakage of rivers, lakes, seas, and oceans. They can remain intact for many years. Reuse in manufacturing, incineration for energy generation, and biodegradation in compost in soil can be counted as disposal processes for plastic waste. To reduce all negativities caused by polymers, "A EU Strategy for Plastics in a Circular Economy" and “Plastic Waste: A EU Strategy to protect the Planet, defend our citizens and empower our industries” has been developed. In the EU, around 25.8 million tons of plastic waste are produced every year. EU reports also state that only 6% of plastic products are demanded in the EU as recycled plastics. Polymeric waste is frightfully increased with ‘single use’ plastics each year. Reusability and nature- degradable polymer production are important parts of these strategies. According to the European Green Deal Communication, reducing wastes, compensating carbon footprint emissions, saving resources, and sustainability are key priorities for the EU now and in the future. For a more livable and GREENER world, biopolymers should be developed and used. The FutureBio project was carried out to contribute to these basic priorities. Project aims to make the use of innovative practices among university students, academic staff, industry employees, and the community and to increase the competencies of academics and students with in-place training. This project has been prepared in accordance with the European Union's strategy of developing cooperation, increasing quality and encouraging innovation in the learning activities of individuals and groups in the field of education and training. In the preparation of the project, especially the difficulties and crisis caused by Covid-19, the importance of digital education for digital transformation in accordance with the Digital Education Action Plan was taken into consideration. Considering these issues, it is our priority to develop a high-performance digital technology for university students and industrial workers within the scope of the project. In this way, we aim to develop high quality digital technologies for education of universities and industrial institutions providing information on polymer and biopolymer and their manufacturing technologies all over Europe. We aim to improve capacity and flexibility in education by making digital tools. The project applied the most innovative training technologies based on E-LEARNING and mobile learning tools with INTERACTIVE VIDEOS and animation applications in game format and VIRTUAL REALITY tools that contribute to improve the trainees’ motivation and engagement. The learning material is structured according to a competency-based learning approach. The use of e-learning and other related technologies in the FutureBio project can provide new opportunities for learners increasing flexibility, motivation and engagement. Students can take control of their learning and be an active part of the learning process. In addition, online learning offers several new opportunities for learners and teachers, including the relatively low cost of technologies.

FutureBio was a two-year KA220-HED-Cooperation Partnerships in Higher Education project supported by Turkish National Agency, on biopolymers between nine partners from Turkey and

EU. The FutureBio project, which has provided information about bioplastics and production methods and carried out awareness studies with new innovative training materials, is the first project in the field. FutureBio has five work packages and phases categorized into four management levels to benefit from innovative practices among university students, academic staff, industry workers, and society, and to increase the competencies of academics and students with on-site training:

- Management Level: Phase1: Management
- Operation Level: Phase 2 and Phase 3: Curriculum preparation, including needs analysis, company visits and survey applications, report preparation, the creation of interactive open-access education modules, lecture guidebook, and VR exercises.
- Dissemination Level: Phase 4: Dissemination and sustainable implementation of the products
- Monitoring and Control Level: Phase5: Quality Control and Monitoring

As is known, a European project and its outputs and results are only successful when they are of sustainable value. The further use of the project outcomes is basically connected with successful project results and exploitation activities. The sustainability and exploitation strategy ensures the sustainability of the project and its results after the end of the funding period and will provide recommendations and guidelines for the continuous use of the project's results after the end of the project.

The dissemination actions of FutureBio project are:

- Establish or connect with existing networks to promote awareness and engagement;
- Provide information and assistance to local and regional institutions;
- Distribute information to EU-wide networks, stakeholders, influential institutions and opinion-formers relevant to the topic;
- Disseminate new content for academics, university students, industrial workers, institutions, and general public;
- Stimulate dialogue between educational institutions and public and private institutions related to manufacturing, environment, energy, and agriculture sectors

The dissemination plan is based on the following characteristics and principles:

- it has been oriented towards the needs of the users, incorporating the types and levels of information needed into the forms and language preferred by the users, various dissemination methods, including written information, electronic media, and person-to-person contact, were used;
- it has incorporated both proactive and reactive dissemination channels;
- it has included information that target groups have identified as important and are likely to need;

- it has drawn upon existing resources, relationships, and networks to the maximum extent possible while building new resources as needed by target groups,
- it has included effective quality control mechanisms to assure that information to be included in the system is accurate, relevant, and representative;
- it has included sufficient information so that the target groups can determine the basic principles underlying specific practices and the settings in which these practices may be used most productively;
- it has established connections to resources that may be needed to implement the information.

The dissemination process was considered an essential and critical project activity, not only for spreading information among target groups but also for motivating external actors to be involved in the different project activities in order to include their contribution within the project outputs and activities.

This document is prepared based on information obtained from the following documents:

1. Erasmus+ KA204: Cooperation Partnerships in Adult Education Project Proposal for “Click me if you forgot”,

2. Partnership Agreement,

3. Erasmus+ Programme Guide Version 2 (2019): 15/01/2019.

2. Sustainability of FutureBio project results

Sustainability is the capacity of the FutureBio project to continue its existence, effect, and functioning beyond its end. The main aim of the sustainability strategy is to discuss, create, and develop ways in which the project outputs can be led to further sustainable use. FutureBio's sustainability strategy does not focus only on the individual suggestions of each partner but also provides some general information and suggestions on how to use the results of the project after the end of the funding period.

The following two key aspects are very important for the successful exploitation of the REMEM project results:

- Producing relevant results of good quality to satisfy the demands of target groups and stakeholders.
- Ensuring that results reach the right target audiences in the right format and at the right time, which provides the greatest benefit.

Within the scope of the FutureBio project,

- A detailed field study was carried out.
- A detailed book and online application research were conducted.
- Surveys and pilot studies were conducted to determine the needs of university students, academicians, industrial workers, and high school students.
- As a result of all the studies, a SWOT analysis of the project was made.
- A cross-cultural analysis of knowledge and needs between partner countries was conducted.

- Book chapters and online laboratory video topics were determined according to the needs of the target groups.
- The content of the e-learning materials and VR tools was determined according to the needs of the target group as a result of this research.
- A guide for the use of the VR application has been prepared.
- A training activity (C1) was organized for the staff of the partner organizations in cooperation with the Bruno Kessler Foundation, Università Degli Studi Di Trento and Indivenire srl.
- A training activity for students of the partner universities (C2) was organized in cooperation with the Bruno Kessler Foundation and Università Degli Studi Di Trento and Indivenire srl.
- Information meetings were held in partner countries for high school and university students and participants with different levels of education.
- Students who received these trainings participated in various national and international competitions with their project ideas and achieved successful results.
- Within the scope of the project, consortium carried out various promotional activities in high schools and secondary schools to increase impact: In high schools and secondary schools, activities have been organized, such as art competitions and poster presentations. Earth Day STEM Challenge activities were organized to reach young people with activities at the secondary and high school level, which were held locally in Italy, Romania, and Turkey.
- A poster competition was organized in Germany.
- Social responsibility movements such as collecting plastics, etc. were initiated.
- Within the scope of June 5 Environment Day activities, a painting and assemblage contest was organized with the participation of 40 schools across the province in cooperation with Kırklareli University and Kırklareli Provincial Directorate of National Education. At the school, our students were first shown a video containing information about the degradation processes of plastics in nature and biodegradable plastics. Then the painting contest was announced.
- Fondazione Bruno Kessler, Università Degli Studi Di Trento, and Indivenire Srl participated in EDUCA: TOWARD A NEW SCHOOL (education festival) event held in Rovereto/Italy on 14-16 April 2023, with 13 posters.
- The VR materials created in FutureBio have been published in the Meta Store for VR, and on a webpage for more traditional access. Below are the instructions for accessing the material on both technologies:
    - For VR, the FutureBio 360 materials can be accessed on Meta Quest 2, Meta Vision Pro and Meta Quest 3 goggles through the Meta Store. Someone can install the application on her/his goggles by one of two ways:
        - Either visit the application's Meta Store page on your mobile phone or desktop by visiting the store page and adding the application to her/his account.

- Or she/he can put on VR headset, go to the Meta Store inside the VR operating system and then search for "FutureBio". The application is released in the Meta App Lab.

- For desktop and mobile use, the FutureBio 360 materials can be found by visiting the link at: https://ctrl.studio/play/futurebio or by embedding the content using an iframe to any web page.

Thus, studies were conducted on the main factors contributing to the sustainability of the results of the FutureBio project[1]:

- **Output quality:** The FutureBio project has WP5 (quality assurance of the products). All project outputs have been prepared and tested, considering quality indicators. In addition, the project outputs are constantly updated to ensure sustainability. The platforms required for the website and applications will remain functional for at least 5 years after the project is completed.
- **The adaptability of outputs to the specific circumstances of the countries and organizations involved:** Considering the importance of the high adaptability of the project results and outputs to different country conditions, the FutureBio project outputs were created in 6 languages. The outputs were prepared to consider the results of the field studies and analyses conducted in each partner country.
- **Clear definition of advantages for users:** The capacity of the project and the partnership is very important in reaching the target groups, promoting the project outputs, and increasing the usability of the outputs. All partner institutions have always agreed to share and make the benefits and results of the project transparent and obvious. For this purpose, articles, oral presentations, and promotional activities related to the project will continue without slowing down.
- **Early identification of stakeholders and potential users:** Potential stakeholders were identified in the first 6 months of the project. All project outputs were prepared in consultation with target groups and stakeholders. Those were contacted and kept informed throughout the whole project process to ensure the sustainable use of the results after the project ends.

3. Project Objectives

The target group of the FutureBio project is all project stakeholders, including the project team members, university teachers and students, industrial institutions and their workers, high school students and teachers, public and private institutions, associations, individuals, and general society. The results of the project are to develop a curriculum, prepare a guidebook, and produce educational materials with innovative and interactive tools for university students. The project applies innovative technologies based on e-learning and VR tools with interactive videos and animations in game format. The learning materials are structured according to a competency-based learning approach.

FutureBio is aimed at determining the basic knowledge level of target groups on biopolymers by preparing a short survey during the preparation phase of the project.

[1] https://ec.europa.eu/programmes/erasmus-plus/project-result-content/f60b3b1f-0dcb-460e-95e9-2353343b7373/Sustainability%20PLAN.pdf

The objectives of FutureBio are classified depending on target groups of the project as follows:

For ACADEMICIANS and university STUDENTS

- To create an innovative curriculum, open education resources (OERs), virtual reality (VR) tools, laboratory videos, a lecture guidebook,
- To encourage the development of biodegradable polymers (BDPs) and products via courses and outputs
- To guide them to prioritize in their academic career planning
- To increase the scientific competencies with in-place trainings

For INDUSTRY

- To create an industrial needs report, a value chain extending from lab to industry, from industry to environment and economy

For SOCIETY

- To raise social awareness that plastic pollution is an issue that needs urgent action
- To obtain awareness about BDP products

For PROJECT PARTNER

- To increase digital skills
- Developing new projects

We aimed to improve capacity and flexibility in education by creating digital tools. The project applies the most innovative training technologies based on E-LEARNING and mobile learning tools with laboratory videos and VIRTUAL REALITY tools that contribute to improving the trainees' motivation and engagement. The learning material is structured according to a competency-based learning approach. The use of e-learning and other related technologies in the FutureBio project can provide new opportunities for learners, increasing flexibility, motivation, and engagement. Students can take control of their learning and be an active part of the learning process. In addition, online learning offers several new opportunities for learners and teachers, including the relatively low cost of technology.

In summary, the objectives of the FutureBio project include:

- Supporting the setting up of, and access to, upskilling pathways
- Improving and extending the supply of high-quality learning opportunities tailored to the needs of all target groups
- Open education and innovative practices in a digital era
- Both the figures put forward by the European Union and the European Commission reveal the importance of taking urgent and effective measures and developing strategies in this regard.

The project team planned to spread project results faster by taking the opinions of all target groups and institutions. In this way, new projects can be produced.

Dissemination and sustainable implementation of the products are the 4th WP of FutureBio during the whole project life cycle. The dissemination plan, as a draft version, was prepared by PAU, and at the 1st TPM it was discussed by all partners. Necessary arrangements were made on the plan in line with the opinions and suggestions of the partners. This plan included all activities carried out during the project period for dissemination and sustainability.

Dissemination materials, activities, the number of people to reach, and their expected impact are the following:

- The website was set up in all partner languages and constantly updated.
- 6 webinars as alive were organized through the project's YouTube account. Other broadcasts, including congress presentations, have also been added to the YouTube channel.
- The establishment of social media platforms was done by PAU.
- Newsletters were prepared every six months.
- 7 National Informative Meetings and 1 Workshop/Panel (E1-E8) were organized.
- Announcement of the activities was performed on local and national platforms. The results of the FutureBio project were presented in relevant seminars/conferences, and news.
- Some review and research papers were published in highly-ranked international journals.
- FutureBio Consortium has formed competent institutions in the scientific and technological fields. Dozens of congresses are organized or attended by our partners every year. Within the participation in various conferences/seminars, we distributed approx. 1000 leaflet by PAU and all partners, and via website, social media, press/media we reached over the 20000 people (For example, the news on the PAU official twitter page for the C2 (student trainig) activity of the project, received 1,494 views (https://twitter.com/pauedutr/status/1724700933508989235), and a Linkedin post about the C2 activity received 2485 views (https://www.linkedin.com/feed/update/urn:li:activity:7129262393120948224/).
- Project partners have attended various congress/symposium related to the BDPs.
- A master thesis has been completed in the context of FutureBio.
- A patent application was filed for one of the ideas developed by the PAU team within the scope of the FutureBio project. This patent idea was awarded a silver medal at ISIF 2023.
- The PAU team participated in Teknofest 2022 and Teknofest 2023 with the ideas developed by the FutureBio project. In both years, the project made it to the finals in the Environment, Energy, and Technologies for the Benefit of Humanity / Disaster categories. In Teknofest 2022, the best presentation award was won. a patent application was made for one of these ideas.
- Within the scope of TÜBİTAK 2209-A University Students Research Projects Support Program, student projects on the use of bioplastics were supported in 2022 and 2023 under the supervision of FutureBio PAU team.
- FutureBio's main target group was university students and academicians. With the dissemination activities, additionally, it was reached to industry, high school students, and society using visual and printed materials, website, social media, webinars, and informative meetings.

- At least 285 people were expected to attend national informative meetings. People who work on polymers and their production from the public and private sectors and Municipality were invited. We reached 600 people with those activities directly.
- FutureBio had a workshop/panel held by KLU. This event has been organized to present all the outcomes of the project. 70 local participants attended this activity, including the Vice Governor of Kırklareli.
- Within the scope of the project, the consortium carried out various promotional activities in high schools and secondary schools to increase impact: In high schools and secondary schools, activities have been organized, such as art competitions and poster presentations. Earth Day STEM Challenge activities were organized to reach at least 350 young people with activities at the secondary and high school level, which were held locally in Italy, Romania, and Turkey.
- For university students, various activities were organized. A poster competition organized by OTH. Social responsibility movements such as collecting plastics, etc. were initiated.
- The number of people we directly reached among university students was planned to be 500. With the events organized, press reports, lectures given at university level, and project outputs, we have reached more than this number of university students. Thus, we expect awareness raising efforts to continue locally and across countries.
- One of the expected effects of the project was to combine the theoretical knowledge of universities with industry and to create an environment for joint work. In this context, information was exchanged with PAGEV on many issues.
- Above all, it was expected that educational materials produced using high technology would be met with great interest, especially by Generation Z, and this has happened.
- eTwinnig, Erasmus+ Project Results Platform, and EPALE platforms are also used for dissemination.
- Within the dissemination activities for the public, the Layman's Report provides a general and brief overview of the project and its outcomes, such as the challenges faced by the project, the proposed solutions, the innovative aspects of such solutions, the main achievements and outputs, and the main results of the implemented pilots or recommendations for future. The Layman's Report was the final dissemination activity within the project's duration. Layman's report summarizes the work of a LIFE FutureBio project for a general audience. They are a means of extending the impact of the project beyond the area of implementation.
- Beyond all this, the web platform, which contains all project outputs, will be kept up to date for at least 5 years by the project team.
- The FutureBio 360 VR materials can be accessed on Meta Quest 2, Meta Vision Pro and Meta Quest 3 goggles through the Meta Store.
- For desktop and mobile use, the FutureBio 360 materials can be found by visiting the link at: https://ctrl.studio/play/futurebio or by embedding the content using an iframe to any web page.

All partners have agreed on dissemination, and all partners hold one informative meeting within the project, except IND and FBK. However, leading FBK, UNITN, and IND have attended a lot

of dissemination activities. They worked to disseminate project results using their local and national links.

The creation of the website and leaflet and the opening of social media accounts (Instagram and YouTube) were done by PAU at the beginning of the project. All partners shared project news and announcements on their official websites. In addition, since all partner institutions have very strong local press relations, the project activities are promoted in the local and national press.

For the project logo, PAU, COSVITEC, and CTRL prepared a draft before TPM1, and the project logo was selected during TPM1. After the logo selection, a draft leaflet was prepared by PAU, and after the approval of the partners, all project partners were translated into languages and used in all promotion and dissemination activities.

E-Newsletters have been issued to promote the project and its outputs and translated for dissemination to national training organizations, stakeholders, and media. For this purpose, the partnership used its National Informal Networks. Newsletters were foreseen, 1 every 6 months of the project. Additionally, partners took advantage of their own networks and of the existing platforms and tools for promotion on European level to maximize the publicity effect. At the beginning of the project, the dissemination plan has been prepared by all partners to widespread the products and have a vast outreach.

All documented activities were collected in a final dissemination report, which was made available to the national agency and the public. Arzum Işıtan from PAU, Yasemin Öztekin from SU, Evren Çağlarer from KLU, Gratiela Dana Boca from UTCLUJ, Massimo Bersani from FBK, Alessandro Pegoretti from UNITN, Aniello Gervasio from COSVITEC, Teijo Lehtonen from CTRL, Charlotte Thiel from OTH, and Laura Pasquardini from IND were responsible for dissemination activities as team leaders. COSVITEC and FBK supported the dissemination plan and activities due to their solid experience with several former European projects. They have experts in managing project advertising, plan and advertising campaigns, considering especially dissemination purposes, structuring main paths for main goals and objectives promotion, involving stakeholders and the press, and effectively using 2.0 web tools. They also have an extensive stakeholders' network that includes local, national, and International SMEs, Public Entities, NGOs, schools, and universities that benefited from the outputs of FutureBio and helped in the dissemination of the project results.

SU and KLU are in industrial areas, so they also contributed not only web-based dissemination activities but also industrial cooperation to raise awareness.

Before TPM5, PAU prepared a sustainability plan and shared it with all partners. During TPM5, the plan was discussed, its final form was created, and the activities planned to be attended in the next 3 years and the activities planned to be organized were discussed:

- Writing new Erasmus+ and Horizon projects as a continuation of the project,
- Established partnership to produce projects on other subjects,
- Writing at least 2 more articles describing the project and its results,
- Participation of each institution in activities to promote project outputs.

The partnership will create a Horizon project as a continuation of FutureBio.

4. Activities carried out during the project for the sustainability of FutureBio

1. The partnership wrote a new KA220-HED project as a continuation of FutureBio (TEXSUS project, Form ID KA220-HED-4B1062CA). The summary of the project application can be seen in Annex 1.
2. A new consortium under the coordination of COSVITEC, including PAU and SUPSI, got a grant for a new project: FOOD CHASE Food Supply—Chain Ecosystems for Sustainability/ Food Chase (ERASMUS-EDU-2023-PI-ALL-INNO-EDU-ENTERP-101140250).
3. Within the scope of TUBITAK-2209-A UNIVERSITY STUDENTS RESEARCH PROJECTS SUPPORT PROGRAM, 2 undergraduate student projects were entitled to be supported in 2022 and 2023 under the supervision of project coordinator Arzum Işıtan. The summaries of the projects with the student and advisor information below are included at the end of this plan as Annex 2 and Annex 3:
    a. Fire Extinguishing Rocket (Ahmet Gül and Arzum Işıtan)
    b. The Use of Doped Biopolymer Plastics in Different Fields (Kenan Semiz and Arzum Işıtan)
4. Within the scope of TUBITAK-2209-A UNIVERSITY STUDENTS RESEARCH PROJECTS SUPPORT PROGRAM, 3 undergraduate student projects were entitled to be supported in 2023 under the supervision of the project coordinator of the Selçuk University Yasemin Öztekin. The summaries of the projects with the student and advisor information below are included at the end of this plan as Annex 4,5, and Annex 6
    a. Printing 3D Electrodes and Investigating the Effect of Surface Activation on Surface Properties (Neslihan ŞENTÜRK and Yasemin Öztekin)
    b. Investigation of the Effect of CAD Application and FullControl GCode Designer on Electrode Properties in 3D Printing (Yasemin CÖMERT and Yasemin Öztekin)
    c. Production of Reusable Wound Dressing Using Fused Deposition Modeling (FDM) with 4D Printing (Rahime ATİK and Yasemin Öztekin)
5. The master science thesis titled "Production of Nanosilver Reinforced Biodegradable Polymer Coating Material Obtained By Green Synthesis Method" was completed by Hatice Elvan Erkan under the supervision of Arzum Işıtan and Mine Sulak at PAU Institute of Science and Technology. The abstract of the thesis is given in Annex 7.
6. A master science thesis titled "Biokunststoffe im Bauwesen" (Biopolymers in the construction sector) was completed by Lisa Schmidt under the supervision of Charlotte Thiel and Susanne Hüttner at OTH Regensburg. The abstract of the thesis is given in Annex 8.
7. The patent application “NANO ZINC-OXIDE BORON DOPED BIODEGRADABLE POLYMER FIRE EXTINGUISHING BALL AND ITS PRODUCTION METHOD” was done, and the details are given in Annex 9.
8. Boca, G.D.; Işitan, A.; Çağlarer, E.; Saraçli, S. A Cross-Cultural Analysis for Plastic Waste Perception of Students from Romania and Turkey. Sustainability 2023, 15, 16594. https://doi.org/10.3390/su152416594 The summary is given in Annex 10.
9. BOCA, G. D., ISITAN, A., & ÇAĞLARER, E. (2023). A CROSS MODEL FOR ACADEMIC STAFF REGARDING BIO PLASTIC. Review of Management & Economic

Engineering, 22(1). https://www.rmee.org/abstracturi/87/01_Articol_665_.pdf The summary is given in Annex 11.

10. BOCA, G. D., & ÇAĞLARER, E. (2023). A CROSS MODEL FOR INDUSTRIAL WORKERS REGARDING BIOPLASTIC. Review of Management & Economic Engineering, 22(1). https://www.rmee.org/abstracturi/87/06_Articol_664_.pdf The summary is given in Annex 12.
11. IŞITAN, A., Cem, G. Ö. K., Sulak, M., KIRMIZI, F., Volkan, O. N. A. R., & Kutlubay, R. Ç. (2022). Bioplasti and s/biopolymers: How aware are we?. Avrupa Bilim ve TeknolojDergisi, 3737) 36–414141. https://dergipark.org.tr/en/download/article-file/2481203 The summary is given in Annex 13.
12. Project coordinator Assoc. Prof. Dr. Arzum Işıtan has been awarded a post-doctoral fellowship with the project titled "Investigation of Mechanical and Thermal Properties of PLA Matrix Biocomposites Reinforced with Micro and Nanocrystalline Cellulose from Waste Textile Products" submitted within the scope of TÜBİTAK-2219 INTERNATIONAL POSTDOCTORAL RESEARCH FELLOWSHIP PROGRAM. She will be at the BRUNO KESSLER FOUNDATION under the supervision of Dr. Massimo Bersani from March 2024 to March 2025 for her postdoctoral studies. In this context, FutureBio has paved the way for new collaborations and new scientific and industrial studies. The summary is given in Annex 14.
13. Nadia Catenazzi from SUPSI published an article titled "The Futurebio project - Open Educational Resources Creation in H5P" on the EPALE platform (Annex 15).

Also, the following papers have been prepared and submitted to journals, and they are under peer review:

“Bioplastics Awareness Scale (BIYOF): Validity and Reliability”

“Production of Nanosilver Reinforced Biodegradable Polymer Coating Material Obtained by Green Synthesis Method”

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ANNEXES

Annex 1: The Summary of TEXSUS Project

Call 2024 Round 1 KA2, KA220-HED: Cooperation partnerships in higher education (KA220-HED), Form ID KA220-HED-4B1062CA Deadline (Brussels Time) 05 Mar 2024 12:00:00, Innovation and sustainability of textile waste: Transformation to Biopolymers

Objectives: The project aims to promote environmental sustainability and advance the circular economy regarding textile waste, to raise awareness and knowledge among students, academics, industrial workers, and the public about sustainable textile recycling and biodegradable plastics production to reduce carbon emissions and environmental pollution by creating flexible and attractive training materials, as well as to increase the digital competencies of the entire target audience.

Implementation: TEXSUS uses advanced digital technologies (metaverse application) and pedagogical methods (curriculum, competence map, course book, open education resources, peer learning) to train the target group members, reducing environmental impact of textile waste and promoting a circular economy. For this purpose, 5 project meetings, 10 informational meetings, 1 congress, pilot application, online education week, social activities, and a LTT activity for students will be organized.

Results: TEXSUS expects to yield an informed community on sustainable textile recycling and bioplastics. Open Education Resources enhanced digital literacy as Metaverse tool, Curriculum, Competence Map, Course Book, Good Practice Examples' Videos, and How to Use Guide are outputs of TEXSUS. These outcomes aim to make positive contributions to education, foster a circular economy, reduce environmental impact, and pave the way for sustainable practices in the textile, bioplastics, and related industries.

Annex 2: The Summary of TÜBİTAK 2209-A Project/1

2209-A University Students Research Projects Support Program

APPLICATION NUMBER: 1919B012106054

PROJECT NAME: Fire Extinguishing Rocket

SUMMARY

A forest fire is the partial or total burning of forests by natural or human-caused fires. As global warming increases, so do forest fires and floods. Forest fires cause an increase in global warming and a decrease in biodiversity. Therefore, controlling and preventing forest fires is of great importance. In our country, forest fires are fought by land vehicles, helicopters, and airplanes. However, it is very difficult to intervene in forest fires that break out in large-scale and different areas at the same time, and forest loss increases. The extinguishing rocket project we have developed aims to intervene in fires in a short time and effectively, to help the personnel in charge by surrounding the forest fire with the chemicals that the rocket will throw into the fire, and to prevent the extinguishing process from damaging the natural area by producing the chemicals to be used from natural materials. Thus, new and advanced technologies will be used not only in space and aviation systems but also to protect our natural environments. A new chemical for fire extinguishing will also be developed within the scope of the project.

Annex 3: The Summary of TÜBİTAK 2209-A Project/2

2209-A University Students Research Projects Support Program

APPLICATION NUMBER: 1919B012301731

PROJECT NAME: Utilization of Doped Biopolymer Plastics in Different Areas

SUMMARY

After the modern world was introduced to polymer materials in the 1400s, the first synthetic polymer was obtained in the early 1900s, and different polymers started to be produced since the 1950s. Today, plastics and polymers have an important place in our lives. They have found a wide range of uses due to many reasons, such as their lightness, easy shaping, ability to be mixed with different additives and easily change their properties, and good corrosion resistance. Polymeric materials find a wide range of uses, from kitchen utensils to car bumpers, from chairs to artificial heart valves. However, polymeric materials are especially widely used in packaging (food, textiles, machinery, etc.). Plastic waste is an important part of solid waste disposed of in landfills. Most of these wastes are packaging plastics. Microplastics, which are small particles under 5 mm in size, are also a major problem. Their leakage and pollution are increasing day by day, and they are almost part of the food chain in the oceans.

Biodegradation of organic matter is the result of the activities of microorganisms such as fungi, yeasts, actinomycetes, and bacteria. As a result of our research, we studied the production of additive biocomposites with PLA matrix. It takes 450 years for plastics to disappear in nature, and about eight percent of the world's oil is used to produce plastic materials. In addition, when a plastic item is thrown into nature, it emits carbon emissions as it degrades. The European Commission published "A European Strategy for Plastics in the Circular Economy" and "Plastic Waste: A European Strategy to Protect the Planet, Defend Our Citizens, and Strengthen Our Industries." Reports published by the European

Commission state that approximately 25.8 million tons of plastic waste are produced in the EU every year. Furthermore, the report "Preventing Plastic Waste in Europe 02/2019" reports that collected plastic waste is less than 30% of all plastic produced and that only 6% of plastic products in Europe are claimed to be recycled plastic. Around 99% of plastic materials are derived from petroleum-derived products. Worldwide, between 5 and 13 million tons of plastic are transported into the oceans annually. This amount is rising alarmingly as the amount of plastic waste produced each year increases.

In order to protect nature and living beings, the production of plastics using natural materials instead of petroleum products should increase and become widespread. This strategy includes actions related to compostable and biodegradable plastics. In this way, it is aimed at reducing plastic waste and our carbon footprint and degrading plastics quickly without harming nature by using materials derived from natural resources. With this project, we aim to contribute to all environmental methods developed, including the Green Deal.

Annex 4:

The Summary of TÜBİTAK 2209-A Project/3

2209-A University Students Research Projects Support Program

APPLICATION NUMBER: 1919B012219002

PROJECT NAME: Printing 3D Electrodes and Investigating the Effect of Surface Activation on Surface Properties

With the widespread adoption of 3D technology, 3D printers, which can be defined as machines used for designing a product in a computer-aided environment and printing the final product, have garnered significant interest. The proliferation of 3D technology has made 3D printers usable in many fields. The ability of 3D printers to provide a product designed in a virtual environment within hours or even minutes has eliminated the need for traditional methods involving machinery, equipment, and labor during production. Additionally, one of their most important advantages is their low production cost. Considering these advantages, the ability to obtain three-dimensionally printed working electrodes in a very short time and at a cost well below market values plays a significant role in making them preferable over ready-made electrodes used in electrochemical analyses.
In this study, the design and printing of three-dimensional electrodes, as well as the activation, modification, and characterization of surfaces, were planned. The effects of activation and electrochemical activation in the solvent on the morphological characteristics and electrochemical responses of surfaces modified with gold nanostructures were investigated by comparisons. Providing a comparative presentation of the effects of electrode activation and electrochemical activation in the solvent on surface properties constituted the primary objective and uniqueness of the study. At the end of the study, understanding of the operational principle of 3D printers, how surface activations of working electrodes were performed and determined to be completed, surface

modifications, characterization of bare and modified surfaces, and creating awareness in activation processes were also among the objectives of the study. In line with these objectives, the study addresses Sustainable Development Goals: Goal 3: Good Health and Well-being, Goal 4: Quality Education, Goal 5: Gender Equality; Goal 6: Clean Water and Sanitation; Goal 8: Decent Work and Economic Growth; Goal 9: Industry, Innovation, and Infrastructure; Goal 12: Responsible Consumption and Production.
All stages of the project were conducted under the supervision of Prof. Dr. Yasemin ÖZTEKİN, a faculty member in the Department of Chemistry at Selçuk University; and were carried out by Neslihan ŞENTÜRK. Support was provided to the applicant by Yasemin CÖMERT, a second-year student in the Department of Chemistry at Selçuk University, for the design and printing of electrodes to be used in the project. A. Taha GÜLDEREN, a doctoral student in the Department of Nanotechnology and Advanced Materials at Selçuk University, was mentored by Neslihan ŞENTÜRK on the content of the study, reporting, and 2209 project processes due to his knowledge. This study, which was conducted as a team effort within the research group, aimed to produce one publication.

Annex 5:

The Summary of TÜBİTAK 2209-A Project/4

2209-A University Students Research Projects Support Program

APPLICATION NUMBER: 1919B012215607

PROJECT NAME: Investigation of the Effect of CAD Application and FullControl GCode Designer on Electrode Properties in 3D Printing

Additive manufacturing technology is widely accepted due to its design flexibility, various material options, and wide application areas. Fused deposition modeling, a type of additive manufacturing technology, which generally involves layer-by-layer addition of thermoplastic material to create a 3-dimensional object, thus enabling material savings, eliminating the need for molds, providing design flexibility even in complex parts, is used in a wide range of fields such as architecture, engineering, art, education, jewelry and accessories, and white goods components.

In this research project, electrode prints were obtained using the 3D printing technique, which is one of the additive manufacturing technologies. Electrode designs were realized separately using conventional computer-aided design (CAD application) and the newly introduced FullControl GCode Designer method. The surfaces of the electrodes designed and printed using different methods were coated with silver electrochemically. The bare electrode surfaces and the surfaces modified with silver were characterized using electrochemical and microscopic techniques. The evaluation was made regarding the effect of two different design methods applied in the 3D printing technique on both the preparation of modified surfaces and the contribution to the properties of the surfaces after modification. This study, being the first to present a comparative evaluation of two different design

approaches used in electrode printing in terms of surface preparation and characterization, had high original value.

Among the objectives of the study were minimizing the environmental negative effects in scientific studies, highlighting female empowerment through work, creating awareness of teamwork among undergraduate students, and realizing the importance of economic and social contributions to society in scientific studies. In line with these objectives, the study addressed Goal 3: Good Health and Well-being; Goal 4: Quality Education; Goal 5: Gender Equality; Goal 6: Clean Water and Sanitation; Goal 8: Decent Work and Economic Growth; Goal 9: Industry, Innovation, and Infrastructure; and Goal 12: Responsible Consumption and Production, identified as Sustainable Development Goals in the 70th Session of the United Nations General Assembly in 2015 with active participation of UNESCO.

The study was conducted by Yasemin CÖMERT, a second-year student under the supervision of Prof. Dr. Yasemin ÖZTEKİN, a faculty member in the Chemistry Department of Selçuk University Faculty of Science. The study consisted of electrode design, printing, modification, electrochemical, and microscopic characterization steps. Yasemin CÖMERT, who has been a member of Prof. Dr. Yasemin ÖZTEKİN's Research Group for 1 year, has been working on 3D electrode design, printing, and microscopic characterization steps, so she carried out these steps under the mentorship of A. Taha GÜLDEREN, a doctoral student in the Department of Nanotechnology and Advanced Materials at Selçuk University Graduate School of Natural and Applied Sciences. The modification and electrochemical characterization steps of the project were carried out by Yasemin CÖMERT under the supervision of Neslihan ŞENTÜRK, a fourth-year student who has been a member of Prof. Dr. Yasemin ÖZTEKİN's Research Group for over a year. Considering the original value of the study, it is aimed to publish an article in an international journal based on the study.

Annex 6:

The Summary of TÜBİTAK 2209-A Project/5

2209-A University Students Research Projects Support Program

APPLICATION NUMBER: 1919B012311004

PROJECT NAME: Production of Reusable Wound Dressing Using Fused Deposition Modeling (FDM) with 4D Printing

4D printing is the ultimate product obtained by the gradual reversal over time of the shape, properties, and functionality of a 3D printed structure when exposed to a predetermined stimulus such as heat, light, pH, etc. Essentially, 4D printing stems from the rapid advancements in smart materials and designs, as well as the interdisciplinary use of 3D printers. Currently in its infancy, 4D printing has become an exciting branch of additive manufacturing and is drawing significant interest from academia and industry across various disciplines. The use of 4D printing in various fields such as healthcare, biomedicine, textiles, aviation, construction, infrastructure, and more holds promise for the future. Given its current relevance, every contribution to 4D systems is deemed important, thus a project proposal titled "Production of Reusable Wound Dressing Using Fused Deposition Modeling (FDM) with 4D Printing" was being presented by a 2nd-year undergraduate student of the Department of Chemistry, Faculty of Science, Selçuk University. The proposed study was conducted by Rahime ATİK under the supervision of Associate Professor Yasemin ÖZTEKİN from the Department of Chemistry, Faculty of Science, Selçuk University. The aim of the proposed study was to investigate the sustainable and recyclable use of a wound dressing designed utilizing the shape memory property of PLA via the FDM method. The workflow included designing the sample using CAD application, slicing it at appropriate parameters using Ultimaker Cura, printing the wound dressing sample with PLA filament and FDM method, preparing a mixture with desired physical

properties and sterilization capabilities, subjecting the 3D printed wound dressing to physical interactions with external stimuli, and characterizing the surfaces. While the steps of 3D design and printing have been ongoing for over a year under the guidance of Associate Professor Yasemin ÖZTEKİN's Research Group, the study hold high originality value in terms of the final product and subsequent planned works. Considering the originality of the study, the aim was to publish it in an international journal and further develop the idea of a 4D reusable wound dressing to the R&D level. The proposed study was an output of the ERASMUS+ project titled "Let's Use Biodegradable Plastic for the Future-FutureBio" with the project number 2021-1-TR01-KA220-HED-000032160, in which Selçuk University was a partner.

Annex 7: The Summary of Master Science Thesis/1

Titled: Production of nanosilver-reinforced biodegradable polymer coating material obtained by green synthesis method

Author: Erkan, Hatice Elvan

Consultants: Işıtan, Arzum and Sulak, Mine

Keywords: Biodegradable polymer, Nanotechnology, Nanomaterial, Polymer coating, Antibacterial coating, Biodegradable polymer, Nanotechnology, Nanomaterial, Polymer coating, Antibacterial coating.

Abstract: In many places in daily life, bacteria that are harmful to human health and can multiply very quickly under favorable conditions can be found and reproduced. The presence and growth of bacteria can be prevented with antibacterial coatings. The problem is that the physical and chemical methods used in the production of antibacterial coatings create wastes harmful to the environment and human health, and the techniques used to remove these wastes are expensive and difficult to apply. In this thesis, antibacterial silver nanoparticles (R-AgNP) with facecubic shape and average grain size of 16 nm were obtained by green synthesis method using aromatic arugula plant. The obtained nanoparticles were characterized by UV-VEDX, SEM, FT-IR, EDX, and XRD methods, considering the storage and preservation methods suitable for the analysis conditions. Biodegradable polymer matrices were prepared in 4 different combinations using chitosan and alginate produced from biodegradable and edible sources. The biodegradable polymer matrices were subjected to tensile tests, density measurements, moisture tests, and swelling tests. Optical microscope and SEM characterization methods were used for internal structure analysis. Antibacterial biodegradable coating material was produced by adding pre-prepared silver nanoparticles at rates of 1%, 2.5%, and 5% to the chitosan solution prepared at 45 °C, which obtained the best results in the tests, and its antibacterial properties

were examined. solvent-casting method was used in the production of biodegradable coating materials. After drying process, tensile tests, density measurements, moisture, and swelling tests were applied to the nano-silver-doped biodegradable coating materials and characterized by optical microscope, SEM, and FT-IR methods. disk diffusion technique was used to determine antibacterial susceptibility. As a result of the study, the antibacterial activity increased with increasing nanosilver additions to the chitosan biodegradable matrix at 45 °C.

In many places in daily life, there are bacteria that are harmful to human health, can multiply very quickly under suitable conditions, and can reproduce. Antibacterial coatings prevent the presence of bacteria and reproduction. It is a problem that the physical and chemical methods used in the production of antibacterial coatings create wastes harmful to the environment and human health, and the techniques used to remove these wastes are expensive and difficult to implement. In this thesis study, antibacterial silver nanoparticles (R-AgNP) with a face-cencentershape and an average particle size of 16 nm were obtained using the green synthesis method using theomatic arugula plants. The obtained nanoparticles were characterized by UV-Vis, SEM, FT-EDX, EDX and XRD methods, taking into account the appropriate storage and preservation methods for the analysis conditions. By using chitosan and alginate produced from biodegradable and edible sources, biodegradable polymer matrices were prepared in 4 different combinations.

tensile test, density measurement, humidity, and swelling tests of the obtained biodegradable polymer matrices were applied. Optical microscope and SEM characterization methods were used for internal structure analysis. Antibacterial properties were investigated by producing antibacterial biodegradable coating material by adding % 1, % 2.5, and % 5 previously prepared silver nanoparticles to the chitosan solution prepared at 45 °C, which had the best results in the tests. The solvent-casting method was used in the production of biodegradable coating materials. After drying, tensile tests, density measurements, moisture, and swelling tests were applied to nano-silver-doped biodegradable coating materials, and they were characterized by optical microscope, SEM, and FT-IR methods. disc diffusion technique was used to detect antibacterial susceptibility. As a result of the study, the antibacterial activity increased as the addition of nanosilver to the chitosan biodegradable matrix at 45 °C increased.

Acknowledgement: This thesis work was supported by the project numbered 2021-1-TR01-KA220-HED-000032160, supported by the Turkish National Agency and coordinated by Pamukkale University.

URI: https://hdl.handle.net/11499/50325

https://tez.yok.gov.tr/UlusalTezMerkezi/TezGoster?key=r4I1HnmXxFQovUpyAyUmxMo5ht52j9u_YsVLTyA7__2epKO3KYXId7YpHQeWXpNY

Bu tez çalışması Türkiye Ulusal Ajansı tarafından desteklenen ve Pamukkale Üniversitesi'nin koordinatör olduğu 2021-1-TR01-KA220-HED 000032160 nolu proje ile desteklenmiştir.

Annex 8: The Summary of Master Science Thesis/2

OSTBAYERISCHE TECHNISCHE HOCHSCHULE REGENSBURG

MASTERARBEIT

Lisa Schmidt

Biokunststoffe im Bauwesen

Fakultät:	Bauingenieurswesen
Studiengang:	Master Bauingenieurswesen
Abgabefrist:	30.09.2022
Aufgabenstellerin:	Prof. Dipl. Ing. Charlotte Thiel
Zweitprüferin:	M.Sc. Dipl. Ing. Susanne Hüttner

Kurzfassung

Kunststoffe sind aufgrund des fossilen Rohstoffursprungs, der Umweltverschmutzung und der generellen Müllproblematik in den letzten Jahren stark kritisiert worden. Eine Alternative zu den erdölbasierten Kunststoffen sind die aus nachwachsenden Rohstoffen hergestellten Biokunststoffe. Im Rahmen dieser Arbeit konnte gezeigt werden, dass Biokunststoffe eine nachhaltige Alternative darstellen. Der zweite Teil der Arbeit beschäftigt sich mit der Möglichkeit, Biokunststoffe im Baubereich als Verpackung oder Dämmstoff einzusetzen. Es zeigt sich, dass bei den Verpackungen bereits eine Recyclinginfrastruktur für die erdölbasierten Kunststoffe besteht. Die innovativen Biokunststoffe (z.B. PHA) werden bisher aufgrund der geringen Mengen nicht kommerziell recycelt. Das bedeutet für die recyclingfähigen Verpackungen, dass Drop-In Lösungen geeignet sind, weil hierbei die Recyclingfähigkeit erhalten bleibt. Bei den nicht recyclingfähigen Verpackungen zeigt sich sowohl der Einsatz von Drop-In-Kunststoffen als auch der von innovativen Biokunststoffen vorteilhaft. Da aus deren thermischen Verwertung erneuerbare Energie erzeugt und zusätzlich fossile Treibhausgasemission vermieden werden können. Bei den Dämmstoffen findet bisher kein Recycling der Baustellenabfälle statt. Hier steht die Etablierung einer Recyclinginfrastruktur an erster Stelle, um die Nachhaltigkeit der Dämmstoffe zu verbessern. Darüber hinaus kann eine Schonung der fossilen Ressourcen durch den Einsatz von Drop-In-Kunststoffen erzielt werden. Das hat den Vorteil das sie anders als die innovativen Biokunststoffe keinen eigenen Recyclingstrom benötigen, sondern mit ihren petrochemischen Pendants recycelt werden können.

Annex 9: The Summary of Patent Application

NANO ZINC-OXIDE BORON DOPED BIODEGRADABLE POLYMER FIRE EXTINGUISHING BALL AND ITS PRODUCTION METHOD

EVRAKLAR | İNCELEME RAPORU | ARAŞTIRMA RAPORU

Başvuru Bilgileri

Başvuru Numarası	2023/006055	Başvuru Tarihi	26.05.2023
Başvuru Şekli	-	Evrak Numarası	2023-GE-330411
Evrak Tarihi	26.05.2023	Tescil Numarası	-
Tescil Tarihi	-	Koruma Tipi	Patent
EPC Yayın Numarası	-	EPC Başvuru Numarası	-
PCT Yayın Numarası	-	PCT Başvuru Numarası	-
PCT Yayın Tarihi	-		

Başvuru Sahipleri

Kişi No	İsim	Adres
6493423	PAMUKKALE ÜNİVERSİTESİ	PAMUKKALE ÜNİ REKTÖR LÜĞÜ İNCİLİPINAR - TÜRKİYE

Buluş Sahipleri

Kişi No	İsim	Adres
7512689	AHMET GÜL	- -
6334478	ARZUM IŞITAN	- -
7512696	AHMET AKİF SAYGIN	- -
7512694	CEM GÖK	- -
7512695	MİNE SULAK	- -
7512692	BEYZA KAHRAMAN	- -

Buluş Bilgileri

Buluş Başlığı	NANO ÇİNKO-OKSİT BOR KATKILI BİYOBOZUNUR POLİMER YANGIN SÖNDÜRME TOPU VE BUNUN ÜRETİM YÖNTEMİ
Buluş Özeti	Buluş, yangın söndürme alanında özellikle açık hava yangınlarının kontrol altına alınması ve söndürülmesinde kullanılacak nano çinko-oksit bor katkılı biyobozunur polimer yangın söndürme topları ile ilgilidir. Buluş özellikle, doğadaki canlılara ve çevreye zararı çok büyük olan orman ve açık hava yangınlarının kontrol altına alınması ve söndürülmesinde kullanılacak, söndürücü madde olarak yeşil sentez yöntemi ile üretilen bor katkılı çinko oksit nanopartiküllerini içeren biyobozunur polimer yangın söndürme topları ve bunların üretim yöntemi ile ilgilidir.

Annex 10: The Summary of "a Cross-Cultural Analysis for Plastic Waste Perception of Students from Romania and Turkey"

Abstract

The article brings to attention a cross cultural model related to the perception of students in relation to the current problem of plastic waste. To create the model, a questionnaire was applied online in two countries at the same time, among students from different specializations. The survey was structured in several parts, with the first part meant to identify individual characteristics of the responders, the second part to identify their knowledge about plastic, determine their beliefs in the new material—bioplastic, their preference in using plastic or bioplastic, and the last part meant to determine students' attitude towards the environment. The model wants to highlight the preferences and knowledge of students about plastic, the degree of information and students' knowledge about plastic waste, and if these are influenced by culture; in our case, the country was considered. Also, we established that gender or specialization have no influence on the perception of bioplastic. A total of 39.79% of the students from both countries participate in and attend conferences about nature protection and plastic waste, and only 58.69% of the students do not participate in any conferences about nature conservation or recycling materials. As a conclusion, we can mention that Turkish students are more responsible and more active in environmental activities regarding plastic waste in comparison with Romanian students. In comparison with Romanian students, Turkish students are more careful when it comes to recycling waste plastic and when choosing products that are less harmful to nature. The young generation is open to selective recycling, even if they sometimes do not follow the established rules. Based on this model, common problems can be identified and universities, as incubators of ideas, can welcome the use of the necessary methods and tools to stimulate care and students' awareness of the environment and its protection.

Keywords: plastic waste; recycling; knowledge; perception; beliefs; cross cultural model

Author Contributions

Conceptualization, G.D.B., A.I., S.S. and E.Ç.; methodology, G.D.B., A.I., S.S. and E.Ç.; validation; G.D.B., A.I., S.S. and E.Ç.; writing—original draft preparation, G.D.B., A.I., S.S. and E.Ç.; writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Pamukkale University (protocol code E-93803232-622.02114625/18-14/07.10.2021) and Ethics Committee of Technical University of Cluj Napoca (CEU 515/20/03/2023).

Annex 11: The Summary of "a Cross-Cultural Analysis for A Cross Model for Academic Staff Regarding Bio Plastic"

https://www.rmee.org/abstracturi/87/01_Articol_665_.pdf

Abstract: This study creates a cross model contributing to sustainable plastic management and suggests solutions for future role of universities and academic staff research in young generation orientation and environmental education. We define the importance for academic staff for sustainable plastic management and the environmental damage of plastic material. A survey was applied in same period and 271 academic staff from Turkey, Romania, Italy and Switzerland participates. The survey contains 47 items and was structure in more parts: individual characteristics (gender, age, academic title, country, field of specialization), knowledge about plastic, behavior regarding the dissemination of plastic information and needs (training, special lecturers, conferences, workshops). To be able to create the cross model we take in consideration a new variable for a better understanding of academic staff his/her awareness regarding the plastic waste problem. Our cross model results suggest that academic staff knowledge and needs influence their awareness regarding bio plastic and also academic staff awareness influence their behavior regarding the plastic phenomenon. There are no borders between countries and culture and information about plastic and recycling, as well as bio plastic it is very well know. Finally, we present a synthesis of the barriers and opportunities for academic staff in sustainable plastic management by universities. Barriers frequently mentioned were high costs and lack of new information. Further research should expand the survey, identify the enabling conditions for sustainable plastic management, and determine environmental impact for each country and realize a cross cultural model.

Keywords: waste management, bioplastic, plastic waste, recycle, environmental education

Acknowledgment

This study has been prepared within the scope of the FutureBio project (Erasmus+ KA220-HED-Cooperation Partnerships in Higher Education) supported by the Turkish National Agency and EU. "Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein"

Annex 12: The Summary of "a Cross Model for Industrial Workers Regarding Bioplastic"

https://www.rmee.org/abstracturi/87/06_Articol_664_.pdf

Abstract: The vision in the field of industry is to build a world in which plastic will never end up as waste, which means efforts in the area of recycling and reuse of packaging. By applying a questionnaire in same time and period in Turkey, Romania, Italy and Finland a number of 271 respondents which were working in different fields of industry in technological process were answer to some specific questions in special about plastic waste. The questionnaire was structured in four parts that made it possible to identify workers' level of information and specific education regarding the issue of plastic in different stages of the technological process or at the workplace in different organizations. The questionnaire collects data indicators about workers' knowledge's of working methods, if they have information about the use of bio plastic in production processes or only certain raw materials, improving quality by using the new type of plastic, what are the factors that prevent the use of the new type of plastic. The study takes into account the following variables: individual characteristics (gender, age and country), information (about raw material, advantages of bio plastic), knowledge (use of plastic in production processes, recycling) and ways to promote bio plastic and workers' needs. Based on the data obtained, it was possible to create a cross model for industrial workers regarding bio degradable plastic. Workers would prefer to be informed about new trends in the industry in our case about bio plastic. The cross model for workers' awareness obtains the biggest value showing the direct relation with needs of information about the new bio plastic and waste plastic. The article presents some solutions taken in different countries by organizations with reference to the new bio plastic.

Keywords: management change, plastic waste, recycle, bio degradable plastic

Acknowledgment

This study has been prepared within the scope of the Future Bio project (Erasmus+ KA220-HED-Cooperation Partnerships in Higher Education) supported by the Turkish National Agency and EU. "Funded by the Erasmus+ Program of the European Union. European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein"

Annex 13: The Summary of "Bioplastics / Biopolymers: How Aware Are We?"

https://dergipark.org.tr/en/download/article-file/2481203

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.

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:

5. Acknowledge

FutureBio project is 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. The project is "Funded by the Erasmus+ Programme of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein".

Annex 14: The Summary of "Investigation of Mechanical and Thermal Properties of PLA Matrix Biocomposites Reinforced with Micro and Nanocrystalline Cellulose from Waste Textile Products"

Today, the need for new materials that are environmentally and human-friendly, sustainable, and, at the same time, high performance is increasing. Composite materials can have these properties and are also seen as important materials with their properties such as lightness and strength. Polymer matrix composites are especially important in this context. Due to their advantages, such as high corrosion resistance, cheapness, and lightness, polymers and polymer matrix composites are increasingly used in machine elements operating under mechanical load. Increasing carbon footprints and oil prices, together with the recycling and disposal problems of plastics, increase the importance of polymeric materials consisting of renewable, biocompatible, biodegradable, and sustainable raw materials instead of petroleum-based polymers. However, the strength values of bioplastic materials remain low for parts such as gear wheels compared to conventional plastics. Poly(D,L-lactic acid) (PLA) is a biocompatible, easy to manufacture, abundant, and non-toxic material. Although PLA does not have sufficient mechanical properties for its widespread use in engineering applications such as gear wheels, the properties of PLA can be improved by adding micro and/or nanoparticles without losing the already available benefits. The most suitable candidate material for both improving the mechanical properties of PLA and maximizing the interaction between the reinforcing element matrix is cellulose, a biopolymer that has been reduced to microcrystalline and nanocrystalline dimensions. Cellulose fibers and crystals can be recycled from textile waste without an increase in energy consumption from complex processing steps.

This research proposal includes the production and characterization of microcrystalline and nanocrystalline cellulose reinforced PLA matrix composites to be obtained from textile wastes, the determination of their mechanical and thermal properties, and the determination of biodegradable matrix and reinforced composite materials with optimum properties as machine elements. Materials production and characterization studies will be carried out with Dr. Massimo BERSANI and his team at the Fondazione Bruno Kessler (FBK) SD- Center for Sensors and Devices. In order for the study to reach its purpose, the proposal was built on 3 basic work packages, and the objectives and success criteria of each work package were determined. The work includes the stages of obtaining micro and nanocrystalline cellulose from textile wastes via chemical methods (a), obtaining composites by solution mixing and casting method (b), determining the microstructure, interface condition, physical, thermal, and mechanical properties of the composite that can work under mechanical load via advanced characterization techniques (c), and then the recommendation of the most suitable composite/composites. This study will be the first in the literature to compare the microstructure, interfacial properties, and thermal and mechanical properties of PLA matrix composites reinforced with micro and nanocrystalline cellulose obtained from textile wastes and to suggest composites that can be used as machine elements.

Annex 15: The FUTUREbio project – Open Educational Resources creation in H5P

EPALE > Contribute > News > The FUTUREbio project – Open Educational Resources creation in H5P

News 28 February 2024

The FUTUREbio project – Open Educational Resources creation in H5P

Nadia Catenazzi

The ERASMUS+ FUTUREbio project (Let's use biodegradable plastic for the future, https://www.futurebioproject.eu/) has been successfully completed!

Its main objective is to raise awareness about plastic pollution and biodegradable products, through the creation of different training material, including a lecture guidebook, interactive educational resources, laboratory videos and virtual reality exercises.

This news focuses on interactive educational resources, which were created using H5P (https://h5p.org/), which allows anyone to create engaging cross-browser and cross-platform interactive content such as presentations, videos, quizzes, games and more, without the need for programming skills. H5P also provides easy integration with existing content management systems and provides support for collaborative authoring.

Within the project, the interactive content creation was quite complex since it involved different actors in different countries: content authors, technology experts and people responsible for translation. Therefore, a

https://epale.ec.europa.eu/en/content/futurebio-project-open-educational-resources-creation-h5p