NATIONAL DEVELOPMENT PLAN 2020

EUROPEAN UNION
European Regional Development Fund

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Decision Support Tool for an Integrated Food Waste Valorisation System

Annual report on dissemination, communication, mobility and training activities, and progress and risk monitoring: 2022

DeSTInation

Prepared within the project "Decision Support Tool for an Integrated Food Waste Valorisation System (DeSTInation)" (No. 1.1.1.2/VIAA/3/19/528)

12.05.2022.

The report is prepared within the project's work package 4.

The scientific objective of the project is to develop a decision support tool for an integrated food waste valorisation system where the availability of feedstock, its bioconversion efficiency, and the related environmental and techno-economic effects are considered.

Results of the project: Four activities are planned in the project:

1. Modelling of food production and waste management macro-systems,
2. Modelling of biotechnology and waste conversion micro-systems,
3. Evaluation of an integrated food waste valorisation system,
4. Knowledge transfer, mobility and training.

The project will develop and validate an innovative methodology based on the Latvian example. The method will combine mathematical models created for different purposes in a single tool. In addition (1) 3 scientific articles will be published in journals indexed in Scopus and Web of Science databases with a citation index of 50% of the industry average; (2) results will be presented at 2 international scientific conferences; and (3) the young researcher (postdoctoral student) will develop her competence in research, study, international mobility and networking activities for a total of at least 3 months, as well as develop her transferable skills.

Information about the project: Food waste is among the most generated biogenic waste around the globe. Annually 1/3 of the global food produced is wasted, and waste occurs at all stages of the food supply chain causing negative environmental, economic and social effects. Food waste can efficiently be used as feedstock in waste biorefinery that can result in a number of value-added products. Food waste can play an important role in developing sustainable circular bioeconomy. Yet, there is a lack of tools for assessment of food waste valorisation systems. In the project a decision support tool will be developed for an integrated food waste valorisation system where the availability of feedstock, its bioconversion efficiency, and the related environmental and techno-economic effects are considered. The novelty of the project is the selected hybrid modelling methodology that provides the possibility to test and assess a variety of food waste valorisation scenarios before their implementation.

As a result of the project, the postdoctoral researcher will significantly improve her scientific, managerial and communication skills, which will help her achieve the status of an independent, mature researcher.

The project will promote the development and implementation of the smart specialization strategy area "Knowledge-intensive bioeconomy" through more efficient use of resources (eco-innovative products, new technologies), innovation capacity building (innovative decision support tool), knowledge base and human resources development (knowledge-intensive bioeconomy), innovation systems (eco-innovative products) and overcoming social, environmental, climate and energy challenges. The results of the project will be used by several target groups.

Project period: 01.05.2020. – 30.04.2023. (36 months)

Project costs: 133 805.88 EUR (113 734.99 EUR from EU as ERDF funding; 6690.31 EUR – the share of the University of Latvia)

Source of funding: European Regional Development Fund Specific Objective 1.1.1 "Improve research and innovation capacity and the ability of Latvian research institutions to attract external funding, by investing in human capital and infrastructure" 1.1.1.2. measure "Post-doctoral Research Aid". Project application selection round No.3.

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CONTENT

DISSEMINATION, EXPLOITATION AND COMMUNICATION ACTIVITIES

The project was started on May 1, 2020. In the second year of the project, dissemination and communication activities have been carried out as laid out further.

Three scientific articles have been envisaged to report the results of the project. In the second year of the project, two articles have been published.

1) Liepins, J, Balina, K, Soloha, R, Berzina, I, Lukasa, LK & Dace, E 2021, 'Glycolipid biosurfactant production from waste cooking oils by yeast: Review of substrates, producers and products', Fermentation, vol. 7, no. 3, 136. https://doi.org/10.3390/fermentation7030136 One of the major types of food waste is waste cooking oils and fats from the catering sector, animal fats from food processing and production industry, and fats (grease) that accumulate in sewage system. The paper reviews the amount and composition of such waste and its management alternatives, while looking for opportunities to use this waste in the production of high value-added products. Currently, waste cooking oils are managed through separate collection and delivery to biodiesel or biogas plants. However, there is also the possibility of using them in the production of higher value-added products using various microorganisms such as yeasts and bacteria. The review article summarizes the existing knowledge of yeast metabolism mechanisms in bioconversion of the waste cooking oil into value-added biosurfactants.
2) Stalidzans, E & Dace, E 2021, 'Sustainable metabolic engineering for sustainability optimisation of industrial biotechnology', Computational and Structural Biotechnology Journal, vol. 19, pp. 4770-4776. https://doi.org/10.1016/j.csbj.2021.08.034 Industrial biotechnology represents one of the most innovating and labour-productive industries with an estimated stable economic growth, thus giving space for improvement of the existing and setting up new value chains. In addition, biotechnology has clear environmental advantages over the chemical industry. Still, biotechnology's environmental contribution is sometimes valued with controversy. Environmental, economic and societal sustainability of various bioprocesses becomes increasingly important due to the growing understanding about complex and interlinked consequences of different human activities. Neglecting the sustainability issues in the development process of novel solutions may lead to sub-optimal biotechnological production, causing adverse environmental and societal problems proportional to the production volumes. The paper defines and presents a novel concept for assessing and optimizing the sustainability of biotechnological production that can be derived from the features of metabolism of the exploited organism. The sustainable metabolic engineering (SME) concept is optimization of metabolism where economic, environmental and societal sustainability parameters of all incoming and outgoing fluxes and produced biomass of the applied organisms are considered. The extension of metabolic engineering's design characterising features with sustainability estimation enables *ab initio* improvement of the biotechnological production design.

The communication activities of the project include (chronologically) (1) demonstration of system dynamics modelling approach and its application cases to research staff of the Department of Land, Environment, Agriculture and Forestry, University of Padua, Italy, (2) presentation to and discussion with researchers and PhD students of the Department of Sustainability Science, Lappeenranta-Lahti University of Technology, Finland about food waste valorisation options, technology and topicality at European level, (3) presentation to the staff of the Department of Sustainability Science, Lappeenranta-Lahti University of Technology, Finland about research approaches – system dynamics and metabolic modelling – used by the Computational Systems Biology Group of the University of Latvia, (4) Participation in the 2nd international scientific conference Strategies toward Green Deal Implementation with presentation "Enabling Circular Bioeconomy via Estimating Biowaste and Food Loss Valorisation Potential in Latvia", (5) Participation in the Job Shadow Day, introducing three young students from the Riga State German Grammar School with the scientists profession, (6)

Participation in the Vidzeme Innovation Week's event "Kas vienam lieks, otram – prieks! Bet ko darīt ar ražošanas blakus produktiem un bioatkritumiem?" with presentation "The challenge of the circular economy and the role of cooperation", (7) Participation in the International Conference for Young Scientists on Biorefinery Technologies and Products with presentation "Enabling circular bioeconomy via estimating the potentially valorisable food loss and waste in the Northern European region".

A dedicated section has been developed at the website of the University of Latvia, that informs visitors about the project's aims, tasks and progress, while also providing links to all results published as an outcome of the project (information is provided in Latvian). Also, the website of the Computational Systems Biology Group holds a section dedicated to the project (information is provided in English). In addition, a project has been developed at ResearchGate, where periodic updates of the project's progress are published.

At the beginning of the project, an information plate (A3 size) about the project and funding provider was placed in the premises of the University of Latvia – the House of Nature. The plate will be maintained for the whole project, thus informing employees and visitors of the House of Nature and acknowledging the funder of the research project.

MOBILITY AND TRAINING ACTIVITIES

In the second year of the project, research mobility activities have been implemented in three high-reputation foreign research institutions – University of Padua, Italy (3 weeks), Lappeenranta-Lahti University of Technology, Finland (3 weeks), Thomas More University of Applied Sciences, Belgium (1 week). The research, knowledge and experience exchange on food waste management and valorisation and on different environmental and economic assessment techniques has been invaluable and will be applied in further implementation of the project, as well as beyond this specific project.

Several national and international level webinars and conferences have been attended to learn about a range of topics, including scientific, motivational, managerial, and personal development topics. No certificates of attendance have been received, yet the post-doctoral researcher has used the vast opportunities provided by organizers of virtual events available during the pandemics.

Importantly, multiple international contacts have been established by the post-doctoral researcher. An international collaboration has been discussed and initiated with colleagues from the universities attended during the research exchange visits, and from other research institutions as University of Nottingham (UK), University of Boras (Sweden), Norwegian University of Life Sciences (Norway), Ca' Foscari University of Venice (Italy), Baltic Studies Centre (Latvia), and organizations as International Waste Management Association (Netherlands), and many others.

The research activities have resulted in Latvian Council of Science assigning the post-doctoral researcher a three-year expert rights in the fields of industrial biotechnology (2.9), primary scientific field of the project, and environmental engineering and energy (2.7), related scientific field of the project.

To ensure the continuity and sustainability of the carrier development also after finishing this project, the postdoctoral researcher has participated in and/or initiated preparation of several project proposals submitted together with collaboration partners to the national (Latvian Council of Science) and international (ERA-Net, Horizon Europe) project calls. That way, the field of study is evolved while establishing collaboration with multi-disciplinary research teams. All these activities have contributed also to the development of the institution – implementer of the project, both resource-wise and thematically.

PROGRESS AND RISK MONITORING

The project was started at the peak of the global pandemics, thus challenging implementation of the project according to the initial work plan and timely delivery of the envisaged results. Nevertheless, the work package #1 has been completed with a system dynamics model for biowaste and food waste management. A public report on the modelling results has been prepared, and one scientific research article has been published in an open access journal indexed in Scopus with >50% of the average citation in the domain of environmental science.

Implementation of work package #2 is in progress. Midway through the project, a local database has been built containing information about the main food waste flows, value-added products that can be obtained from these waste flows, and the applicable technique and microorganisms for the waste bioconversion. For now, *Saccharomyces cerevisiaea* was identified as the most appropriate microorganism for obtaining various value-added products from a diverse set of food waste. An initial constraint based stoichiometric model of *S.cerevisiaea* has been prepared and currently the work is continued with the adaptation of the model for the specific needs of the project.

Implementation of work package #3 started on month #21 of the project. Two scientific research articles that have been published in open access journals indexed in Scopus with >50% of the average citation in the domain of biotechnology have been allocated to WP3 as they discuss valorisation of food waste and present the novel sustainable metabolic engineering concept.

Work package #4 was started right from the beginning of the project by regular updates and information releases about the activities and results of the project. Regular internal meetings with the scientific advisor have been organized to follow the progress of the project and discuss various issues related to research and personal development of the post-doctoral researcher. Due to the global pandemics mobility and training activities initially planned for the 1st year of the project were moved to the 2nd year of the project. Currently, 7 weeks of the minimum required 3 month of research mobility have been realized in three high-reputation foreign research institutions.

The articles published, submitted and in preparation indicate that the results generated during the first two years of the project are novel and topical to the scientific community. Thus, with some minor rescheduling the project is being implemented and run to deliver all the planned results by the end of the project.

Risk and progress monitoring has been performed on a regular basis to identify and address the potential barriers for successful project implementation, assess the correspondence with the project's timeline and evaluate the possible risks in coming phases of the project. The needed mitigation and contingency actions have been initiated and implemented by rescheduling some of the planned activities and deliverables.

Overall, the project is being implemented according to the planned timeline and envisaged results.