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Sustainability, safety and End of Life studies of new multilayer packaging developed in BBI-JU - MANDALA PROJECT

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Full text:

Introduction

Food packaging facilitates storage, handling, transport and preservation of food and it is essential for preventing or at least decreasing food waste. Besides these beneficial properties, food packaging causes rising concern for the environment due to its high production volume, often short usage time, and problems related to waste management and littering. Reduction, reuse, and recycling, but also redesign support the aims of the Circular Economy to decrease the environmental impact of food packaging: the sustainability of packaging made from natural and synthetic polymeric materials developed within the MANDALA project is provided and discussed. In particular, the End-of-life of compostable packaging sent to controlled composting plants can be an important method of reducing garbage. The main pre-requisites defined by official regulations are related to biodegradability, physical breakdown and the quality of the compost produced in terms of agronomic parameters and toxicity towards plants, and these requisites for the compostability assessment are defined in the EN 13432 official Standard[1]: the biodegradability of the test material is determined in a laboratory aerobic controlled composting test based on the evolution of carbon dioxide. The laboratory tests are followed by investigations of the disintegration of the material in composting reactors and analysis to determine the quality of the final compost produced.

Experimental

Life Cycle Assessment (LCA) was performed according to the ISO 14040-44 standard[2,3], following the sequent steps: (i) goal and scope definition, (ii) inventory analysis (LCI), (iii) impact assessment (LCIA) and (iv) results interpretation. The commercial software SimaPro 9.2 and available databases were used in order to carry on the analysis.

For impact assessment the EF 3.0 method [4] was chosen thanks to its comprehensive vision on environmental problems associated to a product life cycle, and the included weighting phase and single score aggregation procedures (optional step in the LCIA phase).
The compostability tests are performed according to EN 13432 standard; biodegradation test is performed as described by EN ISO 14855-1 standard [5], disintegration test is performed according to ISO 16929 standard [6] and the final compost quality is evaluated according to OECD 208 [7].
All the biodegradability tests under different conditions are performed according to standard: home biodegradability test following EN ISO 14855-1 standard (at temperature below 30°C), soil biodegradability test following ASTM D5988:2018 [8], marine biodegradability test following ASTM D6691:2017 [9], freshwater biodegradability test following ISO 14852:2021 [10].
The Health & Safety assessment on new products, entire manufacturing cycles and application pilot scale process are performed both for workers and workplaces to assure the compliance with the official Limits of the specific Regulations (for example, ACGIH 2021).

Results and Discussion

For the purpose of the MANDALA project, the LCA study considers the environmental burdens associated with the production of 1 m2 of packaging film in a “Cradle-to-grave” approach: the selected bioplastic materials compared with the fossil-based one (as benchmark) represent the largest share of the total impact of "cradle" and "grave" stages for both products (almost 30%). Furthermore, MANDALA raw materials are characterized by higher impact for their production, but lower impacts for their end-of-life options if compared to benchmark fossil-based raw materials.
About the end-of-life study, the tested packaging is analyzed according to EN 13432 standard: i) the biodegradation tests on the selected samples provide the compliance with the EN 13432 requirement defined as more than 90% of biodegradability percentage reached within 6 months under industrial composting condition. ii) the disintegration requirement (sample reduced into dimension less than 2 mm) is fulfilled reaching more than 90% within 12 weeks. iii) the final compost quality analysed both in terms of ecotoxicity towards two different plants is assessed and provide a germination rate and biomass growth more than 90% compared to the control sample (to indicate the not toxic effect for the plant growth by using the final compost as fertilizer).
Furthermore, the final composition of the developed packaging is tested for biodegradability determination under several environments: home composting, soil (still ongoing), marine and freshwater: all the completed biodegradability tests provide more than 90% as percentage of transformation of the organic carbon into CO2, within the specific timeframe of the test. The soil biodegradability is 77% after less than 1 year with a continuous production of CO2, meaning that the test is not finished, yet.
The Health & Safety assessment on new products, entire manufacturing cycles and application pilot scale process has provided an overall identification and quantification of hazards and exposure of developed products and processes and good practice procedures to eliminate or minimise the risks.

Conclusions

The new packaging products developed during MANDALA EU project were tested for safety and for the assessment of the biodegradability and compostability performances and were studied for LCA: the obtained results provided the compliance with the current EN 13432 Regulation and the quantification of the main environmental impacts and sustainability of the materials and the proposed technologies. The H&S results demonstrate that the process for the production of the packaging complies with the ACGIH limits and the process is safe for workers.

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Biography

Francesca Braca has Degree in Chemistry and she is EU Project manager. In ARCHA since 2001, Drs. Braca has been involved in conduction of R&D project in the field of waste and wastewater analysis, management and recycling, industrial process optimization, H&S risk assessment, biodegradability and compostability analyses, sustainability assessment of processes and products.