

**The role of biodegradable materials in food packaging in the context of
circular economy**

Singh¹ S, Lamsaf¹ H, Mota² I, Mendes¹ R, Goes¹ CB, Poças F.^{1,2*}

¹*Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Rua Diogo Botelho 1327, 4169-005 Porto, Portugal*

²*Universidade Católica Portuguesa, Escola Superior de Biotecnologia - Centre for Food Quality and Safety*

*Corresponding author: fpocas@ucp.pt

The concept of circular economy (CE) is intensively discussed and addressed by different actors of value chains, politicians, and academia. As applied to food packaging, it is frequently depicted as a combination of reducing, reusing, and recycling activities. Packaging plays an essential role in the food supply, protecting and containing food from processing and manufacturing, through distribution, handling, and storage to the final consumer. Without packaging, food distribution would be inefficient and much more costly. Despite the critical role it plays and its economic relevance, packaging is, in the view of many consumers, a waste of resources, which ends up exclusively as an environmental burden. Such views arise because the functions packaging must perform are either unknown or not fully considered and appreciated by the consumer. The recent review of the European packaging and packaging waste directive under discussion proposes sustainability requirements for packaging and apart from recyclability, bio-based, compostable, and biodegradable packaging are addressed. Bio-based materials, and in particular biodegradable, are generally perceived by consumer as a solution for more sustainable packaging, although the difference between both concepts is not generally appreciated.

However, the properties of biodegradable materials may not suffice the required protection and shelf-life specifications as under the today's standards of distribution and supply chains. As a consequence, the use of biodegradable materials as food packaging may result in shorter shelf-life and increased food losses. Furthermore, contamination of recyclables streams with biodegradable articles is a problem for the quality of the conventional recovery streams intended to be recycled. Therefore, the benefits of using biodegradable materials as food packaging needs to be critically evaluated using recognized tools, such as life cycle assessment (LCA).

Polybutylene Adipate Terephthalate (PBAT), a synthetic biodegradable polyester, is the main biodegradable material commercially used today for flexible packaging. PBAT and its blends has raised much attention of researchers and industry. It is fully biodegradable and compostable. It can be produced from biomass but currently still relies on fossil-based resources. Therefore, it is arguable if it fits into the concept of circular economy, although this situation is common to other biopolymers. It may be anticipated that PBAT will be made from biobased resources in 2030 and therefore, PBAT is targeted in many studies highlighting its biodegradability and dedicating efforts in improving its functionality for food preservation, including antimicrobial active packaging.

This work presents a critical review, based on scientific literature focusing on the role biodegradable materials on food packaging considering the need of closing the loop underlying

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circular economy. PBAT is addressed as a case study. The search was based in articles retrieved from ScienceDirect published between 2018 – 2022 and using selected keywords: “food packaging”, “shelf-life”, combined with “biodegradable”, “PBAT”. Only studies focusing on the performance of the material as packaging for real food products were considered. The key word “PBAT” was also combined with “LCA” and “End-of-life” to address the loop closing.

The data from the selected studies were analysed regarding the food applications and the impact on the shelf-life performance. Most of the studies published focus on modified biodegradable materials to enhance packaging films properties through incorporation of nanoparticles and active substances with synergic functions, such as antimicrobial and antioxidant. Results indicate six end-of-life routes suitable for PBAT: re-use; mechanical and chemical recycling, industrial composting, incineration and biodegradation in soil.

Key words: food shelf-life, PBAT, biodegradable packaging material, circular economy,

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