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# Environmental Hotspots of the Life Cycle of Pumpkin Pulp: Conventional vs Waste-derived Preservatives

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## Abstract

Throughout its entire life cycle, food contributes to several environmental impacts (Poore and Nemecek, 2018). Food waste is of particular interest since resources are being depleted for no practical use in this case, and the need for further treatment implies additional impacts. Consequently, alternatives for food waste valorisation are crucially needed [2]. This is the aim of the project PulpIng – Development of pumpkin pulp formulation using a sustainable integrated strategy – which intends to valorise pumpkin crop by-products, to develop a new preservative for packaged pumpkin pulp, while simultaneously avoiding bio-waste generation, promoting circular economy and substituting typical synthetic preservatives with a bio-based solution. For a thorough evaluation of the environmental benefits of this project's strategy, the potential environmental impacts resulting from packaged pumpkin pulp throughout its life cycle were assessed. All stages of the life cycle were considered (cradle-to-grave), from pumpkin cultivation and packaged pulp production to the end-of-life (which, considering the typical whole use of pumpkin pulp, integrates the end-of-life of the packaging). In the

first phase, an assessment of the traditional life cycle environmental impacts of packaged pumpkin pulp production, during which pumpkin by-products are considered waste and pulp production uses traditional preservatives, was performed. The same cradle-to-grave assessment will later be executed considering the use of a preservative derived from the pumpkin by-products. Preliminary life cycle assessment results for the traditional life cycle of packaged pumpkin pulp are now available. These show that the agricultural phase has the highest contribution to most impact categories (13 out of 18 at midpoint level). The production of packaged pumpkin pulp is the second highest contributor in 4 midpoint categories, standing out relatively to the agricultural phase, particularly in terms of potential terrestrial ecotoxicity and fossil resource scarcity. The end-of-life is not a particularly relevant stage in comparison. On the one hand, in the agricultural stage of the life cycle of packaged pumpkin pulp, the hotspot is usually the treatment of the bio-waste, i.e., the by-products of pumpkin which have no use (stems, leaves, rinds, and fibres), which contributes on average to approximately half of the potential environmental impacts. Hence, an alternative to this waste treatment is recommended. On the other hand, in the production stage of packaged pumpkin pulp, preliminary results show that preservatives production may have a relevant contribution to its potential life cycle impacts (the thickening agent is typically the main contributor, however, following it, the most relevant are electricity use, preservatives production, and polypropylene buckets production), implying that the use of alternative preservatives would be beneficial. Thus, the assessment of the current life cycle of packaged pumpkin pulp production supports the idea of intervening both at the level of valorisation of the agricultural by-products and at the pulp additives production, for a relevant reduction of potential environmental impacts.

**Keywords:** pumpkin pulp; life cycle assessment; agricultural waste; preservatives; bio-waste

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