Environmental hotspots of the life cycle of pumpkin pulp: conventional vs waste-derived preservatives

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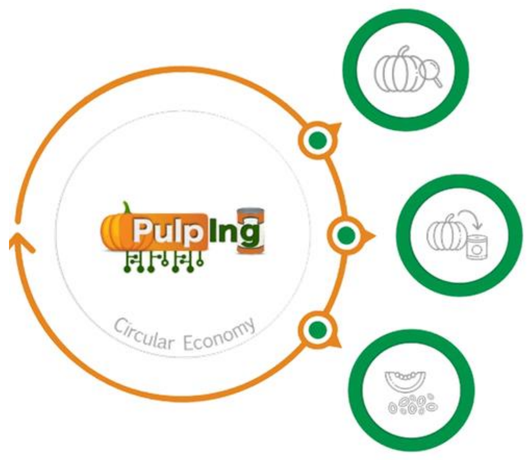
Introduction

Throughout its entire life cycle, food contributes to several environmental impacts. 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. 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.



Methodology

In this study, the **Life Cycle Assessment (LCA)** methodology was applied to evaluate the potential environmental impacts resulting from **packaged pumpkin pulp**. All stages of the life cycle were considered (**cradle-to-grave**).

In the first phase, an assessment of the **traditional life cycle** environmental impacts of packaged pumpkin pulp, 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.

Data for the agriculture phase was obtained from experiments performed at pilot-scale in Greece.

Open-field cultivation (1280 m²)

320 pumpkins in 6 months
5.8 kg of pumpkin flesh/pumpkin

1.79 kg of by-products (*e.g.* stems, leaves, rinds) per kg of pumpkin flesh

Data for the **pulp production** was collected from a real industry in Portugal.

Transport was excluded as it varies. The use phase is not expected to generate impacts, and an average waste treatment was assumed for the packaging.

The **ReCiPe** methodology and data from the **ecoinvent v3** database were used.

Results

These are preliminary results for the traditional life cycle of 1 kg of packaged pumpkin pulp.

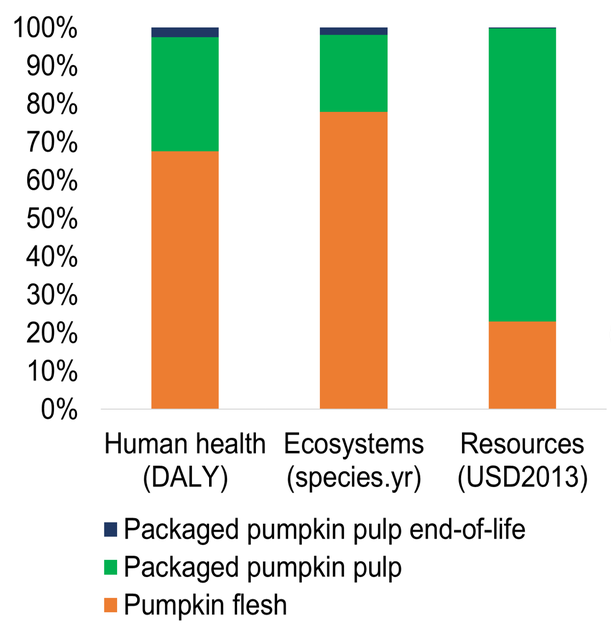


Fig 1. Contribution of the life cycle stages to each endpoint category.

- Under the studied conditions, it is estimated that **the agricultural phase** (resulting in pumpkin flesh) **has the highest contribution to most impact categories** (13 out of 18 at midpoint level), and the 2nd highest to the remaining.
- The **production of packaged pumpkin pulp** is the **highest contributor to the remaining**, standing out particularly in terms of fossil resource scarcity. The end-of-life is not a particularly relevant stage in comparison. These results are reflected at endpoint (damage) level (Fig 1).

- In the **agricultural phase** 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). It contributes on average to approximately half of the potential environmental impacts of this stage.
- In the **production phase 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).

Conclusions

Given that, on one hand, in the agricultural phase of the life cycle of packaged pumpkin pulp the treatment of the bio-waste is a main hotspot; and that, on the other hand, in the production phase, preliminary results show that preservatives production may have a relevant contribution, both alternatives to bio-waste treatment and to the preservatives used are recommended. Hence, **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. This work is thus of great interest and will continue to be developed. The inventory data will continue to be refined, and the life cycle assessment will then be performed incorporating the reclamation of the pumpkin by-products for the production of an alternative preservative for pumpkin pulp, to estimate potential avoided impacts.

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