LCA OF BOTTLES MADE FROM BIO-BASED PHB WITH A FOCUS ON ALLOCATION OF SUGARS IN WASTEWATER

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PHBOTTLE

BACKGROUND & AIMS

The juice industry generates large streams of wastewater. As some streams are rich in fermentable sugars they are suitable for producing PHB (poly-ß-hydroxybutyrate). PHB can be used for packaging replacing PET.
The sugars in the wastewater can be seen as waste but also as by-product of the juice production. Depending of the view taken the sugars are allocated no or part of the environmental burden of the juice production in a Life Cycle Assessment (LCA). This study focuses on the effect of different allocation schemes on the LCA of PHB bottles produced from wastewater of the juice industry.
The first aim of the study is to explore the impact of different allocation schemes for sugars in the wastewater of juice production. The second aim is to compare the environmental performance of PHB and PET bottles.

METHODS

The reference unit is 1 kg of plastic bottles. Both PHB produced from wastewater (rinse water) as fossil-based PET are studied, assuming the same bottle mass. We analyse three scenarios for an orange juice producer. The first scenario is based on the sugars sharing no burden from the juice production; the non-inherited burden scenario. The other two scenarios are based the sugars having an economic value and being a by-product. Both mass allocation and economic allocation are applied.
The treatment for the end-of-life bottles is based on the situation in the EU-27 (60% energy recovery; 32% recycling; 8% landfill).
The CML impact assessment method is used for the LCA calculations. By using shadows prices the environmental impact can be expressed in a single monetary value.

RESULTS

Sugars in rinse water can be seen as waste with no environmental burden or as by-product. Depending of the approach taken the allocation factors differ (see Table 1).

Table 1. Mass and economic value allocation of orange juice concentrate and by-products.

(By-)products	Mass	Economic value
Orange juice concentrate	26.01%	99.435%
Orange oil	0.39%	0.526%
Orange peel	73.56%	0.036%
Sucrose in rinse water	0.05%	0.003%
Total	**100%**	**100%**

In the non-inherited burden scenario the use of energy from fossil fuels dominates the environmental impact of PHB production (see Figure 1). The use of steam for sterilizing the wastewater is especially important.

This is also the case of the scenario of economic allocation. However, the scenario of mass allocation shows a considerable inherited impact of the orange cultivation.

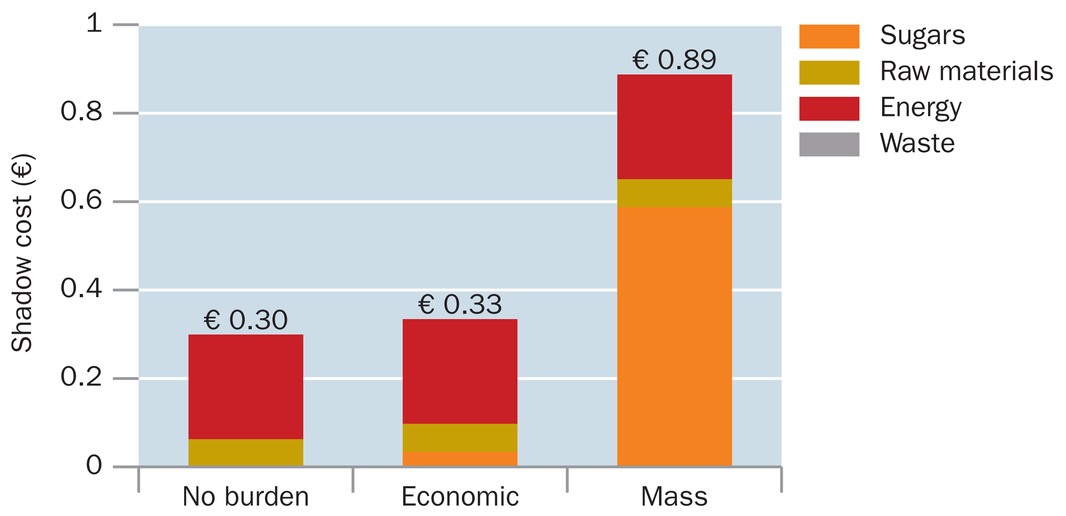

Figure 1. Environmental impact (shadow costs) of the production of 1 kg PHB from rinse water of orange juice concentrate.

The environmental impact of PHB bottles is comparable with PET bottles for the mass allocation scenario (see Figure 2). In the other scenarios the PHB bottles outperform the PET bottles. Due to a heating value higher than PET and because of the biobased origin PHB bottles gain an environmental benefit over PET bottles when incinerated with energy recovery.

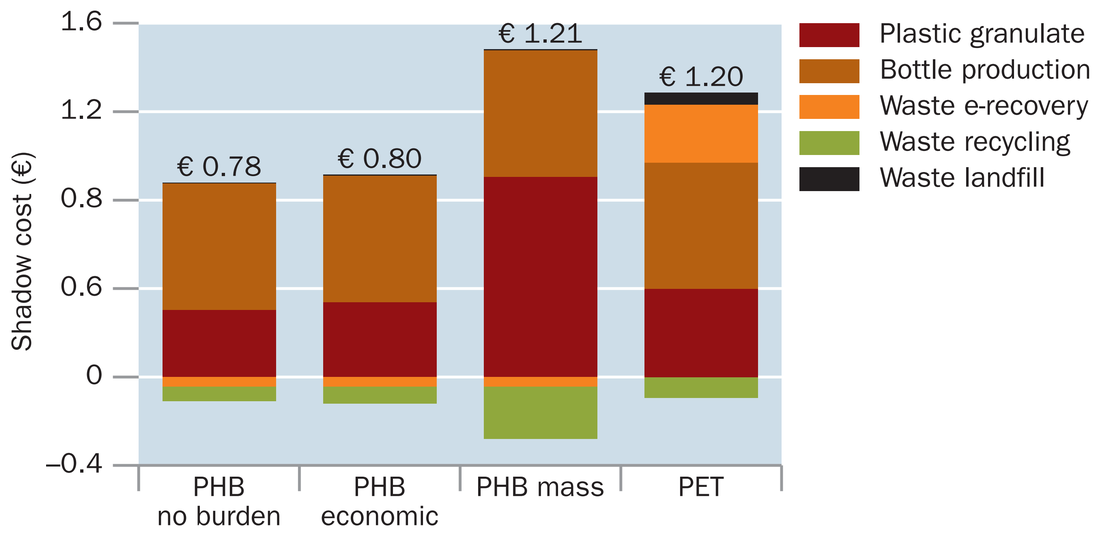

Figure 2. Environmental impact (shadow costs) of the cradle to gate life cycle of 1 kg bottles from PHB (different allocation schemes) and PET.

CONCLUSIONS

The production of PHB from sugars in the wastewater of the juice industry has the potential of reducing the environmental impact of packaging materials. In case of mass allocation for the sugars PHB has a comparable environmental impact as PET. Mass allocation is seen a less appropriate allocation in this specific case. Using economic allocation or seeing the sugars as waste leads to PHB outperforming PET. In case the heat treatment of the feed can be reduced PHB will perform even better.

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