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Do you sell fruit and vegetables in 500g containers?

This is how you can reduce the carbon footprint of your packaging trays

RESULTS IN BRIEF

- We compare two of the most commonly used food packaging materials, PET and corrugated cardboard, using the example of fruit punnets.
- The results show that a corrugated cardboard fruit punnet generates less harmful climate emissions than an equivalent PET fruit punnet due to the greenhouse gas potential of biological raw materials.
- If PET fruit punnets were replaced with corrugated cardboard in Germany, the annual CO_2 emissions generated in the production of fruit punnets could be reduced by 34%.

We propose the following measures for reducing the environmental footprint of fruit and vegetable packaging:

- Selling loose fruit and vegetables should be a priority (as far as possible)
- Corrugated cardboard should be considered before PET as packaging material.
- Recycled materials should be used for the production of packaging.

WHAT - WHY - HOW: THE RESEARCH APPROACH

Packaging is a crucial factor in the value chain of many products and a continuously growing industry (Breitkopf, 2018). However, its environmental impacts are also growing and have thus become the focus of public attention. Yet, it is often not clear what kind of packaging is the most sustainable option.

To this end, this study compares the environmental impacts of a common packaging design in the fruit and vegetable sector: the **fruit punnet** (see Figure 1). Fresh fruit and vegetables are a relevant sector, as 63% of products are sold in a package and experts see potential to reduce their environmental impacts through a circular economy approach (Istel et al., 2017).

Figure 1. Examples of fruit punnets (source: https://www.klingele.com/ & own image)

In this study, we compare the most common fruit punnet options - corrugated cardboard and PET (GVM, 2019). For this purpose, we conducted a **life cycle assessment (LCA):** a tool that analyses the environmental impacts of a product's life cycle (ISO, 2006). As part of the LCA, the functional unit defined in the study is a punnet used for packaging, transporting and distributing 500g of fresh fruit or vegetables. The PET punnet has a lid, whereas the corrugated cardboard basket has a plastic film. The unit weight is 20 grams for both corrugated cardboard and PET.

Figure 2 shows the system boundaries of our study:

- Pre-production: Production of basic materials.
- Production phase: Production of the packaging (corrugated cardboard or PET).
- Transport phase: Transport between the different phases.
- End-of-life phase: Recycling or recovery of the packaging.

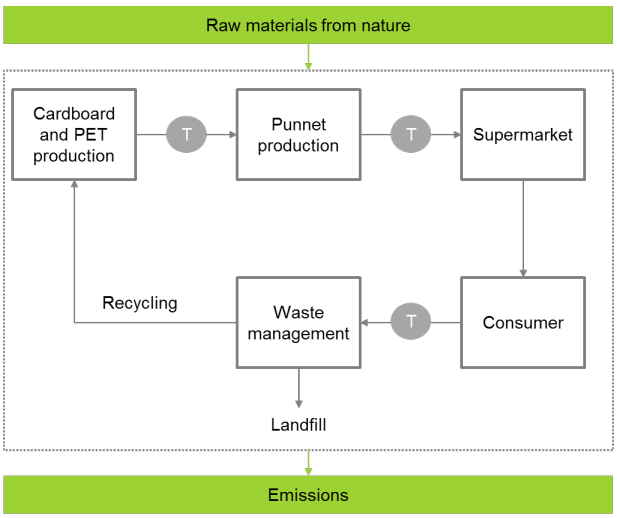

Figure 2: System boundaries of the food packaging industry. Own figure.

The results of this LCA refer exclusively to the carbon footprint. This focus was chosen because, on the one hand, it enables the analysis of the potential carbon storage in bio-based raw materials based on data from the European Federation of Corrugated Board Manufacturers (FEFCO, 2019). On the other hand, it can be used to create scenarios for the German market in order to model the contribution of bio-based raw materials such as corrugated cardboard to climate change.

WHICH PACKAGING IS MORE ECO-FRIENDLY?

The results of the carbon footprint analysis (Figure 3) show that the life cycle of a corrugated cardboard punnet generates less CO_2 emissions (0.017 kg CO_2 eq.) than the PET option (0.036 kg CO_2 eq.). The contribution of a PET punnet to climate change is 2.2 times higher than that of a corrugated cardboard punnet. This can be explained by the energy sources and recycling rates. For corrugated cardboard, the recycling rate is 89%, while for PET it is between 10% and 50% (GMV, 2019). While for corrugated cardboard the pre-production (23% of the total impact) and production (57%) phases are the main impact contributors, for PET it is mainly the production phase and end-of-life (31% and 62% of the total impact, respectively).

In the case of the corrugated cardboard punnet, the carbon storage potential of the forests also contributes to minimizing the carbon footprint.

Subtracting the amount of stored carbon from the negative environmental impact of the life cycle (0.030 kg CO_2 eq.) reduces the carbon footprint of the corrugated cardboard punnet by 43%.

Our results reflect the CO_2 values published by FEFCO (2019) for corrugated cardboard packaging. However, we obtained 840 kg CO_2 eq. per tonne of fruit punnet, while the guidelines for corrugated cardboard packaging suggest a value of 538 kg CO_2 eq. per tonne. This difference results from assumptions we made about the German market (e.g. electricity mix) and our choice of databases and methodologies for this study (in our case ecoinvent).

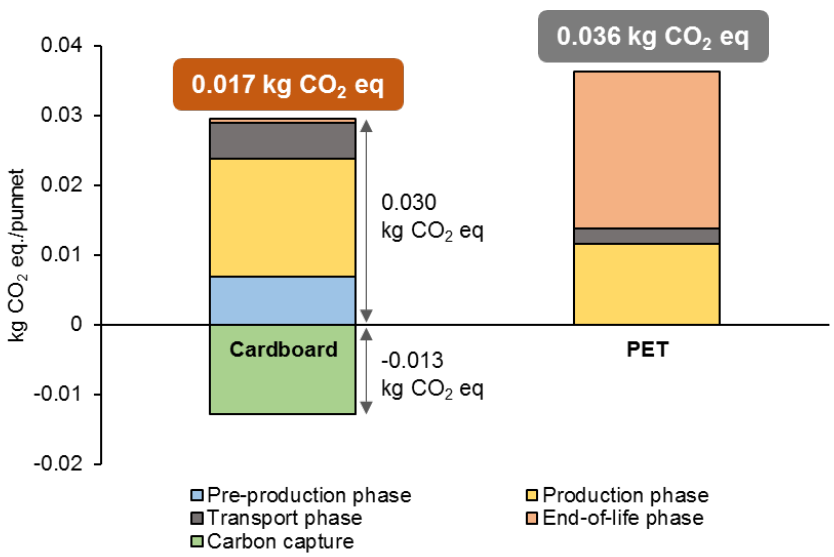

Figure 3. Carbon footprint of corrugated cardboard and PET punnets. Own figure.

In a next step, we scaled up the results of the individual fruit punnets to the entire German market. To do so, we draw on data from GVM (2019). The results show that the consumption of PET and corrugated cardboard punnets increased by 37% between 2010 and 2018 (Figure 4, left). In parallel, CO_2 emissions have increased by 35% during this period (Figure 4, right).

The increase in environmental impact directly correlates with the packaging material. The share of corrugated cardboard punnets in the German market is slightly higher than that of PET, especially in 2018 with 55%. Nevertheless, 64-66% of the annual CO_2 emissions are caused by PET punnets.

The scenarios below show the potential CO_2 savings of using corrugated cardboard instead of PET punnets in the German market, with shares from zero to 100% (Figure 4, below). The year 2018 represents the status quo with 55% corrugated cardboard. As the figure shows, the status quo already causes 29% less emissions than a scenario with 100% PET punnets. If the share of PET punnets produced in 2018 (45%) were replaced with corrugated cardboard, 6.7 kilotonnes of CO_2 emissions could be saved annually. This means that the carbon footprint could be reduced by up to 34% if all fruit punnets were made of corrugated cardboard.

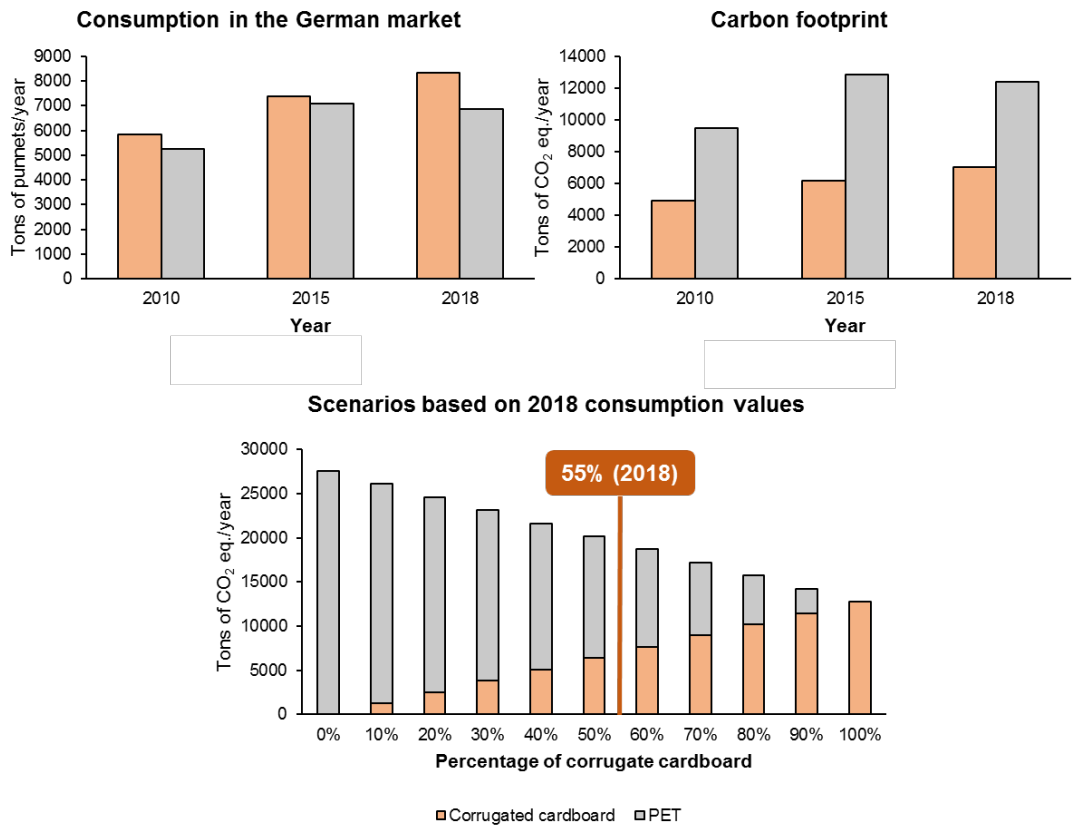

Figure 4: Share of PET and corrugated cardboard in the German fruit punnet market (left), carbon footprint (right) and potential CO_2 savings when using corrugated board instead of PET punnets (bottom). Own presentation based on GVM (2019)

Limits of the study

In order to be able to carry out a life cycle assessment, the object of investigation has to be limited. Here, PET and corrugated cardboard punnets for 500 g of fresh fruit and vegetables were examined. This presented considerable data collection challenges, as this type of packaging is very specific and the data is limited and different from other types of packaging. In order to be able to more comprehensively assess the environmental impacts of different packaging options available in the German market, future studies should include additional materials.

In addition, the scope of the LCA could be extended by accounting for both the product (fruit and vegetables) and its packaging in the functional unit. Furthermore, more environmental indicators are needed, e.g. water consumption, in order to make decisions that take all natural resources into account.

WHAT CAN YOU DO?

Unless fruit and vegetables are damaged without packaging, the most eco-friendly packaging is usually no packaging at all. Therefore, supermarkets and retailers should be encouraged to sell **loose fruit and vegetables.** Especially in the fruit and vegetable sector there is great potential to do so. This approach is in line with the German Packaging Act 2019, which stipulates material and weight reductions for packaging.

If loose sales are not possible, e.g. for berries or stone fruit, the **use of corrugated cardboard packaging** should be examined. As a "bio-based" material, corrugated cardboard also offers savings on licence fees for recycling. If a conversion to corrugated cardboard is not possible, other packaging options should be explored, such as reusable trays or nets, as well as the use of recyclates in PET packaging.

FURTHER INFORMATION AND SOURCES

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The **Circular Economy Series** presents research results of the research group "Circulus - Opportunities and challenges of transition to a sustainable circular bio-economy". The researchers are developing a comprehensive understanding of possible pathways to a circular economy in Germany and Europe. To this end, they combine perspectives from the social, environmental and engineering sciences to analyse the ecological and socio-economic consequences of the circular economy in various sectors.

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