How Packaging Contributes to Food Waste Prevention

Summary of a study by denkstatt GmbH in cooperation with ARA AG (Austrian packaging recycling association) and further partners from the sectors retail, packaging production and science (Denkstatt 2014)
Food waste – an important issue

- About **30 percent of the carbon footprint** of an average European are linked to the production and distribution of food and to nutrition [European Commission 2006]

- **More than 100 Mill. tonnes of food are wasted** in Europe every year [European Commission 2014]

- Proposal for amending Directives 2008/98/EC on waste and others [European Commission 2014]:
  
  ... a framework should be established for Member States to collect and report levels of food waste across all sectors in a comparable way, and request developing national food waste prevention plans aimed at meeting an aspirational objective to **reduce food waste by 30 % by 2025**.
Packaging support the prevention of food waste (I)

Packaging supply chain’s good practices to prevent food waste [Europen 2013]

“Packaging is part of the solution to tackle food waste:

- Packaging prevents food spoilage,
- ensures food quality and safety along the supply chain and at home,
- informs consumers on how to use and store packaged food products,
- increases shelf-life
- and provides portion sizes answering the multiple needs of consumer lifestyles and demographic changes.”
Packaging supports the prevention of food waste (II)

Packaging protects food by

- Preventing damage, contamination, contact, etc.
- Providing a barrier against oxygen, moisture, etc.
- Optimizing humidity and temperature
- Keeping food in protective atmosphere or vacuum
- Prolonging shelf life

Further optimization by

- Suitable portion sizes,
- Improved barrier layers
- Improved puncture resistance
- Inclosing components for modifying the atmosphere (for example scavenging Oxygen)
- Better sealing, ...

But there is a lack of quantitative data about these issues.
Module 1: Collection of data in retail enterprises

Module 2: Quantitative assessment of 6 case studies

Module 3: Workshop with project partners – opportunities for future improvements
Project partners

Packaging Recycling Association

Retailers

Polymer producer

Packaging producers

Meat packer

Industry association

Research institute
## Investigated case studies

<table>
<thead>
<tr>
<th>Packed Food</th>
<th>Previous Version</th>
<th>Improved Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sirloin steak (and similar cuts of beef steak), 330 g</td>
<td>EPS Top seal tray with modified atmosphere, 34 % waste</td>
<td>PS/EVA/PE based skin packaging, 18 % waste</td>
</tr>
<tr>
<td>Bergbaron cheese, 150 g in slices</td>
<td>Cut from a 5 kg bar and sold at counter, 5 % waste</td>
<td>Slices in APET/PE/PSA tray + film packaging, 0.14 % waste</td>
</tr>
<tr>
<td>Plaited yeast bun, 400 g</td>
<td>Paper bag with plastic strip window, 11 % waste</td>
<td>OPP film packaging, 0.8 % waste</td>
</tr>
<tr>
<td>Garden cress growing on substrate, 100 g</td>
<td>In PS tray, 42 % waste</td>
<td>Additional PP film, 3.4 % waste</td>
</tr>
<tr>
<td>Cucumber, 350 g</td>
<td>Without packaging, 9.4 % waste</td>
<td>PE film, 4.6 % waste</td>
</tr>
<tr>
<td>Chicken meat, 350 g</td>
<td>PP tray plus lidding, 14 % waste at home</td>
<td>PP tray plus lidding, meat separated into two pieces, 5 % less waste at home</td>
</tr>
</tbody>
</table>
The examples cover all major sectors of fresh food:

- Meat
- Cheese and dairy products
- Vegetable and fruits
- Bakery products

In cooperation with packaging producers, packers and retail enterprises, additional examples shall be identified and assessed within follow-up projects.
Methodology used for assessing the case studies in total life-cycle

- Comparison of total waste amounts and of Carbon Footprint (CO₂-equiv.) of previous and improved packaging solution
- Consideration of production, transport (displayed separately only for examples 1 and 2), use-phase, and waste treatment of food and packaging
- All results are based on the same functional unit = same amount of consumed food for each case study
- Food waste in households is not included (except in example 6 for chicken meat)
- Net greenhouse gas emissions of packaging recovery are calculated with an existing reviewed ARA/denkstatt-model
- No greenhouse gas emissions are assigned to treatment of food waste in waste incineration plants
## 5 concrete examples as result of data collection within Austrian retailers

<table>
<thead>
<tr>
<th>Item</th>
<th>Original Waste Share</th>
<th>Change to Waste Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sirloin steak:</td>
<td>34 %</td>
<td>18 %</td>
</tr>
<tr>
<td>“Bergbaron” cheese:</td>
<td>5 %</td>
<td>0.14 %</td>
</tr>
<tr>
<td>Yeast bun:</td>
<td>11 %</td>
<td>0.8 %</td>
</tr>
<tr>
<td>Garden cress:</td>
<td>42 %</td>
<td>3.4 %</td>
</tr>
<tr>
<td>Cucumber:</td>
<td>9.4 %</td>
<td>4.6 %</td>
</tr>
</tbody>
</table>

Recorded changes of food waste shares due to changes in packaging:
Example 1 – Sirloin steak

Darfresh skin packaging extends the shelf life from 6 to 16 days; enables steaks to be cut and aged in pack, eliminating separate packaging for aging; reduction of food waste by 16 percentage points.
Example 1 – Sirloin steak

Basic input data

1a: previous packaging

- 20 g PE/EVA+PE/PVdC/EVA+PE vacuum-bag (for 6 kg meat) = aging packaging
- 11 g EPS tray and 4 g EVOH/PE/PA film – final packaging (absorbent pad not considered)
- 358 g of packed food (scaled down to 330 g)
- Food waste: 34 %

1b: improved packaging (shelf life of 16 days instead of 6 days; no separate aging packaging needed)

- 19 g PS/EVA/PE based “Darfresh” skin packaging (absorbent pad not considered); aging takes place in final packaging
- 300 g of packed food (scaled up to 330 g)
- Food waste: 18 %

Data provided by REWE, Sealed Air, OFI, Köhrer
Example 1 – Sirloin steak: results

Carbon Footprint, excluding consumed food

<table>
<thead>
<tr>
<th>Category</th>
<th>CO2e [gram per functional unit]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of wasted food</td>
<td>-6000</td>
</tr>
<tr>
<td>Production of packaging</td>
<td>-4000</td>
</tr>
<tr>
<td>Transport</td>
<td>-2000</td>
</tr>
<tr>
<td>Waste treatment food</td>
<td>0</td>
</tr>
<tr>
<td>Packaging recovery</td>
<td>0</td>
</tr>
<tr>
<td>Total GHG balance</td>
<td>3700</td>
</tr>
</tbody>
</table>

**Effect of optimised packaging:** - 6 g CO2e

**Savings of reduced food waste:** - 2,100 g CO2e

functional unit = consumed amount = 330 g Sirloin steak
Results example 1 – Sirloin steak

- Total waste (product and packaging) reduced by 50 %
- The high environmental impact of top quality beef results in high environmental benefit of reduced food waste
- The differences concerning production and recovery of packaging are comparably small
- As a general rule: the more valuable / expensive the product, the more important is a robust protection of the product by high quality packaging
Example 2 – “Bergbaron” cheese

Photo: denkstatt
Example 2 – “Bergbaron” cheese
Basic input data

2a: distribution via delicatessen counter
- 16.8 g PE/EVA+PE/PVdC/EVA+PE shrink bag for 5 kg of cheese, plus transport packaging
- 150 g sliced cheese sold at the delicatessen counter in 6.9 g wrapping paper & “1/3” paper bag (3 products per bag)
- **Food waste: 5 %**
- Net load on the transport truck: about 22 t

2b: distribution via self service shelf
- 150 g sliced packed cheese in self service shelf. Packaging: 11.9 g APET/PE tray with PET/PE/PSA/PE lidding film, plus transport packaging
- **Food waste: 0,14 %**
- Net load of the transport truck: about 14 t

Data provided by REWE, Berglandmilch, OFI
Example 2 – "Bergbaron" cheese: results
Carbon Footprint, excluding consumed food

**Gram CO\textsubscript{2}e per 150 g of sliced cheese**

- Reduced GHG emissions due to reduction of food losses from 5% to 0.14%: \(-69 \text{ g CO}_2\text{e}\)
- Increased GHG emissions for better packaging: \(+28 \text{ g CO}_2\text{e}\)
- Small relevance of increased transport and less recyclability

**Impact : benefit ratio = 1 : 2.5**

**Net-benefit of improved packaging solution**

- **Cheese sold at counter**
- **Packed cheese at shelf**

**functional unit = consumed amount = 150 g Bergbaron cheese**
Results example 2 – “Bergbaron” cheese

- Amount of packaging material per consumed food amount increases. Small increase of the total waste amount (product plus packaging)

- High environmental impact of cheese production results in high environmental benefit related to prevention of 5% cheese waste

- This benefit is 2.5 times higher than the sum of the additional environmental impacts of
  - the production of an increased amount of packaging material
  - increased impact of transport (less load on truck)
  - higher emissions related to recovery of packaging

- Remark: Limited comparability of the two distribution methods “delicatessen counter” and “self service shelf”, which provide different offers, address different needs and target groups, ....
Example 3 – plaited yeast bun

PP film bag instead of paper bag – less dehydration
0,8 % food waste instead of 11 %

Photo: denkstatt
Example 3 – plaited yeast bun
Basic input data

3a: previous packaging
   - 11.5 g paper bag with PP viewing stripe
   - 400 g plaited yeast bun
   - Food waste: 11 %

3b: improved packaging (less dehydration)
   - 3.5 g OPP film
   - 400 g plaited yeast bun
   - Food waste: 0.8 %

Date provided by MPREIS
Example 3 – plaited yeast bun: results
Carbon Footprint, excluding consumed food

Optimization of packaging: - 12 g CO$_2$e
Reduced food waste: - 136 g CO$_2$e

functional unit = consumed amount = 400 g plaited bun
Results example 3 – plaited yeast bun

- Significant reduction of both, the amount of packaging and the amount of food waste
- Both effects reduce greenhouse gas emissions in total life-cycle
- Substituting paper by plastic packaging has advantages in this example, even if (slightly) higher emissions occur within waste management
Example 4 – garden cress

Additional breathable PP film (protection against being touched by customers, improving humidity and temperature for the cress) 3.4 % food waste instead of 42 %

Photo: denkstatt
Example 4 – garden cress

Basic input data

4a: previous packaging
- 75 g PS tray
- 100 g salad cress and hemp substratum (25 g cress harvested)
- Food waste: 42%

4b: improved packaging (protection against contact by the customer, optimum air moisture for the cress)
- 75 g PS tray, 10 g breathable PP film
- 100 g salad cress and hemp substratum (25 g cress harvested)
- Food waste: 3.4%

Data provided by EMO Eigenmarken GmbH / Pfeiffer-Handelsgruppe
Example 4 – garden cress: results
Carbon Footprint, excluding consumed food

 Optimization of packaging: - 121 g CO$_2$e
Reduced food waste: - 65 g CO$_2$e

<table>
<thead>
<tr>
<th>Process</th>
<th>CO$_2$e [gram per functional unit]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of wasted food</td>
<td></td>
</tr>
<tr>
<td>Production of packaging</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td></td>
</tr>
<tr>
<td>Waste treatment food</td>
<td></td>
</tr>
<tr>
<td>Packaging recovery</td>
<td></td>
</tr>
<tr>
<td>Total GHG balance</td>
<td></td>
</tr>
</tbody>
</table>

4a Garden cress + substrate in tray
4b Plus additional film packaging

functional unit (FU) = consumed amount = 25 g cress
Results example 4 – garden cress

- Less amount of packaging per unit of consumed food (although the amount of packaging per unit of packed food increases)
- By applying an additional film packaging, food waste could be reduced by more than 90%
- Both effects reduce greenhouse gas emissions in total life-cycle
Example 5 – cucumber

No packaging versus PE film  
(prolonged shelf life, less moisture loss)  
4.6% food waste instead of 9.4% (at the retailer)

Foto: denkstatt
Example 5 – cucumber

Basic input data

5a: previous situation

- No packaging
- Average weight of the cucumber: 480 g (own measurements, 11 products)
- Food waste: 9.4 %

5b: cucumber with packaging (prolonged shelf life, less moisture loss)

- Average weight of the film: 1.5 g (own measurements)
- Average weight of the cucumber: 480 g (own measurements)
- Food waste: 4.6 %

Data provided by MPREIS, OFI
Example 5 – cucumber: results
Carbon Footprint, excluding consumed food

“best case calculation” for cucumber without packaging

Additional emission of packaging: + 4.5 g CO$_2$e
Reduction of the food waste – 3.5 g CO$_2$e
Alternative results: see next slide

<table>
<thead>
<tr>
<th>CO$_2$e [gram per functional unit]</th>
<th>Production of wasted food</th>
<th>Production of packaging</th>
<th>Transport</th>
<th>Waste treatment food</th>
<th>Packaging recovery</th>
<th>Total GHG balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>5a Cucumber without packaging</td>
<td>Blue</td>
<td>Yellow</td>
<td></td>
<td>Green</td>
<td>Blue</td>
<td>Green</td>
</tr>
<tr>
<td>5b Cucumber in PE film</td>
<td>Green</td>
<td>Blue</td>
<td></td>
<td>Green</td>
<td>Green</td>
<td>Blue</td>
</tr>
</tbody>
</table>

functional unit = consumed amount = 480 g cucumber
The environmental benefits of food waste reduction surpass the environmental impact of the film packaging, if ONE of the following conditions is fulfilled:

- The food waste is reduced by >6.3 percentage points (e.g. 3.7 % instead of 10 % food waste); in the example above the reduction is 4.8 % points (remark: the impact of food waste in households is not included in the calculation)

- The thickness of the film is reduced by 22 % (films with different thicknesses are used today, the calculation is based on an average value)

- The distance for transport is increased by 60 % (the calculation is based on local production)

- The cucumber is grown in a greenhouse (calculation: open field)

- 2/3 of film packaging is collected separately (calculation: 1/3)
Example 6 – chicken meat

On average 14% of chicken meat is wasted by consumers. A tray with two segregated cavities contributes to reducing food waste. Waste reduction by only 0.5% percentage points is enough to compensate the impacts of additional packaging.
This example refers to benefits on the consumer level (example 1 to 5 focused on waste at retail level)

Unfortunately no quantitative data for the possible improvements are available

The initial value of 14% food waste has been estimated by DEFRA (UK) based on statistics about sales and waste amounts from consumers

Segregated cavities reduce the probability of wasted meat, if not all meat is immediately cooked and eaten when packaging is opened
Example 6 – chicken meat
Basic input data

6a: previous packaging
- 20.6 g PP tray and film
- 350 g chicken meta
- Food waste: 14 %

6b: improved packaging (tray with two segregated cavities)
- 24 g PP tray and film
- 350 g chicken meat in 2 segregated cavities
- Assumed food waste: 9 % (reduction by 5 percentage points)

Data source “Packaging design to reduce household meat waste” (WRAP, 2011)
Example 6 – chicken meat: results
Carbon Footprint, excluding consumed food

Example is based on a food waste reduction by 5 percentage points

Improved packaging: + 7.6 g CO$_2$e
Reduction of food waste - 108 g CO$_2$e
Impact benefit ratio = 1 : 14
Break-even point: reduction > 0.5 percentage points, for example 13.5 % food waste instead of 14.0 %
The additional packaging amount (16 % due to segregation into 2 cavities) is already compensated if food waste is reduced by only 0,5 percentage points.

In case of the assumed reduction of food waste from 14 % to 9 % the resulting CO₂-benefit is 14 times higher than the CO₂-emissions caused by the packaging amount additionally used.

As a general rule: the more valuable / expensive the product, the more important is a robust protection of the product by high quality packaging.
Even if improved packaging solutions contribute to increased CO2 emissions, the CO2 savings from reduced food waste are in most cases much higher.
1. Optimized packaging often provides environmental advantages. The reason is that benefits of prevented food waste are usually much higher than environmental impacts of production or optimization of the packaging involved.
2. In most cases the **protective function** of food packaging is more important than the impact of different packaging materials, also regarding their recyclability.

3. A **high value of the product** should be complemented by a high standard of packaging to ensure optimal product protection.

4. Advantages of improved packaging solutions should be **communicated along the value chain** in a transparent way.

5. Intense **communication and cooperation within all stakeholders** in the value chain will support future optimization.

6. In **follow-up projects** additional examples shall be identified and assessed.
We drive the change to a sustainable society.

Contact:

Katharina Aspalter
katharina.aspalter@denkstatt.at