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Frozen or chilled: what is the more sustainable choice? A case study on French fries

Perceived sustainability

The supermarket offers a wide range of frozen and refrigerated products. These products differ in shelf-life, storage conditions and processing history, but it is not always obvious which option is more sustainable. This factsheet shows an example of environmental impact comparison of frozen and chilled chain differences using the case of French fries.

Take home message

The more sustainable choice can be made by quantifying sustainability indicators as water and energy consumption and greenhouse gas emissions (GHG in CO_2 equivalents). Here the AgroChain greenhouse gas Emissions (ACE) calculator was used to visualise, identify and prioritise hotspots. The chilled French fries perform slightly better in terms of GHG emissions and energy use. The freezing process and longer storage times of the frozen fries make it more energy-intensive compared to chilled fries. The slightly higher product loss at retail of the chilled fries (2% compared to 1% for frozen fries) has a negligible impact on the environmental sustainability.

The ACE calculator

*The ACE calculator provides **insights** in the effects of **interventions** on **sustainability** within **boundaries** of the food production and distribution chain.*

The calculator aids in quantification of the environmental sustainability impacts of food processing systems and is able to include a wide range of interventions. Possible interventions include alternative ingredient and sourcing, energy sources, packaging, processing and end-of-life options.

Sustainability indicators: CO_2-eq, energy, water

Case study

The functional unit in the case study is 1 kg of French fries at retail, made of potatoes cultivated in the Netherlands. The production process of frozen and chilled French fries is based on Somsen (2004). The two chains are identical until the par-frying stage – the differences in the rest of the chain are indicated with an asterisk (*) (Figure 1).

Next, the potato strips are par-fried in rapeseed oil using 0.05 kg oil per kg of potatoes (Mouron, 2016), then cooled down or frozen, and packed (in plastic bags and cardboard boxes). Frozen fries are stored at the factory for 150 days and chilled fries for 1.5 days. Both types are transported to a distribution centre and stored for 3 days before being sent to retail. Frozen fries stay at retail for 4 days on average, and chilled fries for 1.5 days. Product loss at retail is 1% for frozen fries and 2% for chilled fries. All assumptions on distribution and losses are based on Evans (2012).

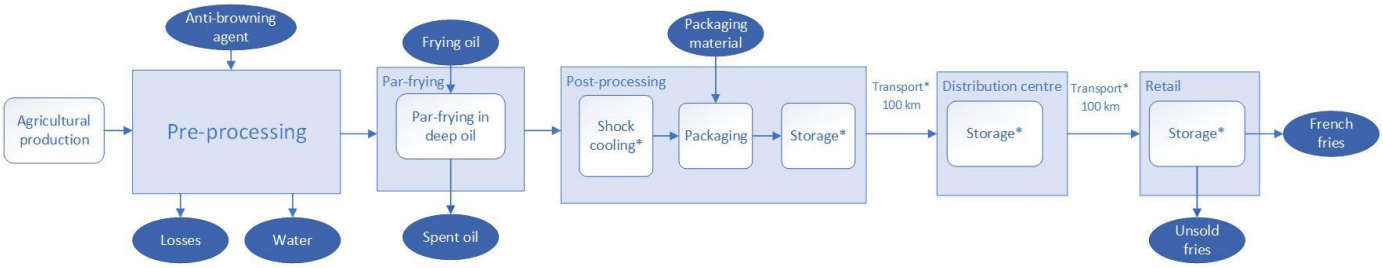

Figure 1: The process to produce 1kg of French fries involves peeling, washing, sorting, cutting, blanching, dipping in anti-browning agent, and drying potato strips. Losses include peels and rejects. * Frozen fries are shock-cooled in freezer, and stored and transported frozen, while chilled fries undergo these steps at refrigerated temperatures.

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Results

Figure 2 shows the environmental impact in GHG emissions (kg CO_2-eq), blue water (e.g. groundwater), green water (e.g. rainwater), and energy use. Frozen fries have 10-15% higher impact in GHG emissions and energy. The chilled fries use <1% more blue and green water, which is negligible. The reasons for the differences are:

- Energy consumption and GHG emissions are higher for frozen fries due to freezing, which uses double the energy of chilling. Along with longer storage times at the factory and retail, where freezers use more energy than refrigerators.

Figure 3 breaks down the GHG emissions and energy consumption per chain stage, highlighting the hotspots of each chain:

- Ingredients and processing are the most important contributors to the GHG emissions and energy use.
- The impact of ingredients is similar for both chains, as they make use of the same raw materials. Potato is responsible for about 2/3 of the impact and the frying oil for 1/3.
- Processing causes the differences between frozen and chilled fries, with frozen fries requiring more energy.
- Contribution of packaging is relatively small.
- The impact differences of frozen transport versus chilled transport appears negligible.
- The par-frying has the largest contribution to the energy consumption (Figure 3C).
- The differences between chains are due to the freezing process, factory storage, and retailer storage, which increase the energy consumption of frozen fries (Figure 3C). Storage at the distribution centre is negligible in both chains.

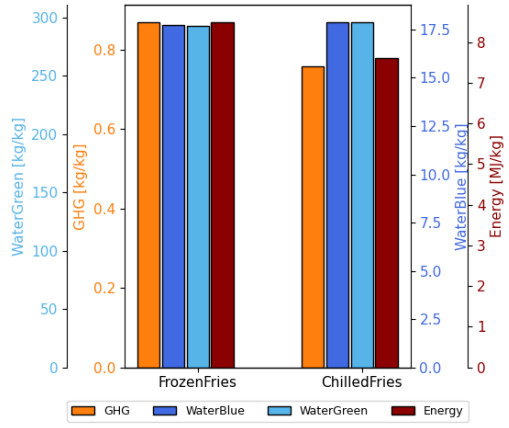

Figure 2: GHG emissions, water, and energy consumption for the frozen and chilled French fries.

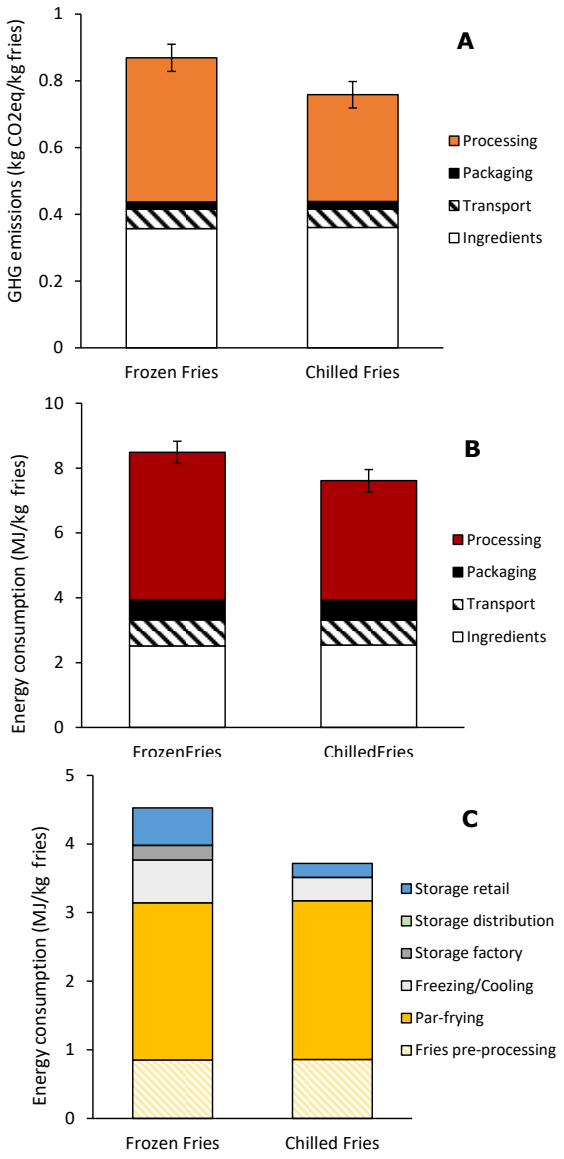

Figure 3: The GHG emissions (A) and energy consumption (B) of frozen and chilled fries per chain stage. (C) Distribution of processing energy.

Advise for 'the sustainable choice': frozen or chilled French fries?

Overall, the environmental impact differences between the two chains are small, but the following aspects stand out:

- Despite the much longer storage time of the frozen fries at the factory, the energy consumption remains relatively low because the freezers are very energy efficient.
- Retail freezers are much less efficient, using about 10 times more energy than factory freezers. Optimizing freezing at retail, like reducing storage time, could lower energy use and environmental impact.
- The differences of impact of food waste at retail are relatively small. At the consumer differences could be larger and may change the overall picture.
- Par-frying is energy-intensive, an alternative process could improve the environmental impact of both chains.

Please find complete information in the report or contact us for more details. Learn more about our sustainability assessment tools. Please keep in mind that the comparison of frozen and chilled product chains is case specific.

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