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Minimizing food waste by improving storage conditions in household refrigeration

Freija van Holsteijn*, René Kemna

VHK BV, Elektronicaweg 14, 2628 XG, Delft, The Netherlands

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ABSTRACT

A considerable amount of food is discarded by households in the EU. Many publications addressing the issue thus far, propose changes of consumer behaviour as the solution to fighting food waste. This article explores the possible contribution of technology, in particular, improvements in storage conditions in household refrigerators towards combating food waste. An optimized refrigerator design better serving its purpose of food preservation can theoretically reduce food waste due to quality loss and spoilage. In the current market, the functionality of refrigeration appliances is only indirectly determined by the quality of food preservation. Actual demand is driven by habits, available physical space, perception of size needed, price and –identified as a main driver in several market surveys– the EU's energy label rating. As a result, 85% of consumers choose an appliance that, apart from the freezer compartment, only has one compartment for perishable fresh food (typically at 4 °C). This article argues that the 4 °C is a compromise: The real optimal preservation temperature, depending on the type and condition of the fresh food products, lies between −1 °C and +17 °C. At those optimal temperatures the 'shelf life' can be increased by a factor of two to three and thus the chance of food spoilage can be significantly reduced. Subsequently, the article tries to quantify the EU-wide potential impact of optimised household refrigeration, as much as current data availability allows.

1. Introduction

Consumers are considered the largest contributors to food waste in the European Union with an average 167 kg waste per capita per year (Kemna et al., 2017). Many publications therefore target food waste at consumer-level and propose behavioural changes as the road towards food waste reduction (e.g.: Stefan et al., 2013; MAGRAM, 2013; Aschemann-Witzel et al., 2015). This article explores the possible contribution of technology, in particular the contribution of household refrigerators in food waste reduction.

Improving storage conditions in household refrigeration appliances can extend the shelf life of fresh food products. The nominal refrigerator temperature of 4 °C is suboptimal for many fresh products.[1] Adequate storage conditions for various fresh products reduce food spoilage and other quality losses (e.g. loss of aromas or vitamins). By creating multiple non-frozen food compartments, including chillers (−1 °C to +2 °C) and a cellar (8–14 °C), household refrigeration appliances have the potential to contribute substantially to food waste reduction.

1.1. Background

This article discusses a section of a complementary study by Kemna et al. (2017), performed within EU's Ecodesign policy framework. The study looked at the potential impact of multiple storage temperatures in refrigeration appliances on avoiding food waste and possible penalty in terms of energy consumption. The first part investigated and quantified EU food flows, trying amongst others to obtain more robust data on the EU's food flows, food waste and its environmental impact, by using comprehensive accounting techniques that are novel to the sector. The second part investigated the effect of prevailing storage conditions in household refrigerators on the shelf life of fresh products that are stored in household refrigerators. This topic will be further discussed in this article. The first part, quantifying EU food flows and their impact will only be summarized in the introduction.

1.2. Food waste and its impact

Eurostat's Domestic Material Consumption (DMC) shows a total 1.44 Gt material resource input for food (incl. feed for livestock

* Corresponding author.
E-mail address: f.van.holsteijn@vhk.nl (F.v. Holsteijn).

[1] Sources: UC Davis (1996); TIS (2002-2016); FAO (2009); WFLO (2010); Boyer and McKinney (2013); Zentrum der Gesundheit (2016); Netherlands Nutrition Centre (2016); BMT Surveys (2016).

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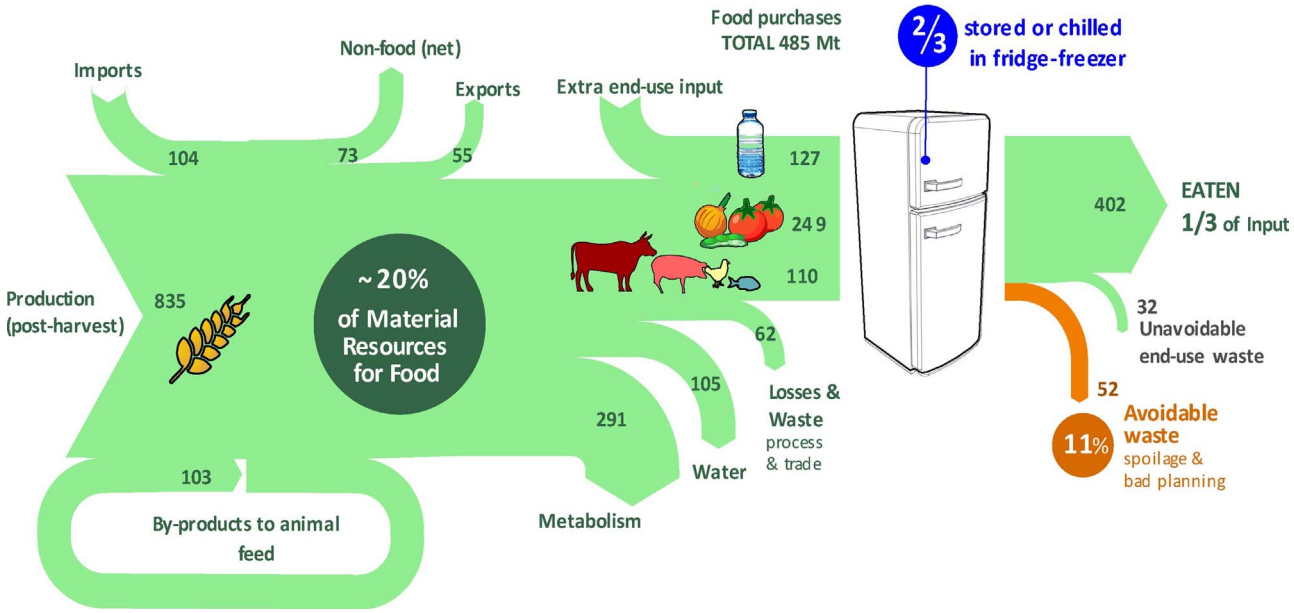

Fig. 1. Simplified EU food flow diagram based on data from 2011 to 2012 (forage expressed in dry hay equivalent).
Source: Kemna et al., 2017.

production). The total input covers 20% of EU's total DMC. Fig. 1 represents a simplified EU food flow diagram, where forage is expressed in dry hay equivalent, leading to a slightly lower material resource input for food. All in all the 1.44 Gt material resource input (incl. wet weight of forage) results in 485 Mt food products purchased by households and food service establishments (see Fig. 1). A factor 3 between the material resource input and food products purchased indicates that 1 Mt food waste reduction at consumer level translates into 3 Mt reduction in material resources required.

Of the 485 Mt food purchased only 402 Mt is actually eaten. More than half (62%) of the food waste created by end-users was considered avoidable, equivalent to 11% of the food purchased. The total food waste created in EU's food system adds up to an annual 155 Mt.

To put things in perspective, and to relate to the general human perception that household appliances like refrigerators generate large waste flows, the impact of food is also compared with the impact that refrigeration appliances themselves have in their production-, use- and waste phase (see Fig. 2).

Looking at waste, EU's food system generates 155 Mt waste per year, where household refrigerators generate 0.85 Mt per year, including combustion waste from primary energy sources (see Fig. 2a; Kemna and Rivière, 2016).

Energy consumption of EU's food system adds up to 283 Mtoe (mega tonnes oil equivalent), or 17% of the total EU gross energy consumption (Monforti-Ferrario et al., 2015). Of this, 229 Mtoe energy is consumed during the production, processing, distribution and packaging of food (see Fig. 2b). Another 54 Mtoe is used by the end-user (e.g. cold storage, cooking, dishwasher, etc.) and at waste disposal. In comparison, refrigerators consume an average 21 Mtoe of which 18 Mtoe during use-phase (Kemna and Rivière, 2016). This 18 Mtoe is included in the energy consumption for food as well.

The figure for greenhouse gases emissions is similar to that of energy consumption. In addition to the GHG emissions related to energy consumption, emissions from agricultural practices (e.g. enteric

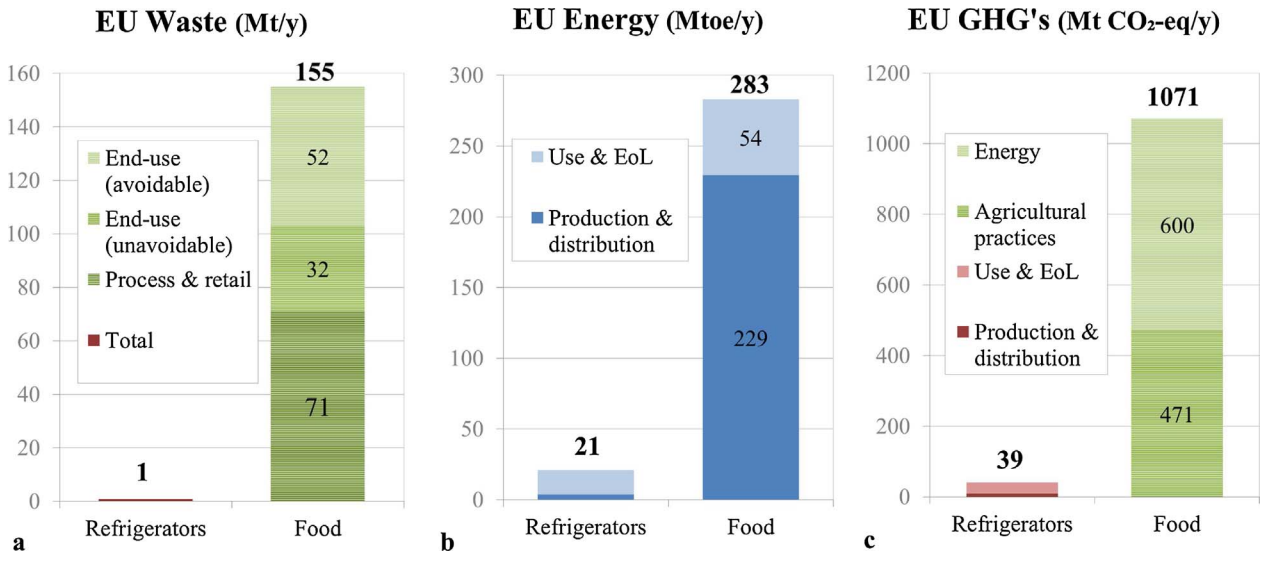

Fig. 2. Comparison of EU impact between food and household refrigerators on **a**) waste in Mt per year (sources: Kemna et al., 2017; Kemna and Rivière, 2016), **b**) energy in Mtoe per year (sources: Monforti-Ferrario et al., 2015), **c**) greenhouse gas emissions in Mt CO_2-eq per year (sources: Eurostat, 2015; Kemna and Rivière, 2016). EoL = End-of-Life.