Quantifying household waste of fresh fruit and vegetables in the EU

Valeria De Laurentiis, Sara Corrado, Serenella Sala *

European Commission-Joint Research Centre, Directorate D-Sustainable Resources, Bioeconomy Unit, Via Enrico Fermi 2749, I-21027 Ispra (VA), Italy

A B S T R A C T

According to national studies conducted in EU countries, fresh fruit and vegetables contribute to almost 50% of the food waste generated by households. This study presents an estimation of this waste flow, differentiating between unavoidable and avoidable waste. The calculation of these two flows serves different purposes. The first (21.1 kg per person per year) provides a measure of the amount of household waste intrinsically linked to the consumption of fresh fruit and vegetables, and which would still be generated even in a zero-avoidable waste future scenario. The second (14.2 kg per person per year) is a quantity that could be reduced/minimised by applying targeted prevention strategies. The unavoidable waste was assessed at product level, by considering the inedible fraction and the purchased amounts of the fifty-one most consumed fruits and vegetables in Europe. The avoidable waste was estimated at commodity group level, based on the results of national studies conducted in six EU member states. Significant differences in the amounts of avoidable and unavoidable waste generated were found across countries, due to different levels of wasteful behaviours (linked to cultural and economic factors) and different consumption patterns (influencing the amount of unavoidable waste generated). The results of this study have implications for policies both on the prevention and the management of household food waste.

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1. Introduction

The Food and Agriculture Organization of the United Nations (FAO) has estimated that approximately one third of the food produced globally for human consumption is lost or wasted, representing a significant loss of the resources spent producing, processing and transporting that food, and a threat to food security (FAO, 2011). As the global population is growing rapidly and becoming wealthier, more resources will be needed in future decades to guarantee food security. The reduction of food waste is therefore a potential strategy for closing the gap between the supply and demand of food (Foley et al., 2011; Godfray and Garnett, 2014). For this reason the United Nations has adopted a specific target in the Sustainable Development Goals (SDG) to halve per capita global food waste at retail and consumer levels and reduce food losses along the production and supply chain by 2030 (Target 12.3) (United Nations, 2015). The European Commission has committed to the SDG 12.3 reduction target and regards food waste as a priority area within its Circular Economy Action Plan (European Commission, 2015).

A quantification of the amount of food wasted is fundamental to the development of effective prevention and reduction strategies

and can be used to verify the efficacy of prevention campaigns over time (Caldeira et al., 2017; Thyberg and Tonjes, 2016). In response to this need, a growing body of literature has recently emerged on the quantification of food waste across the supply chain on a global, regional and national scale. However, due to the lack of a common definitional framework and different methodological approaches, these studies are not always comparable (Caldeira et al., 2017; Xue et al., 2017).

The study conducted by Monier et al. (2010) was the first attempt to quantify the amount of food waste generated at EU scale. This study, which considered food waste generated from the manufacturing stage up to consumption, estimated that approximately 180 kg per person per year (kg/p/y) of food are wasted annually in the EU. Of this amount, the authors quantified that 101 kg/p/y are generated at consumer level (76 kg for households and 25 kg for the food service sector). Therefore, according to this work, households are the highest contributor to food waste generation. In this study, food waste generation was considered as a whole without differentiating between commodity groups. A recent estimate by the European Commission provided a value of 161 kg/p/y of food waste generated in the EU in 2012 (European Commission, 2018). The project FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies) (FUSIONS, 2016), funded by the European Commission, provided an estimation of food waste generated at European level considering the

total food chain of 173 kg/p/y, 21 kg/p/y of which are generated at food service and 92 kg/p/y by households (Stenmarck et al., 2016). Within the same project, the contribution of each commodity group was roughly estimated, obtaining that 31% of the total consumption waste (including both households and food service) was linked to fruit and vegetables, equal to 35.3 kg/p/y (Scherhaufer et al., 2015). Kemna et al. (2017) made a detailed estimation of the overall food flows in Europe, based on a range of data sources (e.g. FAO, Eurostat, the European Food Safety Authority - EFSA, scientific literature and grey literature) and quantified the waste flows through the supply chain. They concluded that 290 kg per capita of food are wasted in total, of which 168 kg per capita at consumer level. A study on consumer food waste in the EU (Vanham et al., 2015), quantified food waste as 123 kg/p/y (considering households and food service together), providing a distinction between commodity groups. According to this work, the categories of fruit and vegetables (including potatoes) are together responsible for 63% of the food waste generated. Three studies conducted at national level in the UK (WRAP, 2012), Germany (Kranert et al., 2012) and Denmark (Edjabou et al., 2016), have quantified the waste generated by households, differentiating between commodity groups. The share of household food waste caused by the consumption of fresh fruit and vegetables (FFVs) was respectively 44% in the first study and 47% in the second and third study.

This large predominance of FFVs in the food waste generated by households is to be expected when considering that:

– FFVs contribute in weight to around one third of the total food purchases (a share of 30% was reported for the UK (DEFRA, 2010a) and Eberle and Fels (2016) reported a share of 29% for Germany).
– Unlike processed products, FFVs generally present an inedible component, which will be discarded in all cases.
– FFVs are highly perishable products (together with meat and fish); therefore, compared to more stable commodities (e.g. pasta, rice, sugar) it is more likely that they will not be consumed in time.
– FFVs are relatively cheap commodities (e.g. compared to meat and fish) and therefore it could be expected that consumers are more careless about letting them spoil.

In order to investigate further how the consumption of FFVs contributes to household food waste generation in the EU, a model was created to estimate household waste of FFVs by capitalising on existing knowledge (e.g. national statistics on food purchases, direct measurements of food waste generation, physical aspects of the products linked to waste production). To this purpose, two main objectives were defined:

1. To estimate the unavoidable waste intensity (UWI) and avoidable waste intensity (AWI) of FFVs purchased in the EU28 at product level and commodity group level respectively (Section 2).
2. To estimate the amount of avoidable and unavoidable FFVs waste generated by EU households (Section 3).

The quantification of the avoidable and unavoidable waste generated serve different purposes. The first is a measure of the amount of FFVs currently wasted in the EU28 that could be reduced by applying prevention strategies. The second, calculated as the inedible fraction of the FFVs purchased, is a measure of the amount of household waste that is intrinsically linked to the consumption of FFVs. Therefore, this amount of waste would still be produced even in a future scenario where avoidable waste is reduced to zero. All the flows presented in this work refer to the EU28 and the year 2010.

Unlike in previous studies that provided an estimation of the consumption waste of FFVs in the EU at commodity group level (Kemna et al., 2017; Scherhaufer et al., 2015; Vanham et al., 2015), the inedible component of FFVs is here assessed at product level in order to provide a more precise estimation of the unavoidable waste linked to the consumption of this group of commodities. Furthermore, the method presented in this study to estimate the unavoidable waste of FFVs at household level has wider potential applications.

Firstly, it can be used to estimate the amount of unavoidable waste generated during the industrial production of derived fruit and vegetable products (e.g. pre-cut or pre-peeled vegetables, canned fruit, tomato sauce). As the waste generated at this stage of the food supply chain often has the potential to be reused in other production systems (Mirabella et al., 2014), this would provide an estimation of the potential quantities of each product available for valorisation, which is of great interest from a circular economy perspective.

Secondly, such a method could help to investigate how the generation of food waste can be influenced by changing consumption patterns. As hectic modern lifestyles are causing a consumption shift to more processed food (Schmidt Rivera et al., 2014), the generation of unavoidable food waste is being transferred from households to food manufacturers. The combination of the method here presented with future scenario analysis would enable to predict where in the food supply chain and in what quantities this waste generation will occur, providing useful information for both waste management and valorisation purposes.

The paper is structured as follows. Section 2 presents the work conducted to estimate the coefficients of avoidable and unavoidable waste intensity for a range of FFV products, defined as the share of household purchases of fruit and vegetables that are wasted (concept defined in the next section). The flows of unavoidable and avoidable waste at EU level and at national level for three selected countries were then calculated based on these coefficients (Section 3). A comparison of the results with the existing literature and a discussion of the implications and limitations of this work are provided in Section 4 and conclusions are drawn in Section 5.

2. Evaluation of the waste intensity of fresh fruit and vegetables

In this paper, food waste is defined as food originally produced for human consumption that leaves the food supply chain. A distinction is made between unavoidable food waste (waste arising from food preparation or consumption that is not, and has never been, edible under normal circumstances), and avoidable food waste (food thrown away that was, at some point prior to disposal, edible) (WRAP, 2009). The unavoidable/avoidable waste intensity of a product is defined as the share in terms of mass of unavoidable/avoidable waste out of the total purchased amount of that product, as illustrated by Eqs. (1) and (2).

$$UWI \ [\%] = unavoidable \ waste \ [Mt]/total \ purchases \ [Mt] \qquad (1)$$

$$AWI \ [\%] = avoidable \ waste \ [Mt]/total \ purchases \ [Mt] \qquad (2)$$

The nominator of Eq. (1) is the total mass of that product which is wasted unavoidably (e.g. peeling, trimmings), the nominator of Eq. (2) is the total mass of that product which is wasted avoidably (e.g. an uneaten apple) and the denominator in both equations is the amount of that product purchased in a given period of time. According to the definition of unavoidable waste adopted in this work, the generation of unavoidable waste is directly linked to a physical property of the product, its inedible component (e.g. the peel of a banana), while the generation of avoidable waste is a