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# Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures

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ABSTRACT

This paper quantifies food loss rates for fruit & vegetables, dairy products and bread & pastry as well as donations to social services. In addition potential influencing factors and reasons for food losses are investigated in order to provide a basis for the development of waste prevention measures. Detailed data from 612 retail outlets all over Austria, which covered the period of one year, were analysed and sorting analyses of discarded food were carried out in a small sample of retail outlets. Food loss amounts to 1.3% of the sales of dairy products, 2.8% for bread & pastry and 4.2% for fruit & vegetables. Returned bread amounts to additional 9.7% of the sales of bread & pastry. The food loss rates are similar to the results of previous publications. At present, 7% of the food loss is donated to social services, 38% of retail outlets do not donate any articles at all. Food loss rates are declining with increasing sales areas, increasing numbers of purchases per year and increasing sales of the retail outlet, but explain only 33% or less of the variation of food loss rates. Large differences between retail outlets of comparable structure indicate potential for reduction. More than a quarter of discarded food articles did not show any flaws besides the expiration of the best before or sell-by date. Waste prevention approaches should focus on avoiding returns, transfer of best practices, information and education of employees and customers as well as strengthening the donation to social services.



## 1. Introduction

In the media and public discussion about food waste and food waste prevention, retail is often blamed for being one of the main contributors (cf. Hölzl, 2014; Schneider and Lebersorger, 2009). However, literature data indicate that only a small percentage of the overall amount of food waste along the supply chain is produced by retail. Excluding agriculture, estimates range between 5% in the food supply chain in Germany (Kranert et al., 2012) 6.5% in the Swedish supply chain (Stare et al., 2013) and 7.6% in the food supply chain in the UK (WRAP, 2010). Recently, retail companies have been making a greater effort to reduce food waste and to communicate their efforts to the public, such as Tesco in UK (TESCO, 2013). From a scientific point of view reliable data are needed in order to quantify the contribution of each stage of the supply chain (e.g. agriculture, production and processing, retail, consumers) to overall food loss quantities, as a basis for planning and evaluation and identification of well-founded waste prevention measures. Although food waste from retail has been investigated in a number of studies, there is still a lack of reliable data (Schneider, 2013b).

This paper is based upon a nationwide sample of 612 retail outlets of different size and type throughout the country. Complete data on the food losses of these outlets and on food donations to social services were provided by an Austrian food retail company which funded the study. Focus was laid on the food losses of fruit & vegetables, dairy products and bread & pastry, which together account for 81% of the company's total food loss in monetary values. In addition, unsold bread & pastry which was returned to the bakeries and which was recorded separately from food loss, was also considered. Results were obtained by a statistical analysis of the provided data and by sorting a small sample of discarded food articles from 6 retail outlets.

The purpose of this paper is to provide a basis for the development of waste prevention measures in food retail, by

- quantifying food loss rates for selected assortment groups,
- investigating correlations between food loss rates and characteristics of the retail outlets,
- and identifying reasons for food loss.

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Focus is laid on food loss rates and on donations for which detailed data were available since they were displayed separately in the company's database.

Literature data on food loss from retail are sparse and often limited in scope. Some studies provide only rough estimations on national basis due to data gaps (e.g. Kranert et al., 2012), others were published by retail interest groups for the national retail branch, but without a transparent description of used methodology and data assessment (e.g. EHI, 2011). Published research on detailed data often investigated only a limited number of outlets (e.g. Hogan et al., 2004; Eriksson et al., 2012,2012; Hanssen and Schakenda, 2011; Hanssen and Møller, 2013) or focuses only on individual food product groups (e.g. Eriksson et al., 2014; Eriksson et al., 2012; Hanssen and Schakenda, 2011; Hanssen and Møller, 2013; WRAP, 2011; Buzby et al., 2009). Tesco (2013), a retailer in UK, was the first to publish detailed data on its food losses and reported a total quantity of 28,500 tonnes of food which was wasted in its stores and distribution centers in UK in the first six months of 2013, which is equivalent to 0.87% of the volume of sold products in the same period.

Compared to previous studies, this paper has the advantage that it covers a large sample size (10.7% of the total number of food retail outlets in Austria 2010 (Höbaus et al., 2012)), a complete time series over the period of one year and a very detailed database. Furthermore it combines the statistical analysis of existing data with an on-site survey in a, though small, sample of retail outlets. Limitations are related to the consideration of only the three most important assortment groups (covering 81% of the company's total food loss value) and only one retail company, as well as the small dimension of the sample for the on-site analyses.

## 2. Materials and methods

### 2.1. Statistical data analysis

#### 2.1.1. Data base and definitions

Data were provided by an Austrian food retail company in the form of extracts from the company's database. Data on food loss (as sum of depreciation and breakage and amounts donated to social services) were available in units of mass, cost price and sales value. Before starting the detailed analysis, aggregated data on a monthly level from about 700 retail outlets for each assortment group and for the period from January 2009 to July 2012 were screened with the aim to identify a representative period of one year. A statistical analysis of variance and post hoc tests did not indicate significant differences between the years 2010, 2011 and 2012. Therefore the available most current data which covered the period from September 2011 to August 2012 were selected for the in depth analysis. Fig. 1 shows the food loss rates for the screened years.

Food loss rates were used as indicators for food loss, and were calculated as the ratio of food loss in Euros cost price to the sales of the respective assortment in Euros cost price. Food loss is the total quantity of articles which were neither sold nor returned, i.e. the sum of depreciation (due to different reasons such as apparent flaws, damaged packaging, expiration of best before or sell-by date...), breakage of goods and transfer to social services such as food banks or food distribution programs. In the original database the amounts donated to social services were reported separately, while depreciation and breakage had not been differentiated. There is an additional option for unsold bread in Austria. Bread is often taken over in commission from bakeries by retail markets, meaning that unsold bread & pastry can be sent back to the bakery (returned bread) for further treatment (Scherhaufer and Schneider, 2011). These amounts of returned bread are reported separately and are not included in food losses as they do not contribute to a monetary loss from the retailer's point of view. However, the returned bread also contributes to food waste and could be targeted by prevention measures. Therefore the respective amounts are reported in this paper.

For the detailed statistical analysis, data were provided on the basis of articles for each of the about 700 retail outlets per month, from September 2011 to August 2012, which entailed an enormous data volume of about 10 million lines in MS Excel. Each of the about 7300 articles was clearly defined by article number, label, producer name and package size. According to the company's categorization system which was also adopted in the study, each article is assigned to a product group, and each product group to an assortment group such as fruit & vegetables, dairy products or bread & pastry.

#### 2.1.2. Data processing and quality

The statistical data analysis was carried out using the programs Excel 2010 and SPSS 15.0. Some restrictions in data quality have to be taken into account. Due to the huge data volume data could not be checked for all errors and inconsistencies in detail. Data were aggregated and analysed at the level of assortment groups for each retail outlet and per year. Apparent outliers and errors were checked by looking at the underlying data at product group and article level and by consulting the responsible person at the company. If possible, data were corrected or the respective retail outlet was excluded from the further analysis. Also retail outlets which showed missing data for one or more months were excluded.

In total, data from 612 retail outlets could be used for the analysis. The retail outlets cover sales areas between 56 and 2039 $m^2$ (mean 705 $m^2$). 26.6% of the outlets were situated in an urban environment, i.e. in cities with more than 190,000 inhabitants, and 73.4% in a rural environment. The retail company differentiates five types of retail outlets with regard to sales area and organisational structure. Table 4 shows the frequency of these types, their mean sales areas and purchases (i.e. number of transactions) per year. The latter were transformed due to data confidentiality, by dividing the mean number per retail outlet by the overall mean.

For the statistical analysis monetary values in cost price were used, i.e. the prices which the company paid for the procurement of the articles. Data by mass were also available, but with lower quality. For some articles, particularly for the assortment of bread & pastry, no mass data were available due to specifics in the accounting system of the company, so that the mass of food loss will be underestimated to different degrees – significantly for bread & pastry, only slightly for fruit & vegetables and for dairy products. For reason of data confidentiality no absolute quantities of food losses will be reported.

Another potential source of data inaccuracy was identified by Eriksson et al. (2012) who found that the recording of wasted fresh fruits & vegetables was quite inaccurate. However, work routines were different in the company investigated in the present study. Packaged fruit and vegetables with a barcode were recorded automatically using a scanner, and unpackaged items were weighed and recorded by mass. In the absence of any other evidence deviations were considered negligible.

The overall food loss rates from all retail outlets (see Table 1) were calculated as the quotient of the sum of food loss from all retail outlets and the sum of the respective sales. The use of arithmetic means would have led to an overrepresentation of smaller retail outlets. Correlations between food loss rates and characteristics of the retail outlets were investigated by using the non-parametric correlation coefficient Kendall's tau-*b*. For differences of food loss rates between different types of retail outlets, analyses of variance and post hoc Tukey tests were used. Differences between retail outlets in urban and rural areas were tested by means of *t*-tests for 2 independent samples. A significance level of 0.05 (two-sided) was used.