



## Food waste volume and origin: Case studies in the Finnish food service sector



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### ARTICLE INFO

#### Article history:

Received 12 May 2015

Revised 26 August 2015

Accepted 6 September 2015

Available online 26 September 2015

#### Keywords:

Food waste

Food services sector

Communal food services

Finland

### ABSTRACT

We carried out a project to map the volume and composition of food waste in the Finnish food service sector. The amount, type and origin of avoidable food waste were investigated in 51 food service outlets, including schools, day-care centres, workplace canteens, petrol stations, restaurants and diners. Food service outlet personnel kept diaries and weighed the food produced and wasted during a one-week or one-day period. For weighing and sorting, the food waste was divided into two categories: originally edible (OE) food waste was separated from originally inedible (OIE) waste, such as vegetable peelings, bones and coffee grounds. In addition, food waste (OE) was divided into three categories in accordance with its origins: kitchen waste, service waste and customer leftovers. According to the results, about 20% of all food handled and prepared in the sector was wasted. The findings also suggest that the main drivers of wasted food are buffet services and overproduction.

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### 1. Introduction

Roughly one-third of global food production is lost or wasted, which amounts to about 1.3 billion tons per year (Gustavsson et al., 2011). It is both ecologically and economically unsustainable to waste edible food rather than consume it because the environmental impacts of producing the raw materials and processing them into food are substantial. Food accounts for more than one-third of the environmental impact of overall Finnish consumption and about one-quarter of the climate impact of consumption (Seppälä et al., 2009), and based on former food waste studies in Finland, there was about 400 million kg of avoidable food waste in the whole food chain (Katajajuuri et al., 2014).

Before our project, there had been no studies in Finland covering the food service sector and food waste using the weighing method, though such studies had been carried out elsewhere in Europe, e.g. in Britain (WRAP, 2011a; Pocock et al., 2010; The School Food Trust, 2012) and Sweden (Engstrom and Carlsson-Kanyama, 2004; Karlsson, 2001). Pocock et al. (2010) weighed food waste and carried out surveys in northeast England, and their study covered a number of different public sector organizations, including schools and

universities. Engstöm and Carlsson-Kanyama (2004) and Karlsson (2001) also sorted and weighed food waste by origin, but only a few outlets took part in the studies. WRAP's (2011a) school food waste studies covered schools and the origin of waste, but the school food system in Britain differs markedly from that in Finland (WRAP, 2011a; The School Food Trust, 2012; Tikkanen and Urho, 2009). Other studies have been done but they have used different methods, such as examinations of statistics (Monier et al., 2009) or surveys of food service management and waste data statistics (Martinsen et al., 2012; WRAP, 2011b).

The aim of our project was to estimate the volume of originally edible (OE) food waste and its distribution among different food service outlets. In addition, we monitored the sources of food waste generation e.g. kitchen, service and customer leftovers. The content of the plate leftovers were analysed. Originally inedible bio waste (OIE) was also monitored.

We defined the *food service sector* as one part of the food system, business or institutional activities responsible for any food or meal prepared and served outside the home. The sector includes different types of *food service outlets* that serve and prepare food.

We targeted waste weighing instead of using estimations or statistics and we incorporated many outlet types to obtain a general overview of the situation. We specifically targeted communal food services, workplace and student canteens, as well as other types like cafes and restaurants, even if not all sectors are included. In total, 51 outlets participated in the study.

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## 2. Methodology

### 2.1. Sample of food service outlets

As partners in the study, we included two communal food services (City of Helsinki and City of Tampere) and the company responsible for the canteens of Helsinki University. These three companies had a total of 40 outlets that participated in this study, providing meals for various day-care centres, and workplace and student canteens. The study period for these food service outlets was one week (5 days; Table 1).

Communal food services are a significant part of the Finnish food service sector and food culture as they provide up to half of the meals consumed outside the home. One-third of the population uses these communal food services daily (Vikstedt et al., 2011). For these reasons we concentrated on such types of outlets to obtain an accurate view of the largest food service type in Finland.

Other types of food service outlets included restaurants and catering businesses, such as diners, restaurants, cafes, petrol stations and similar outlets serving meals. These participated over a shorter, one-day research period.

The communal food services, and workplace and student canteens served lunch, and the amounts of food prepared and wasted were from lunch. Restaurants, diners, cafes and petrol stations included all types of meals they prepared during the day; breakfast, lunch, sandwiches, snacks and dinners. We measured only food waste that ended up inside the outlet, e.g. food taken away and wasted outside was not measured.

Overall, there were 51 participating outlets, and 211 days were spent on research (Table 1) in food service facilities. Nine participating outlets were omitted from the study because of insufficient information and mistakes made in their study forms.

The sample is not statistically representative but does give an overview of this unknown study area in Finland. When looking at communal food services, such as schools, the sample is quite satisfactory as there are tens of outlets from the two towns. The results cannot be extrapolated to cover all of Finland and all types of food services but can provide a first basis for reducing food and bio waste. The study was conducted during the summer and autumn of 2010.

The food waste was measured by establishing the amount of food served and weighing the waste generated during cooking and serving and from customer leftovers.

In the communal food services, the study was generally carried out at lunchtime, with the exception of elderly service centres where dinner was also monitored. In cafes, petrol stations, restaurants and diners the monitoring usually covered the whole day. After the outlet closed, the personnel or the researchers weighed the sorted waste. In addition, the personnel filled in forms for the daily amounts of food prepared and the volumes of food waste from cooking, serving and leftovers. Furthermore, the researchers studied the contents of the leftovers for 26 days in various outlets, establishing the composition and quantity of the leftovers.

### 2.2. Preparations in the food service outlets

Prior to the study period, the researchers briefed the personnel, instructing them on weighing and giving them directions on how to define and sort food waste. The outlets were provided with the necessary diary forms, containers for various food waste, boards with guidelines for sorting food waste, and several scales for weighing the produced food and the food waste. Representatives of the personnel arranged the necessary briefing for the rest of the staff prior to the study period and placed the waste containers and scales in appropriate places.

As the briefing was only directed at managers, who briefed the other staff, and not all personnel, some confusion and misunderstandings may have occurred. We distinguished nine participating restaurants where we noted that the measurements lacked weighing information or mistakes had been made during the study period.

### 2.3. Measuring prepared food

As the amount of waste food was compared with the amount of food prepared, all the prepared food was weighed during the study period. The personnel at the communal food services, and workplace and student canteens participating in the study filled in diary forms on a daily basis, indicating the amount of food prepared and served (kg). The food prepared included all types of food that would have been served to the clients but not included originally inedible (OIE) bio waste like bones. This bio waste was sorted out and measured (Table 2).

The diary forms included information on various components of the meals, e.g. main courses, salads, bread, drinks and special diets. If the food was ordered from a central kitchen, the personnel were asked to calculate the amount of food dispatched. Subsequently,

**Table 1**  
Outlets by type participating in the study and number of research days.

Food service outlet	No	Study period days/outlet	Outlet total days	Days for leftover analysis	Type of meals included
Schools (communal)	23	5	115	8	Lunch
Day-care centres (communal)	12	5	60	2	Lunch
Workplace and student canteens	5	5	25	5	Lunch
Restaurants and diners	7	1	7	7	All
Cafes and petrol stations	4	1	4	4	All
Total	51		211	26	

**Table 2**  
Definition of originally edible and originally inedible food waste, and definition how waste was sorted to kitchen waste, serving waste and customer food waste.

Type of waste/origin of waste	Kitchen waste, preparation and cooking	Serving waste, left from cooked and prepared meals	Customer plate leftovers
<i>Food waste</i>			
Originally edible (OE)	Spoiled products, incorrectly prepared food, expired date products	Overproduction, food left from buffet	Food leftovers by customers on plate
<i>Bio waste</i>			
Originally inedible (OIE)	Inedible parts of vegetables, coffee grounds and bones	Inedible parts of vegetables, bones	Vegetable peelings, bones

the personnel serving the food marked the number of portions served. These numbers have been used to calculate the volume of the portions.

In the restaurants, diners, cafes and petrol stations participating in the study, the number of servings was counted from a journal tape of the cash register, which showed the portions bought on the study date. The weight of each portion was recorded before serving it to the customer. If the restaurant served a buffet lunch, the personnel weighed the prepared food prior to service.

#### 2.4. Measuring wasted food

For weighing and sorting, the food waste was divided into two categories so that the originally edible (OE) food waste was separated from the originally inedible (OIE) bio waste, such as vegetable peelings and coffee grounds (Table 2).

In addition, the originally edible food waste was sorted into three categories in accordance with its origin: kitchen waste, serving waste and customer plate leftovers (Table 2). These three waste fractions contained all the wasted food and raw material that could have been consumed had it been stored or prepared differently, both solid and liquid. Of the liquid foodstuffs, only milk and sour milk were included (serving and customers' food waste) because they are the principal drinks in Finland, especially at schools.

At the end of the working day, the containers were weighed and the results entered on diary forms.

Kitchen waste consisted of spoiled products and incorrectly prepared food. Service waste was food that was cooked but did not for some reason end up with a customer. In the communal food services, workplace and student canteens, and some restaurants, lunch was served as a self-service buffet. In restaurants and diners, outside of lunchtime, the portions were usually selected from the menu, so there was no or very little service waste if part of the meal, for example salad, was not served at a self-service desk.

All the participating outlets sorted and weighed customer leftovers. Members of the research group carried out a more thorough analysis of the leftovers at 26 outlets. For weighing the leftovers, the outlets arranged a station close to the dishwashing return lines where the customers or researchers separated food waste into originally edible and inedible food waste. Next to the sorting areas, there were instructions and guidance for customers, and, when necessary, the restaurant personnel helped them sort their leftovers. In addition, some outlets had a researcher present for the

whole study period to make a more comprehensive analysis of the composition of leftovers.

### 3. Results

#### 3.1. Food prepared

Altogether, 23,220 kg of food was prepared during the study period. This included all types of food that could be served to clients but not originally inedible (OIE) bio waste from the kitchen preparation like bones.

Totally 58,982 portions were prepared during the study period in the 51 outlets that took part in the study. The amount of food prepared per portion differed depending on the type of outlet, from the smallest volume in schools and day-care centres of 343–384 g/portion to the biggest in restaurants and diners, with an average of 815 g/portion. Cafes and petrol stations fell between these with an average of 520 g/portion, as they also serve other portions than meals, like sandwiches and cake and cookies (Table 3).

#### 3.2. Food waste and bio waste volume

The volume of wasted food during the study period was 4396 kg. The wasted food per portion varied least in schools at 58 g/portion and most in workplace canteens at 189 g/portion. The amount of food waste (OE) in relation to prepared food varied depending on the outlet type, ranging between 19% and 27% (Table 3). This covers about one-fifth of all food handled and prepared in the outlets.

In relative terms, most food was wasted (OE) in communal food services in day-care centres, 28%. Workplace and student canteens, schools, cafes, restaurants and diners wasted about 17–25% of the food produced during the study period (Table 3).

Bio waste (OIE) covered 2–11% of all the food handled in the outlets. The biggest amounts of bio waste were at cafes and petrol stations because of the large volumes of coffee grounds (Table 4).

#### 3.3. Origin of food waste and contribution of customer leftovers in different outlets

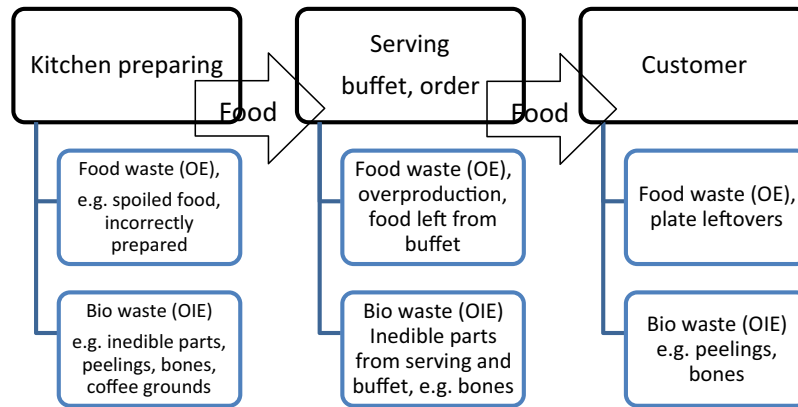
In general, the main cause of food waste (OE) was serving waste. At day-care centres and workplace canteens, this was as

**Table 3**  
Volumes of food prepared (1.) and originally edible (OE) total food waste from food prepared (2.), total food waste (OE) percentage (3.), food prepared per portion (4.) and food waste volume per portion (5.).

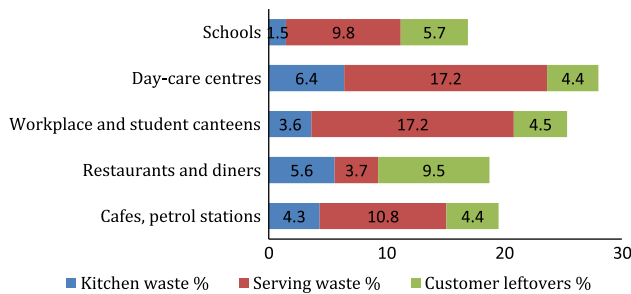
Outlet	Number of outlets	(1) Total food prepared (kg)	(2) Total food waste (OE) (kg)	(3) Total food waste (OE) (%)	(4) Food prepared (g/portion)	(5) Food waste (OE) (g/portion)
Schools	23	16117	2727	17	343	58
Day-care centres	12	1569	439	28	384	108
Workplace, student canteens	5	2786	706	25	747	189
Cafes, petrol stations	4	1117	218	20	520	102
Restaurants, diners	7	1631	306	19	815	153

**Table 4**  
Types and percentages of originally edible food waste (OE) and originally inedible bio waste (OIE) from food produced.

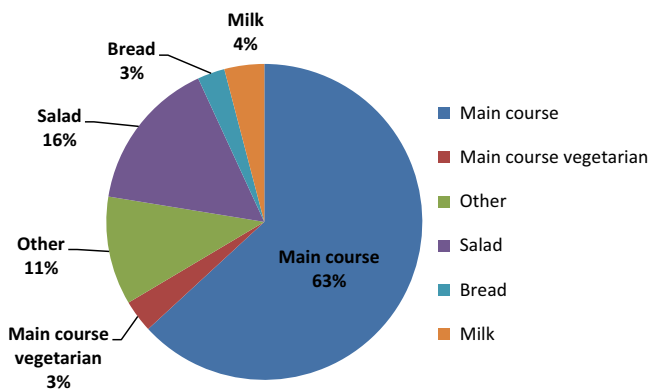
Outlet	Total food waste (OE) (%)	Kitchen waste (OE) (%)	Serving waste (OE) (%)	Customer leftovers (OE) (%)	Bio waste (OIE) (%)
Schools	16.9	1.5	9.8	5.7	3.9
Day-care centres	28.0	6.4	17.2	4.4	2.3
Workplace, student canteens	25.3	3.6	17.2	4.5	6.6
Cafes, petrol stations	19.5	4.3	10.8	4.4	10.7
Restaurants, diners	18.8	5.6	3.7	9.5	3.5



**Fig. 1.** Different waste and how they were sorted in the study. Food is prepared in the kitchen, served from self-service buffet or by order. Food and bio waste are generated in all phases. Waste was measured in each phase and sorted to originally edible food waste (OE) and originally inedible bio waste (OIE).



**Fig. 2.** Estimates of food waste (OE) as percentages of food prepared in different food service outlets and from different origins.



**Fig. 3.** Contribution of the customers' plate leftovers in schools and day-care centres.

high as 17% of the food produced during the study period. Kitchen waste caused by food preparation and storing was relatively low and varied between 1.5% and 6.4%. Leftovers contributed 4–5%. In restaurants and diners only, the main cause was customer leftovers at 9.5% (Fig. 1, definitions in Table 2).

Food waste (OE) in restaurants and diners was influenced by outlet type, and there was a clear difference between à la carte restaurants and diners and buffet type outlets. With self-service buffets, the main cause of food waste was service waste: overproduction of food. In Finland, the majority of food service outlets serving lunch (e.g. workplace and student canteens, schools, diners, etc.) use self-service buffets.

When examining all outlets, service waste generally constituted the main part of the food waste. Only restaurants and diners had plate leftover volumes that were bigger than the service waste. However, the amount and type of customer plate leftovers varied noticeably from one outlet to another, depending on the outlet type (Figs. 3 and 4). The schools and day-care centres, most of the leftovers were main courses of the day and salads. In the schools and day-care centres have only one main course and vegetarian main course choice. The bread and milk shares were low. In schools, pupils can choose vegetarian courses instead of a meat or fish main course. This vegetarian main course waste contributed 3% to the total food waste (Fig. 3).

In restaurant and diner type outlets, the leftovers varied more because the menus were much more diverse. Most of the leftovers were staples like potatoes, rice and pasta. Almost as large a share consisted of salads, vegetables and fruits. Main courses like meat and fish generated less waste, in total about 10% (Fig. 4).

#### 4. Discussion

In Finland, communal food services provide up to half of the meals consumed outside the home, and all schools serve their pupils free lunch. School meals do not only have a nutritional value but also serve a pedagogical purpose: children and young adults learn to eat a varied, balanced diet. This may result in additional food waste but offers an opportunity to learn behavioural models and become acquainted with various cuisines. Finnish schools also teach all pupils home economics in which they learn about sustainable use of resources and reducing food waste. On the other hand, day-care and school lunches represent a situation in which the number of customers is fixed. Therefore, the maximum amount of food consumed should be more easily predictable than in traditional restaurants. This is not necessarily the case, however, as we established that there are always children absent, but food must be ordered in advance.

In communal food services, we found that the distribution of waste depended on how catering was organised. In general, food waste during cooking and amount of leftovers was relatively low. In restaurants and diners, the amount of leftovers was greater, including mainly side dishes like potatoes and rice. Leftovers discarded by customers ranged from 4% to 10%, which is less than recorded in other studies (e.g. Williams and Walton, 2011; Engström and Carlsson-Kanyama, 2004; Edwards and Nash, 1999). Overall, most of the food waste was generated by cooking too much food that could not be stored or served as a different dish later (Fig. 2).

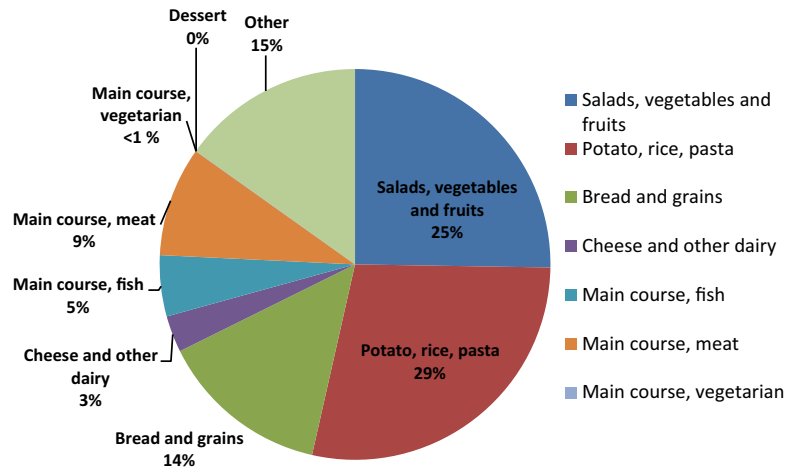


Fig. 4. Contribution of the customer plate leftovers in restaurants and diners.

From our study, we can deduce that one of the main challenges of reducing food waste in the food service sector will be minimizing buffet service waste. The serving waste resulted from difficulties estimating customer portion sizes and food consumption. Based on the management interviews and workshops for the participating company representatives, this could be achieved by having a good estimate of the number of diners and careful menu planning. One solution to these problems would be to get to know the clientele and interacting with them, as well as cooking in stages. The latter could be difficult to organize due to the limited workforce and would require motivation and commitment from the personnel (Silvennoinen et al., 2012). It would be essential to take into consideration the amount of serving waste as that food could be redistributed quite easily if it could not be avoided.

Communal catering services and workplace canteens wasted from serving, they also generated customer leftovers. Possible ways of reducing leftovers in schools could be to ensure that pupils have time enough to eat and educate them innovative ways about food and sustainability. In restaurants and diners, leftovers formed the main part of the food waste, this was due to customer choice and the menu. The leftovers were mainly side dishes and they could be avoided by serving smaller portions of potatoes, rice or pasta.

Food waste can be reduced through careful planning, good management and documenting food waste data, which helps to identify the outlet's food waste sources and forms a basis for finding solutions. Regular weighing allows observation of the changes in food waste and identifying of the most vulnerable areas in each outlet. This cannot be substituted by personal estimates of food waste, as these are a poor reflection of the actual amounts. The former Finnish study revealed that personnel in communal food service outlets estimated their bio waste amounts to be significantly lower than the results of this study indicate – usually estimating them at only 0–5%, though the variation in estimates was marked (Risku-Norja et al., 2010).

To obtain sufficient data for the best practices to avoid food waste in food services we will need more studies based on qualitative methods and structured interviews for persons in management, workforce and customers.

When comparing cautiously, the food waste volumes in this study were similar to those reported in Sweden, at about one-fifth of the food prepared (Engström and Carlsson-Kanyama, 2004; Karlsson 2001). The results were also similar when comparing food waste generated per capita in the food service sector in a study of the Nordic Council of Ministers' report at 18 kg/capita/

year (Martinsen et al., 2012). The BIOIS produced a competent report based on many estimates of food waste in accordance with Eurostat statistics, and those results for the EU15 were 27 kg/capita/year and for the EU12, 12 kg/capita/year (Monier et al., 2009). Beretta et al. (2013) reported that avoidable food waste was about 13% in the food service industry in Switzerland.

When looking at food waste in schools, the amounts of leftovers were lower in our study than in Sweden or Britain (Engström and Carlsson-Kanyama, 2004; The School Food Trust, 2012). In Britain, the WRAP Food waste in schools report showed similar results for school canteens, for which most of the food waste was accounted for by food that was prepared but not served (kitchen) and served but not eaten (canteen; WRAP, 2011a).

In order to paint a more reliable and comprehensive picture of the volume and composition of food waste in food service sectors we still need more information and complementary studies. We also need more representative numbers of outlets, and many sectors are missing, e.g. hospitals, fast food restaurants and hotels.

## 5. Conclusions

About one-fifth of all food prepared in the outlets was wasted in the study period. The biggest contribution to food waste compared with food prepared was in day-care centres and workplace and student canteens. The main source of food waste (OE) was serving waste from self-service buffet and overproduction, only restaurants and diners outlets produced most food waste from customer plate leftovers. The amount and type of plate leftovers varied from one outlet to another, depending on the outlet type. The amount of food waste generated in the kitchen when preparing and cooking food was relatively small, as was originally inedible bio waste, except in cafes and petrol stations due the amount of coffee grounds.

The contribution from customer plate leftovers in communal canteen in schools and day-care centres contained main course of the day and salad. In restaurant and diners customer leftovers were side dishes like potatoes, rice and pasta, as well as salads which could be due portions or side dishes being too big. At schools ensuring sufficient time to eat and food education could reduce plate leftovers.

Ultimately, the goal of avoiding food waste is to increase sustainability in the food supply chain. Improving the efficiency of food production and consumption, as well as changing the general diet in Western countries, is vital to securing the future food supply. Possibilities for redistributing of overproduced food from the

communal food service sector like schools and day-care centres should be developed and food and meals that are already prepared for eating should not be wasted. This practice has been started in some communities in Finland, and pilot projects will test if redistribution can reduce volumes of food waste.

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