Waste Management xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Hospital food waste and environmental and economic indicators – A Portuguese case study

C. Dias-Ferreira [a,b,*], T. Santos [a], V. Oliveira [a]

[a] CERNAS – Research Centre for Natural Resources, Environment and Society, Instituto Politecnico de Coimbra, Escola Superior Agrária de Coimbra, Bencanta, 3045-601 Coimbra, Portugal

[b] Materials and Ceramic Engineering Department, CICECO, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

ARTICLE INFO

Article history:
Received 22 April 2015
Revised 7 August 2015
Accepted 18 September 2015
Available online xxxx

Keywords:
Waste reduction
Meal delivery
Plated system
Bulk delivery
Food loss
Carbon footprint

ABSTRACT

This study presents a comprehensive characterization of plate waste (food served but not eaten) at an acute care hospital in Portugal and elaborates on possible waste reduction measures. Even though waste prevention is a priority in Europe, large amounts of food are still being wasted every day, with hospitals giving rise to two to three times more food waste than other foodservice sectors.

For this work the plate waste arising at the ward level was audited during 8 weeks, covering almost 8000 meals, using a general hospital as case study. Weighing the food served to patients and that returned after the meal allowed calculating plate waste for the average meal, as well as for individual meal items. Comparison of food waste arising showed that differences exist among wards, with some generating more waste than others. On average each patient throws away 953 g of food each day, representing 35% of the food served. This equates to 8.7 thousand tonnes of food waste being thrown away each year at hospitals across Portugal. These tonnes of food transformed into waste represent economic losses and environmental impacts, being estimated that 16.4 thousand tonnes of CO_2 (equivalent) and 35.3 million euros are the annual national indicators in Portugal. This means that 0.5% of the Portuguese National Health budget gets thrown away as food waste. Given the magnitude of the food problem five measures were suggested to reduce food waste, and their potential impact and ease of implementation were discussed. Even though food waste is unavoidable the results obtained in this work highlight the potential financial and environmental savings for Portuguese hospitals, providing a basis to establish future strategies to tackle food waste.

1. Introduction

Throughout the EU27 food waste is a growing concern, mounting to 89 million tonnes per year, or 180 kg per capita (BIO Intelligence Service, 2010). If no action is taken, the projection is that the value will increase 40% in 2020, to 126 million tonnes. Producing food that is not consumed has environmental impacts and costs money. The roadmap to a Resource Efficient Europe (European Commission, 2011) recognises the need for waste prevention and proposes to halve disposal of food waste by 2020.

Food waste generated by meal catering services can arise from spoilage, preparation, unserved food or plate waste (EPA, 2012; Wrap, 2013). Plate waste is defined as food served but not eaten, and in the context of this work it refers both to food tried by patients but incompletely consumed as well as to untouched food. Plate waste is two to three times higher in hospitals than in other foodservice sectors, such as restaurants, cafes, schools and workplace canteens (Williams and Walton, 2011). The reasons have been compiled by Williams and Walton (2011) into four broad categories: (i) clinical condition of patients (ii) food, namely quality, portion sizes, and available choices (iii) service, including difficulty accessing food and complex ordering systems; and (iv) environmental factors, such as meal times, interruptions, surroundings.

An estimate for the year 2000 indicated that the food wasted in British Hospitals was worth 28 million pounds (Cereda and Pedrolli, 2009), and this figure highlights the magnitude of the problem. Williams and Walton (2011) presented an overview of the studies carried out for that last 50 years, showing that in Europe other than the UK, also Denmark and Switzerland have addressed the issue of plate waste and a recent work also exists for Spain (Díaz and García, 2013). For other countries information is scarce, making it difficult to have a European overview of the

* Corresponding author at: Materials and Ceramic Engineering Department, CICECO, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal.

E-mail address: celia@esac.pt (C. Dias-Ferreira).

http://dx.doi.org/10.1016/j.wasman.2015.09.025
0956-053X/

issue. This work aims to contribute toward filling this gap by analyzing for the first time in Portugal the plate waste arising within hospitals, using a general hospital as a case study. The research set out to:

(1) Quantify the overall amounts of plate waste arising from the meal delivery services at hospitals.
(2) Find out what is being offered to patients and which items are returned as waste.
(3) Highlight the environmental cost for society and possible cost savings for the hospital food service budget.

Are the hospitals in Portugal producing more or less plate waste than their European counterparts? Is the percentage of plate waste similar for all the meal items? Are there wards producing more plate waste than others? This work aims at answering these and similar questions, and in doing so, at highlighting hotspots and corrective measures to tackle food waste.

2. Materials and methods

2.1. Case study description

The present study was carried out at one building of a general hospital in Portugal with 2000 beds for acute care. For confidentiality reasons the hospital is not identified. Patients are offered 6 meals a day. The dietician department defines the menu and the amount of food that meets the nutritional requirements of the patients. Breakfast comprises 2 bread rolls, one dose of individually packed butter (or jam) and either tea, coffee or milk. Around midmorning a yogurt or a piece of fruit is served. An afternoon snack is served, similar to breakfast, but with one bread roll instead of two. A night snack is also distributed and consists of one milk cartoon (200 mL) and a packet with 5 cookies. Lunch and dinner include the main course (either meat or fish, with pasta, rice or potatoes and vegetables), the soup, one individually packaged bread roll and one piece of fruit/desert (Fig. 1). Lunch and dinner are prepared according to the cook–chill method (FSAI, 2006) and served plated. The main courses are cooked at the central kitchen, divided into portions and stored refrigerated. The food is distributed to the satellite kitchens (each serving generally one ward, sometimes two), where they are placed inside the regenerators for heating. Trays are then transported to the wards in trolleys and served to patients. A list of patients by ward and type of diet required is available through a computerized system. After the meal the trays are collected and transported back to the satellite kitchen. There the meal waste is placed first into waste bins (60 L, high density polyethylene) and then deposited into two 800-L containers located at the basement and transported twice a day to the hospital waste depot. From there the waste is collected by a specialized private company (against a fee) and taken for landfilling.

Fig. 1. Typical meal (clockwise): main course, soup, bread and fruit.

2.2. Waste audit

The waste audit was carried out in 2 stages. The methodology followed at each stage is detailed below, and is summarized in Table 1.

In the first stage the overall plate waste arising from different medical departments in the study area was quantified in the period 2–8 September 2014 in 32 wards comprising 7258 main meals, plus breakfast and snacks. Waste containers (60 L, high density polyethylene) and plastic bags (100 cm × 75 cm, black, low density polyethylene) with tags were distributed to the satellite kitchens. The waste returned to each satellite kitchen was weighted (Tomopol-d75, max 75 kg ± 10 g) twice a day. The morning/lunch sample included waste arising from breakfast, midmorning snack and lunch (period between 7 and 14 h). The afternoon/evening sample included waste arising from the afternoon snack, dinner and night snack (period between 14 and 22 h). The daily waste was computed as the sum of both samples. The number of solid meals served at each period was obtained by subtracting the number of liquid diets from the number of meals registered at each ward, allowing the calculation of meal waste per patient per day.

The second stage of the waste audit took place from the 15th of September to the 26th of October 2014 and involved a close-up on the plate waste to quantify individual items (soup, main dish, fruit and bread). 32 meal services (including both lunch and dinner) were sampled at a time, and each sampling took place at one ward randomly selected. Before each meal service the weight of the main course was determined by weighting approximately 5 samples (Tomopol-d75, max 75 kg ± 10 g) and calculating the average value. Empty plates were weighted and their mass discounted. The weight of the soup was taken as the average of 16 soups (0.260 kg). The weight for one bread roll was 42.5 g (the regulatory weight is between 40 and 45 g) and for one piece of fruit was 120 g. The weight of the food served was calculated by multiplying the average weight of each component (soup, main course, bread and fruit/desert) by the number of patient meals served.

After the meal, the plate wastes from the ward were sorted out at the satellite kitchen into four waste streams: soup, main course, unopened bread and fruit/desert. The total waste arising from the ward was weighted (Tomopol, model d75, max 75 kg ± 10 g) for each stream. The amount of food waste was then divided by the amount of food served to obtain the plate waste, using the formula:

$$\text{Plate waste } (\text{in}\%) = \text{Food waste}/\text{Food served} * 100$$

Untouched main meals were not individually counted, but their weight was included in waste. Protective clothes were worn during the sorting and quantification of the waste.

2.3. Statistical analysis

Statistical analysis was carried out using the SPSS software, version 21. Comparison between waste arising from lunch and dinner was carried out using the *t*-student test ($p < 0.01$) using the transformed variable [square root of (kg of waste)], after verification that transformed data follows a normal distribution and that variances were homogenously distributed. One-way analysis of variance ($p < 0.05$) was carried out to compare means of plate waste arising across wards, followed by pairwise multiple comparison using Dunnet T3's Test using the transformed variable [log (kg of waste)], after verification that data is normally distributed and assuming variances across wards were not equal (result of the

Please cite this article in press as: Dias-Ferreira, C., et al. Hospital food waste and environmental and economic indicators – A Portuguese case study. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.09.025