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# Food Safety and Food Waste in One Portuguese Public Hospital †

**Carla Gonçalves [1,2,3], Ana Gomes [1], Alexandra Esteves [1,4], José António Silva [1,4] and Cristina Maria Saraiva [1,4,*]**

[1] University of Trás-os-Montes and Alto Douro, Vila Real, Portugal; carlagoncalves.pt@gmail.com (C.G.); ana.filipa111@hotmail.com (A.G.); alexe@utad.pt (A.E.); jasilva@utad.pt (J.A.S.)
[2] CIAFEL—Research Center for Physical Activity, Health and Leisure, Faculty of Sports, University of Porto, Porto, Portugal
[3] CITAB—Centre for the Research and Technology of Agro-Environmental and Biological Sciences, University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
[4] CECAV—Center for Studies in Animal and Veterinary Science, University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
* Correspondence: crisarai@utad.pt
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**Abstract:** The present study aims to contribute to the sustainable development goals by increasing knowledge of food safety and food waste of meals produced by cook-chill system in hospital units. The food waste (FW) of meals served at lunch was evaluated to all new hospitalized patients with light diet (n = 17) and soft texture diet (n = 10), during their hospital stay, using the physical method by weighing for dish and the visual estimation method for the soup. Samples of each diet (light, n = 3; soft texture, n = 3) were also collected in four different moments (after cooked, after cold transportation, after refrigerated storage and after hot regeneration) to detection and enumeration of *Listeria monocytogenes*, *Salmonella* spp. and *Staphylococcus aureus*, *and* enumeration of *Escherichia coli*, *Clostridium* spp., *Bacillus cereus*, Enterobacteriaceae, total viable counts (TVC) at 30 °C, as well as pH, water activity, moisture, ashes and protein. The FW (%) of the light diet (n = 64) was 39.8 ± 6.3 in dish and 14.9 ± 5.4 in soup and of the soft texture diet (n = 51) was 65.1 ± 9.0 in dish and 39.0 ± 5.8 in soup. Regarding the percentage of protein per meal, both light (8.73%) and soft (3.33%) diets presented in average values lower than those recommended by the WHO (10–15% protein). The value of different microorganisms varied along the production moments, however the final products in light diet (after hot regeneration) presented 1.34–1.73 log ufc/g of TVC. Counts of *Bacillus cereus* and *Staphylococcus aureus* were also obtained at low levels (less than 1 log ufc/g). Besides these results, the risk of foodborne diseases should be considered. The implementation of effective measures to increase food safety and reduce FW in hospital is crucial.

**Keywords:** food waste; food safety; hospital; food service; hospital diets

## 1. Introduction

The United Nations aims to achieve a better and more sustainable future for everyone through the overarching of 17 sustainable development goals (SDGs), with 169 measureable targets to be achieved by 2030 [1]. Nutrition is related to the large majority of the goals and include the interacting factors of climate change, agricultural sustainability, challenges of distribution of food and urbanization, food security, food safety, and the combinations of foods eaten, that is, dietary patterns and ensuring adequate nutrition across the life course [2].

Food safety understood as the science of how to handle, prepare, and store foods that prevent food-borne illnesses, is intrinsically related with SDG3 "good health and well-being" and SDS6 "clean water and sanitation". It is also close related with SDG2 "zero hunger" because the access at all times to enough and nutritionally appropriate food to provide the energy and nutrients needed to maintain an active and healthy life must be through the distribution of safe food, in fact, the concepts of food safety and food security need to be considered together[2].

Is estimated that each year, one third of all food produced ends up rotting in the bins of consumers and retailers, or spoiling due to poor transportation and harvesting practices [3]. Indeed food waste (FW) is connected with SDG12 "Responsible Production and Consumption", and the evaluation of FW was a first step for its management [4]. The FW was already become an object of discussion of the hospital food service [5–7], since it is seen as the cause of health, economic, social and environmental negative impacts [8].

The hospital's food service is a key piece in patient care, being crucial for patient treatment and recovery [9–11]. From the food preparation to the distribution the hospital's food service must always provide safe food and within the defined standards about nutritional quality and adequacy, palatability and temperature [12].

In that way, the aim of our study was to evaluate the food safety of meals served at hospital and estimate FW generated by patients during the length of hospital stay in a Portuguese public hospital.

## 2. Materials and Methods

### *2.1. Meals Production*

The present study was carried out in a Portuguese public hospital, from the north of the country, where over 21 days the FW of meals served at lunch was evaluated for all new patients admitted in the paediatric, medicine, oncology and orthopaedic wards. Detailed methodology was described before [13]. Meals were produced according to the cook-chill system and served hot. Patients admitted to the hospital receive a lunch meal consisting of the following items: soup, dish, bread, dessert and water, in which the dish consists of the three components: conduit, garnish and vegetables [14]. The diets are distinguishable by the type of confection and composition, according to the hospital diet manual [15].

For this study, samples were collect from the light diet (that is a therapeutic diet with fat restriction, applicable to adults whose clinical diagnosis requires facilitated digestion), and from the soft texture diet (that is a therapeutic diet with a modified texture, based on easily chewable foods, intended for patients with chewing problems without the need of creamy foods).

### *2.2. Microbiological and Physicochemical Analysis*

For microbiological analysis, samples with 10g were aseptically weighed, added to 90 mL of sterile peptone salt solution (ISO-6887–1), and homogenized in a stomacher (Lab Blender, UK) for 60s. Serial decimal dilutions in peptone salt solution (ISO-6887–1) were prepared and 1 or 0.1 mL of the appropriate dilutions were poured or spread on nonselective and selective agar plates. Enumeration and detection of *Listeria monocytogenes*, Salmonella spp. and *Staphylococcus aureus* were performed according to ISO-11290, ISO-6579, ISO-6888, respectively. Enumeration of *Clostridium perfringens*, *Bacillus cereus*, *Escherichia coli*, Enterobacteriaceae and total viable counts (TVC) at 30 °C were done according to ISO-7937, ISO-7932, ISO-16649-2, ISO-21528-2 and ISO-4833.

The water activity was measured in 10 g of sample in a Rotronic Hygroskop-DT apparatus with a WA40 probe at 25 °C. The pH determination was performed, in duplicate, directly into samples, with a WTW 330i pH meter. The moisture content was determined using the reference method ISO-1442. The ashes were determined from the ISO-936. The determination of total nitrogen was carried out using the Kjeldhal method according to AOAC 981.10 and the automatic distillation/titration apparatus VELP UDK 159 used. The factor of 6.25 was used to convert total nitrogen content in total protein.

### *2.3. Food Waste Analysis*

The FW of the dish was calculated by the physical method by weighing the meal plate carrying out the assessment before and after the distribution of the trays, following the procedures of the European Commission Standard methodology approved in 2019 [16]. For the soup, the visual estimation method was used, using a percentage scale after the distribution of the trays. The weight of the food was measured in grams by a portable high precision electronic kitchen scale (Jata 722P, Portugal), measurements were taken in two stages, that is, the amount of food served and the amount of food scraps in order to obtain FW using the following formula:

$$FW\ (\%) = Food\ Scraps/Food\ Served * 100$$

### *2.4. Statistical Analysis*

The analyses were carried out using the statistical software IBM SPSS STATISTICS Version 20. The statistical analysis involved measures of descriptive statistics (absolute and relative frequencies, means and respective standard deviations). To compare means of two independent samples, non-parametric tests were used, that is, the Mann-Whitney test. The null hypothesis was rejected when the critical significance level was less than 0.05.

## 3. Results and Discussion

The microbiological and physicochemical results of the analysis of meals is presented in Table 1.

**Table 1.** Microbiological and physicochemical analysis of meals.

| | **After Cook** | | **After Transport (Cold)** | | **After Refrigerated Storage** | | **After Regeneration (Hot)** | |
|---|---|---|---|---|---|---|---|---|
| | **Light** | **Soft Texture** | **Light** | **Soft Texture** | **Light** | **Soft Texture** | **Light** | **Soft Texture** |
| **Temperature (°C)** | 80.9 ± 0.8 | 80.9 ± 0.3 | 1.3 ± 0.3 | 2.5 ± 1.7 | 3.6 ± 1.7 | 3.6 ± 0.4 | 77.4 ± 0.4 | 78.3 ± 1.6 |
| **Microbiological** *(log ufc/g)* **(Conduit)** | | | | | | | | |
| *Listeria monocytogenes* | ND | ND | ND | ND | ND | ND | ND | ND |
| *Salmonella* spp. | ND | ND | ND | ND | ND | ND | ND | ND |
| *Staphylococcus aureus* | ND | 0.97 ± 1.38 | ND | ND | ND | ND | ND | ND |
| *Clostridium* spp. | ND | ND | ND | ND | ND | ND | ND | ND |
| *Bacillus cereus* | ND | ND | ND | ND | 0.23 ± 0.33 | ND | ND | ND |
| Enterobacteriaceae | ND | ND | ND | ND | ND | ND | ND | ND |
| *Escherichia coli* | ND | ND | ND | ND | ND | ND | ND | ND |
| *TVC at 30 °C* | 0.95 ± 1.35 | 0.43 ± 0.61 | 1.58 ± 2.24 | 2.30 ± 1.87 | 0.90 ± 1.27 | 1.13 ± 0.98 | 1.34 ± 1.90 | ND |
| **Microbiological** *(log ufc/g)* **(vegetables)** | | | | | | | | |
| *Listeria monocytogenes* | ND | ND | ND | ND | ND | ND | ND | ND |
| *Salmonella* spp. | ND | ND | ND | ND | ND | ND | ND | ND |
| *Staphylococcus aureus* | ND | ND | ND | ND | ND | ND | 0.1±0.14 | ND |
| *Clostridium* spp. | ND | ND | ND | ND | ND | ND | ND | ND |
| *Bacillus cereus* | ND | ND | ND | ND | ND | ND | 0.43 ± 0.61 | ND |
| *Enterobacteriaceae* | ND | ND | ND | ND | ND | ND | ND | ND |
| *Escherichia coli* | ND | ND | ND | ND | ND | ND | ND | ND |
| *TVC at 30 °C* | ND | ND | 1.43 ± 2.02 | ND | ND | ND | 1.73 ± 2.45 | 0.80 ± 0.70 |
| **Physicochemical** | | | | | | | | |
| *pH* | | | | | | | 6.35 ± 0.02 | 6.34 ± 0.01 |
| *Water activity* | | | | | | | 0.98 ± 0.00 | 0.99 ± 0.00 |
| *Moisture (%)* | | | | | | | 76.89 ± 3.28 | 87.35 ± 0.34 |
| *Ashes %(m/m)* | | | | | | | 0.90 ± 0.02 | 0.40 ± 0.00 |
| *Protein %(m/m)* | | | | | | | 8.73 ± 0.35 | 3.33 ± 0.13 |

TVC—total viable count; ND—not detected; results are expressed as mean ± sd.

Regarding the percentage of protein per meal, both light (8.73%) and soft (3.33%) diets presented in average values lower than those recommended by the WHO (10–15% protein). The value of different microorganisms varied along the production moments, however the final products in light diet (after hot regeneration) presented 1.34–1.73 log ufc/g of TVC. Counts of *Bacillus cereus* and *Staphylococcus aureus* were also obtained at low levels (less than 1 log ufc/g). Besides these results, the risk of foodborne diseases should be considered.

The food waste by type of diet is presented in Table 2.

**Table 2.** Food waste by type of diet.

| | n | Days of Hospitalization (mean ± sd) | Soup | Dish | |
|---|---|---|---|---|---|
| | | | FW % (mean ± sd) | Weight Served (Kg) | FW % (mean ± sd) |
| **Light** | 64 | 3.8 ± 0.5 | 14.9 ± 5.4 | 23.2 | 39.8 ± 6.3 |
| **Soft texture** | 51 | 5.0 ± 1.0 | 39.0 ± 5.8 | 17.3 | 65.1 ± 9.0 |
| **ρ** [a] | | | 0.002 * | | 0.008 * |

n—number of meals evaluated; sd—standard deviation; a Mann-Whitney test; * $p \leq 0.05$.

The FW (%) of the light diet (n = 64) was 39.8 ± 6.3 in dish and 14.9 ± 5.4 in soup and of the soft texture diet (n = 51) was 65.1 ± 9.0 in dish and 39.0 ± 5.8 in soup (Table 2). The FW was significantly higher in soft texture diet (soup and dish), and this can be potentially explained by the fact that patients that usually are consumers of this type of diet are more debilitated, may have reduced appetite and many of them need help to eat autonomously [25].

## 4. Conclusions

The data obtained in this study draws attention once again to the importance of the implementation of effective measures to increase food safety and reduce FW at hospital context.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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