EXPLORATORY ANALYSIS OF FOOD WASTE AT PLATE IN SCHOOL CANTEENS IN SPAIN

ANÁLISIS EXPLORATORIO DEL DESPERDICIO DE ALIMENTOS EN PLATO EN COMEDORES ESCOLARES EN ESPAÑA

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Abstract

The research is part of a University-Civil Society relationship, which is framed on UPM-FESBAL Food Banks Chair, as a means to establish a long-term strategic collaboration, in order to "Work with people", to achieve a rational and supportive consumption. A better understanding of food waste generation in school canteens represents a clear opportunity for the application of measures against it, because childhood is considered the best time to raise awareness about this problem and their impacts. Plate waste in school canteens depends of the student's receptivity for each menu, which is affected by individual and contextual factors. The aim of this research is to approximate the amount of plate waste in school canteens in Spain and identified possible drivers at contextual level, based on the analysis of 118 school canteens in 14 autonomous communities. The results show that, at a territorial level, there are significant differences between plate waste on the coast and interior. At school level, the same thing happens between the waste measured before and after the awareness campaign. Finally, the results show that the plate waste per type of menu differs according to the region where the school is located, which suggest that the acceptance or student's preferences for menus are related with the region where the school is located.

Keywords: Food waste; plate waste; school canteens; contextual factors; university- society; rational consumption.

Resumen

La investigación se enmarca en una relación Universidad-Sociedad civil, que se articula en la Cátedra Bancos de Alimentos UPM-FESBAL, como un medio para establecer una colaboración estratégica a largo plazo, con el fin de "Trabajar con la gente", para conseguir un consumo racional y solidario. Comprender mejor el proceso de generación de desperdicios en los comedores escolares representa una oportunidad clara para la aplicación de medidas frente al desperdicio alimentario, debido a que la infancia es el mejor momento para crear conciencia sobre la importancia de abordar este problema. El desperdicio en plato en comedores escolares es causado por la poca receptividad de los alumnos frente al menú, lo que se ve afectado por factores propios de cada comensal y por factores contextuales. La presente investigación tiene como objetivo aproximar la cantidad de desperdicio en plato en comedores escolares en España e identificar posibles factores condicionantes a nivel contextual, a partir del análisis de 118 comedores escolares en 14 comunidades autónomas. Los resultados muestran que, a nivel territorial, existen diferencias significativas entre los desperdicios en costa e interior. A nivel de centro educativo, sucede lo mismo entre los desperdicios medidos antes y después de actividades de sensibilización. Finalmente, los resultados muestran que el desperdicio por tipo de menú difiere según la región en la que se ubica el centro educativo, lo que da indicios de la relación entre la región y el grado de aceptación o preferencias por menús.

Palabras clave: Desperdicio alimentario; desperdicio en plato; comedores escolares; factores contextuales; consumo racional; universidad-sociedad civil.

1   Introduction

In 2011, the Food and Agriculture Organization of the United Nations (FAO) pointed out that in order to meet the nutritional needs of a population that is estimated to go from 7 000 to 9 billion people for 2050, it would be necessary to increase production by 70%. In contrast to the food insecurity problem, FAO (2011) noted that about one-third of the world's food produced was lost or wasted. Since that year, the problem of food waste and loss has become relevant in the fight against poverty, hunger, climate change and the misuse of natural resources.

Lipinski and Lomax (2013) estimate that if food losses and wastes were reduced, the gap to meet FAO's predicted food needs for the 2050 would be halved. In addition, the same authors point out that the loss and waste of food is tantamount to a wasted investment that reduces the economic well-being of the actors in the food value chain.

In relation to environmental impacts, FAO (2014) points out the loss of natural resources used to produce food that are wasted or impacted in their production; it also emphasizes the emission of CO_2-eq by the waste of food in the world along the supply chain.

The FUSIONS study of the European Commission (Stenmarck et al., 2016) estimates the waste of food for the 2012 in 88 million tons, which is equivalent to 173 kilograms of annual waste per person in the European Union (EU-28).Stenmarck et al. (2016) also point out that most of the waste in the European Union is obtained in the final stages of the food supply chain —53% in households, 12% in collective restoration and 5% in marketing— resulting in greater environmental impacts and more amount of wasted money (FAO, 2011). For these reasons, the prevention of waste becomes more important at the end of the chain (Eriksson et al., 2017).

Even though the household sector represents a significant source of consumer-level waste, the institutions providing food services —schools, prisons, and hospitals— are also an important source of waste in developed countries(Cordingley, Reeve and Stephenson, 2011). School cafeterias, for their condition of serving food to students concentrated in one place, represent an ideal opportunity to implement measures aimed at preventing and/or reducing food waste (Wilkie, Graunke and Cornejo, 2015). This is reinforced by a society that demands more and more public and private institutions, initiatives that contribute to sustainable development (Derqui and Agustín, 2016).

It is necessary to understand the problem to solve in order to reduce the waste of food, for this reason it is critical to develop a detailed quantification of the waste (Eriksson et al., 2017; World Resources Institute, 2016). In recent years there have been several studies that analyze the waste in school cafeterias or other collective restoration centers, and most have focused on analyzing dish waste motivated by nutritional concerns (Engström and Carlsson-Kanyama, 2004; Wilkie, Graunke and Cornejo, 2015). Engström and Carlsson-Kanyama indicate that existing studies present highly variable residue generation rates, possibly because the measurements are usually done in short periods of time (Eriksson et al., 2017), or that when presenting the result of the waste measurement the effect of conditioning factors on the variability of the data is not evident (Secondi, Principato and Laureti, 2015).

In Spain, the Ministry of Agriculture and Fisheries, Food and Environment (Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente, 2017) as part of its strategy More food, less waste contemplates the development of studies that allow a better understanding of the phenomenon of food waste generation. For school cafeterias, a pilot study was conducted in four schools, presenting high variability in the results.

Because of the latter and knowing the importance of food waste in school cafeterias, it is necessary to carry out studies of food waste, contemplating the possible determinants of this phenomenon, so that it is possible to explain the high variability of the data. On the other hand, it is necessary to carry out research that contemplates larger samples, for a longer period of time and whose objectives are not focused solely on nutritional aspects, but to contemplate the waste impacts on other levels.

In the present research an exploratory analysis of the amount of dish waste in school cafeterias in Spain is carried out, and its relation with contextual factors —typical of the territory and the educational center— in order to identify possible heterogeneity determinants in dish waste in school cafeterias in Spain. The research is part of the Food Bank Subject-UPM (CBA), as a new way of building University-Company-Society relations for rational consumption (De los Ríos et al., 2015). The idea arose from the Spanish Federation of Food Banks (FESBAL), which seeks the research group on Sustaina-

ble Planning and Management of Local Rural Development (GESPLAN) of the Universidad Politécnica de Madrid (UPM). Since the activity of FESBAL, Spain occupies the first place in Europe in solidarity activity, with 55 food banks out of 257 banks in Europe(FAO, 2014). The activity of FESBAL is integrated in the FEBA (Fédération Europenne des banques Alimentaires) which agglutinates 257 banks operating in 22 European countries (FESBAL, 2017).

2 Revision of previous studies

Based on the importance of deepening the analysis of food waste, this section presents a review of the main considerations for the development of inventories and analysis of food waste. In addition, are summarized the results of studies that quantify the dish waste and explore the waste generation phenomenon from the identification and/or review of conditioning factors.

2.1 Considerations in conducting inventories and analysis of food waste

To study waste and/or loss of foods along the chain, three key definitions used in the literature on this topic need to be addressed: loss, waste and excess. Food loss and waste are differentiated according to the stage in which they occur; thus, the loss or deterioration occurs in the stages of production, post-harvesting and processing, and is related to the need to invest in infrastructure and technology, while in the final stages —marketing and final consumption— the term waste is used, and is mainly related to behavioral aspects (Parfitt, Barthel and Macnaughton, 2010); other authors distinguish both terms by the nature of their causes, attributing behavior causes to the waste (HLPE, 2014). On the other hand, the excess is defined as all the food produced beyond the nutritional needs, while the waste

is the product of this excess (Papargyropoulou et al., 2014).

It is also important to propose an appropriate strategy for the prevention of waste, to distinguish between avoidable and non-avoidable waste (Papargyropoulou et al., 2014). Avoidable waste is everything that was edible at a time, and that at the time of being discarded it could or should not remain being edible (Derqui and Fernández, 2017).

In order to understand the process by which loss and food waste are generated, protocols, strategies and measurement methodologies are developed both globally and by countries. At the global level, the partner institutions of the food loss and waste protocol developed the global standard of food loss and waste measurement (FLW standard), in order to make the requirements for a good measurement known to governments and institutions, and to provide them with guidance in the process (World Resources Institute, 2016).

Regardless the objective of the measurement, the World Resources Institute (2016) considers it important to have clear information on four elements: deadlines, limits, scope and destination of wastes. It should include information on the type of waste analyzed, the causes of its generation and an estimated quantification.

In Spain, the Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente (2017) envisages as part of its strategy More food, less waste, the development of studies that contribute to answer how much, how, where and why of the food waste in different areas. In the pilot in school cafeterias, a methodology was applied from the compression of three areas: the regulatory framework, the elaboration processes of the food and the conditions or causes of the waste (Derqui and Agustín, 2016). This last area is the one that delimits the scope of the study, because it determines the type of waste to be analyzed and its causes, according to the moment in which it is generated (see Table 1).

Table 1. Causes of Food waste according to the moment of its disposal (Derqui and Agustín, 2016).

	Diponsal moment of the waste		
	Before serving the food		**After serving the food**
Causes	Prevision of the demand	Food preparation, storage and handling processes.	Student receptivity
Result	Waste due to overproduction, and expired or damaged products.	Kitchen and unserved waste.	Waste in the dish

The dish waste is a term used by the investigators to refer to the quantity of food served in the dish of the diners, which is finally not consumed. It is usually measured with the aim of evaluating the acceptance degree of food by the diners, measuring the efficiency of the feeding service and/or evaluating the nutritional intake (Derqui and Fernández, 2017; Martins et al., 2014).

According to Buzby, Guthrie et al. (2002) the most suitable method to measure dish waste is the weight by type of food, considering the initial weights of the dishes and the weight of the waste for each diner. In order to simplify and accelerate the data collection, aggregate methods are usually used, in which the total weight of the waste is carried out and the average is obtained for each diner. These methods can be divided into selective and non-selective aggregates; the first ones require differentiating the waste by type of food, unlike the non-selective ones that carry out a total heavy waste (Martins et al., 2014).

2.2 Previous studies of quantification and determinants of food waste

Several studies have quantified the dish waste in the area of collective restoration. Eriksson et al. (2017) obtained in their study 24.75 grams of average dish waste per serving served in the restoration sector in a Swedish municipality, and Engström and Carlsson-Kanyama (2004) also obtained in Sweden between 27 and 33 grams (9 – 11 % of the ration served) —mainly potatoes, rice and pasta— in an exploratory analysis in two school cafeterias. In Spain and Portugal, the quantities recorded were higher. Martins et al. (2014) obtained 49.5 grams in school

cafeteria in Portuguese primary schools. In Spain, Byker et al. (2014) obtained 164 grams (34 % of the ration served) of dish waste in cold-line menus and 106 grams (22 % of the ration served) in hot. On the other hand, Derqui and Agustín (2016) obtained in the four primary schools analyzed in their pilot study, an average dish waste ranging from 35 to 47 grams; finally Derqui and Fernández (2017) tested a standardized tool for the self-assessment of waste in four schools in Barcelona and obtained between 40 and 100 grams of waste on average by dish.

In response to the high variability found in food waste studies, researches have been carried out studying the waste conditions from different approaches and under different levels of analysis. Waste studies in school cafeterias tend to address the determinants at the educational center level, while those covering the entire phase of food consumption perform an analysis at the level of the behavior of individuals against waste. The program of Waste Action and Resources Cordingley, Reeve and Stephenson (2011) considers that the dish waste in school cafeterias can be due to operative, circumstantial or behavioral reasons. Derqui and Agustín (2016) in addition to the above mentioned reasons, include the institutional approach to waste. Table 2 details the aforementioned reasons, including factors influencing the dish waste.

Bartrina et al. (2004); Priefer, Jörissen and Bräutigam (2016); Thyberg and Tonjes (2016) agree that from the factors mentioned in Table 2, those that most affect the food waste in school cafeterias are the size of the portions, the characteristics of the menu —including the types of food and the way of the presentation — and the acceptance degree of the menus.

In relation to behavioral factors, Bartrina et al. (2004) indicate that eating habits in school cafeterias are marked by a clear preference for food such as pasta, rice and potatoes, and rejection by the group of vegetables, legumes and fish. Rodriguez-Tadeo (2014) see these preferences reflected in their research in school cafeterias in Murcia, finding that in the first hot dishes, legumes, salads and stewed fish presented the highest waste proportion, and in the second dishes the ones prepared based on birds, legumes and fish. Rodriguez-Tadeo (2014) besides considering the influence of the acceptance degree of dish waste also found that the cold menus served generate significantly more waste than those of the hot menu.

Continuing with factors associated with behavior, Quested et al. (2013); Secondi, Principato and Laureti (2015) when analyzing waste at consumer level, pointed out that behaviors and practices of the individual associated with the generation of food waste can be explained from a complex relationship between contextual factors and factors of each person as attitudes, values, motivations and habits.

Table 2. Causes and factors influencing dish waste in school cafeterias (Derqui and Agustín, 2016; Cordingley, Reeve and Stephenson, 2011).

Reasons for the generation of dish waste in school cafeterias			
Institutional approach	**Operative**	**Circunstantial**	**Behavior**
Vision regarding the orientation of the school cafeteria: part of an integral education, or only a service.	Menus: Flexibility in the size of the portions. Possibility of choosing the menu. Ways of preparing and presenting the food.	Time available to eat. Conditions of the areas Presence of monitors Time between the break and the mealtime.	Preferences or degrees of acceptance by types of menu. Motivaciones externas Conciencia sobre el desperdicio

Hebrok and Boks (2017); Thyberg and Tonjes (2016) agree that the cultural, demographic, socioeconomic, political and geographical factors influencing behavior in each context should be considered. Cultural factors include habits and attitudes towards waste, emphasizing the differences between countries and within each country. Secondi, Principato and Laureti (2015) prove the existence of a behavior heterogeneity against waste within the countries of the European Union, which is not explained either by the personal variables or by the contextual variables contemplated in its study, and which is still being little explored.

Secondi, Principato and Laureti (2015), in a behavioral analysis against waste performed at the European Union level, confirmed that young people tend to generate more waste than elderly, and that women tend to generate less waste than men; in relation to the degree of education, they found that people who suspended their education at an early age tend to waste less food; finally, regarding the place of residence they found that people who live in medium or large cities, waste more than those living in rural areas.

In relation to intrinsic factors of each person, Hebrok and Boks (2017) indicate that most consumers are not aware of the food they are wasting, reason for which is necessary to raise awareness of the problem to change the behavior of individuals (Quested et al., 2013). Information and education are essential to influence consumer behavior, for this reason Priefer, Jörissen and Bräutigam (2016) indicate that awareness-raising activities should be adapted to the different groups and should begin in childhood to have more effect on waste.

To assess the relationship between people's attitudes and waste, Secondi, Principato and Laureti (2015) analyzed the presence of pro-environmental habits and attitudes such as recycling, and found that people with higher level of environmental commitment and more awareness of the impacts of food waste tend to throw smaller amounts of food.

3   Methodology

The research is framed from a university-civil society relationship, articulated in the form of the UPM-FESBAL food banks subject, as a means to establish a long-term strategic collaboration, in order to "work with people" to achieve a rational and solidary consumption. The methodological framework is framed in the model WWP (Cazorla, De Los Ríos and Salvo, 2013) so that the subject of food banks is configured as a stable and dynamic structure, which favors the interaction of the university with the society, fostering relationships between different types of agents and promoting the development of competencies from social responsibility and the transmission of ethical values (De los Ríos et al., 2015). From this model are emphasized the relations with different schools of Spain to undertake sensitization and formation campaigns (De Los Ríos, Rodriguez and Pé, 2015).

This research analyzes the dish waste in a sample of school cafeterias in Spain. The waste is measured in a selected sample, based on a participatory methodology designed by the PROCLADE Foundation, the PROYDE Association and the SED NGO. According to the objectives set out in the research, contextual variables are defined to identify possible dish waste determinants. Finally, are performed the processing and statistical analysis of the data.

3.1   Data collection

The field work for data collection was in charge of the PROCLADE Foundation, the PROYDE Association and the SED NGO. The choice of the participating centers responded mainly to the willingness of these to carry out an inventory of wastes and to participate actively in the process of sensitizing and information to the educational community on the social impacts and environment of food waste.

The selected sample was 118 educational centers, located in 14 autonomous communities of Spain. The methodology for measuring waste in school cafeterias had a clear participatory approach. The students organized in groups to carry out the counting of diners, the separation of wastes between organic and inorganic, and the weight and record of the waste groups generated daily in each dining room. All the activities, although had the students as main characters involved, were carried out under the supervision of educators or other adults in charge of the dining room.

The measurements of the dish waste were performed daily in a non-selective aggregate, in two consecutive weeks. In the interval between the first and second measurements, food waste awareness-raising activities were carried out with teachers, school cafeteria staff and boys and girls. In the first week 573 measurements were made in 118 school cafeterias, while in the second week 373 measurements were made in 73 school canteens.

4   Definition of the variables under study

For the performance of the analysis was used as dependent variable the daily average waste per diner, obtained from the measurements of the total waste per school cafeteria for each day, previously described, and divided between the numbers of diners. As independent variables, two-level contextual factors were considered at the territory and the educational center— based on what was found in the literature, as well as on the days of the week.

At the territory level, the selection of variables responded to the need to identify new determinants that contribute to explain the behavior heterogeneity against waste within a country (Secondi, Principato and Laureti, 2015). The location of the province, the region and the size of the population, where the school is located, were considered as variables. It should be noted that the first two were employed in a study of food balance in school cafeterias of the Valencian Community, and showed differences regarding the variety of food served (Llorens-Ivorra et al., 2017).

In the variable location are differentiated the schools located in interior provinces and those located in coastal provinces. In the region variable, the Autonomous Communities are classified in three major regions: Center, North and Mediterranean-Canary Islands. Finally, in the variable population size the schools are classified according to the size of the population in which they are located, according to the classification of the National Institute of Statistics. Table 3 classifies the schools and diners according to the contextual variables mentioned.

Table 3. Classification of schools and diners according to contextual variables at the territory level.

Location	Region	Population	Schools	Diners
Interior	Center	<10.000	42	1.156
		20.001 − 50.000	1	16
		50.001 − 100.000	15	566
		100.001 − 500.000	3	364
		>500.001	3	1.136
			64	**3.238**
	Mediterranean-Canary Islands	100.0001 − 500.000	**2**	**164**
	North	<1.000	1	60
		10.001 − 20.000	9	324
		20.001 − 50.000	3	95
		100.0001 − 500.000	21	1.132
			34	**1.611**
			100	**5.013**
Coast	Mediterranean-Canary Islands	20.001 − 50.000	1	88
		100.0001 − 500.000	2	317
		>500.001	3	366
			6	**771**
	North	10.001 − 20.000	2	53
		20.001 − 50.000	2	283
		100.0001 − 500.000	3	278
			7	**614**
			13	**1.385**

At the educational center level, the moment of measurement was used —before and after an awareness campaign— and the menu type as independent variables. The choice of the first variable responds to the relationship between awareness-raising activities, the awareness of waste and its reduction (Priefer, Jörissen and Bräutigam, 2016; Quested et al., 2013). To analyze the menu type variable, menus were classified considering the combination of the main components of the first plate and the second plate (see Table 4). In order to facilitate the interpretation of the results, only menus that had three or more measurements were taken into account. This variable is included based on the relationship mentioned by Rodriguez-Tadeo (2014) between dish waste and the degree of acceptance or preferences for food types in school cafeterias.

Table 4. Main components of the first and second plates considered to define the types of menu.

Main components of the menu	
First plate	**Second plate**
Cream / mashed potato	Fish
Rice / pasta	Meat
Soup	Frieds
Legumes	Egg / Tortilla

Finally, the days of the week were also considered as a variable to be analyzed, with the aim of evaluating their incidence on the dish waste generated.

4.1 Data analysis

El análisis estadístico de los datos se elaboró mediante el paquete estadístico Statgraphics XVII. Se realizó un análisis descriptivo del desperdicio en plato, y contrastes de hipótesis considerando p<0.05 como significación estadística.

In the first place, a descriptive analysis was carried out to the daily average waste measurements per diner of the first week in the 118 selected school cafeterias, in order to characterize waste in school cafeterias. Knowing the average and the typical deviation of the data, the out-of-range values were identified — those separated from the average in more than two typical deviations— resulting in the exclusion of five school cafeterias from subsequent analyses.

Then, hypothesis contrasts were made for each of the dependent variables. To define the statistical tests to be used —parametric or non-parametric— the asymmetry and kurtosis values were assessed. Table 5 shows the tests used for each variable, considering parametric tests for variables with asymmetry and kurtosis values between -2 and 2.

Table 5. Statistical tests by independent variables.

Independent variable	Parametric test	Non-parametric test
Categorical with 2 levels		
- Moment of the measure	*t de Student test*	
- Location		*U de Mann-Whitney test*
Categorical with more than 2 levels		
- Region		*H de Kruskal – Wallis test*
- Size of the population		*H de Kruskal – Wallis test*
- Days of the week		*H de Kruskal – Wallis test*

The 548 measurements made in 113 school cafeterias for the first week were analyzed to determine the differences in waste for contextual variables at the territory level and the type of menu. On the other hand, to determine the differences in waste between before and after sensitization activities, school cafeterias that did not have both measurements were excluded. In addition, in order to minimize the effect of the location and region where the school is located, only 310 measurements of the 63 school cafeterias of the central region were analyzed. Figure 1 details the flow of participating schools and measurements considered for each analysis.
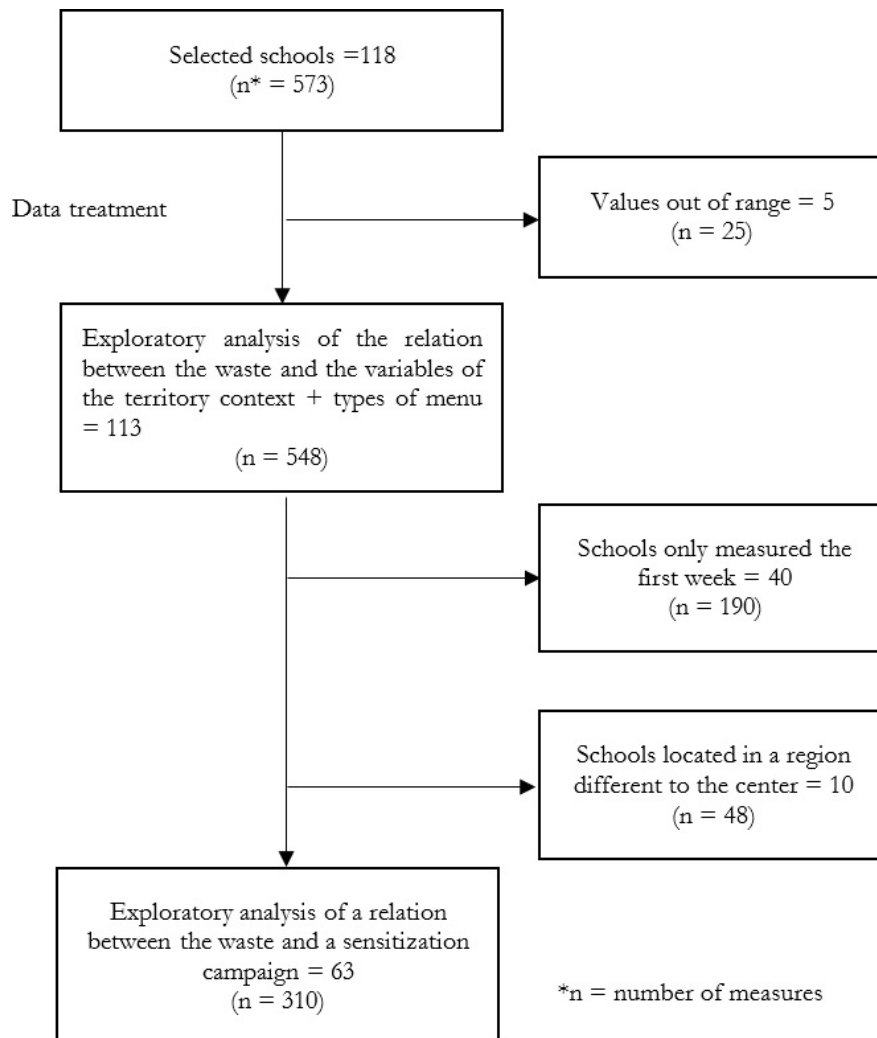
Figure 1. Flow of participant schools and measures performed

Finally, the relationship between the dish waste and the sum of independent variables was analyzed. At the contextual level, the relation of waste with location-region was analyzed; at the school level, the relationship with menu type-awareness campaign was analyzed; it was also analyzed the relationship of a territorial factor with a factor in the educational center from the variables type menu-region; finally, the weekly behavior of the waste was analyzed for the variables region, location and awareness campaign.

In all the analyses mentioned, the statistical significance of waste differences was not tested due to the non-parametric condition of the data.

5 Results

This section presents the results of the investigation. In a first section, the quantification of the average daily dish waste and its weekly behavior; subsequently, the relationship between waste and contextual variables at the territory level is presented. Finally, the relationship between waste and contextual variables is presented at the level of the educational center.

5.1 Quantification of the waste

From the measurements carried out during a week in 113 school cafeterias, an average daily waste per diner of 76.61 grams was obtained ($\pm$ 45.83).

Significant differences were obtained when analyzing the waste for the days of the week (p-value: 0.0023) between the highest values of waste —recorded on Wednesday with 86.91 grams (± 61.27) and on Friday with 86.77 grams (± 61.93)— and the lowest value, recorded on Thursday with 63.51 grams (± 48.33). Figure 2 shows an asymmetric distribution of the data for all days of the week, with higher dispersion of measurements towards higher values and atypical values on all days of the week. It should be noted that the variation coefficient of the waste per day ranges from 67 to 77 percent.
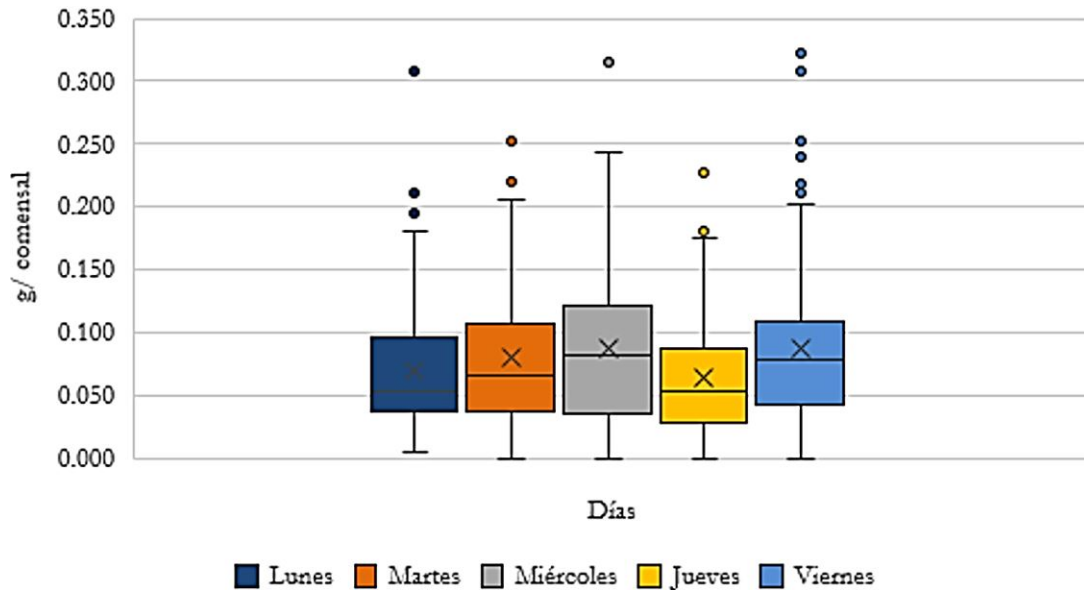
Figure 2. Weekly behavior of the daily average waste (grams/diner)
Note: The box includes the data located between the first and third quartiles, the line inside the box represents the median and the (X) the average. Whiskers have a maximum length of 1.5 times of the length of the box; if values outside this distance are presented, these would be considered as atypical values, and are shown as circles.

5.2 Relationship between dish waste and contextual variables at the territory level

The contrasts of hypothesis indicate that from the contextual variables considered at the territory level, only significant differences were found between the dish wastes of educational centers located in provinces of the coast and in the interior (p-value = 0.039); in the Coast, the average daily waste per diner was 101.15 grams (± 41.23) and in the interior it was 73.42 grams (± 45.20). In Figure 3 is observed that the internal waste values have an asymmetric distribution with more dispersion of the measurements towards higher values, in addition to presenting atypical values. On the other hand, on the coast a more symmetrical distribution is observed, although an atypical value is also registered.

On the other hand, no significant differences were found in the waste both for the variable region and the population size. It is important to emphasize that in the analysis of the three contextual variables at the territory level, the variation coefficient for most of the levels of each variable has high values, between 40 and 70 percent.
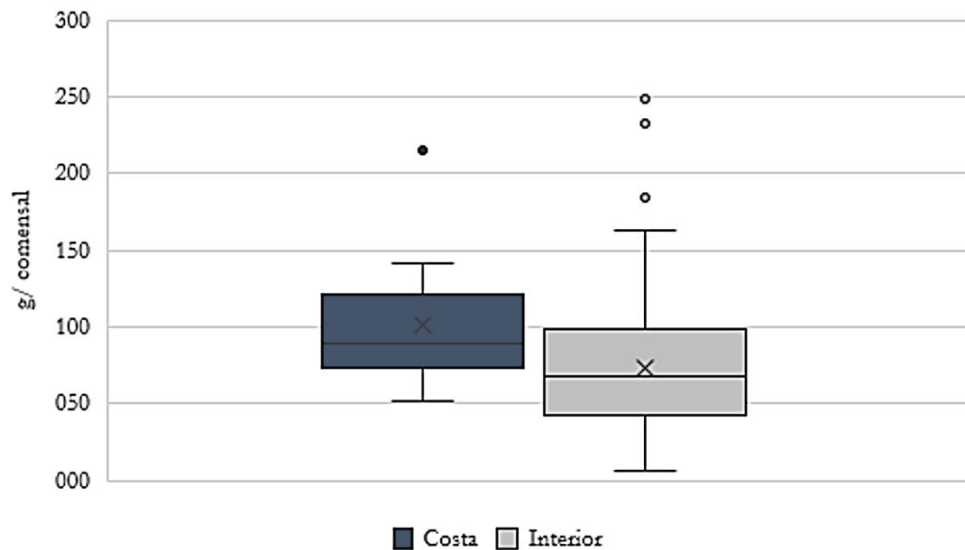
Figure 3. Average daily waste per diner (g) according to the location.
Note: see note in Figure 2.

In order to check whether significant differences of waste, identified between school cafeterias in the coast and in the interior, are observed for both the Mediterranean-Canary region and for the north, an analysis was made of the relationship between the sum of the variables location and region, and dish waste. Figure 4 shows that these differences are met for both regions; the Mediterranean-Canary region presents an average waste of 45.68 grams ($\pm$ 21.68) in the provinces of the interior against 96.30 grams ($\pm$ 28.86) on the coast, while the northern region presents an average waste of 74.99 grams ($\pm$ 46.01) in the interior against 105.31 grams ($\pm$ 49.05) on the coast. .
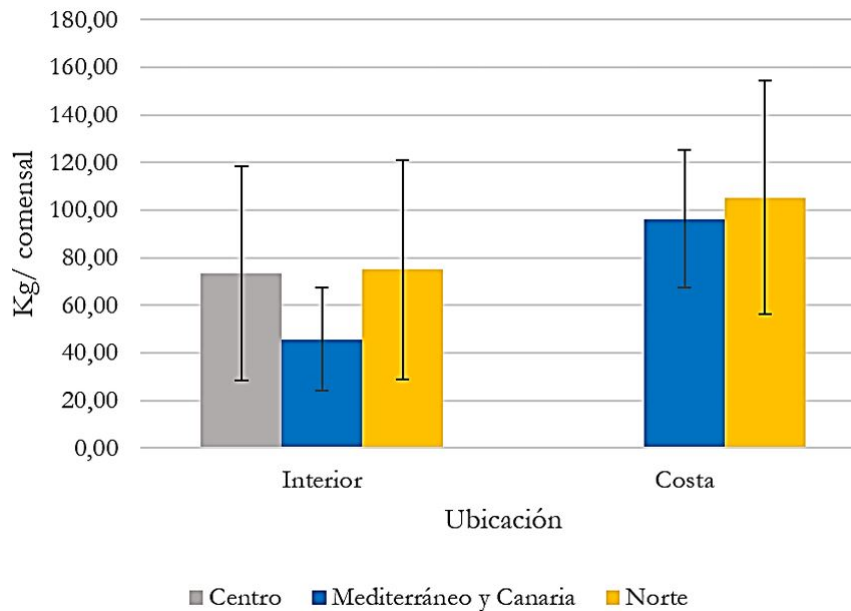
Figure 4. Average daily waste per diner according to location and region of the school.

In analyzing the weekly behavior of average daily waste depending on the location of schools, it was found that school cafeterias located on the coast tend to generate similar amounts of waste every day of the week; meanwhile, on the interior the trend indicates that on Wednesday and Friday more waste is generated and on Thursday the lowest values are registered (see Figure 5).
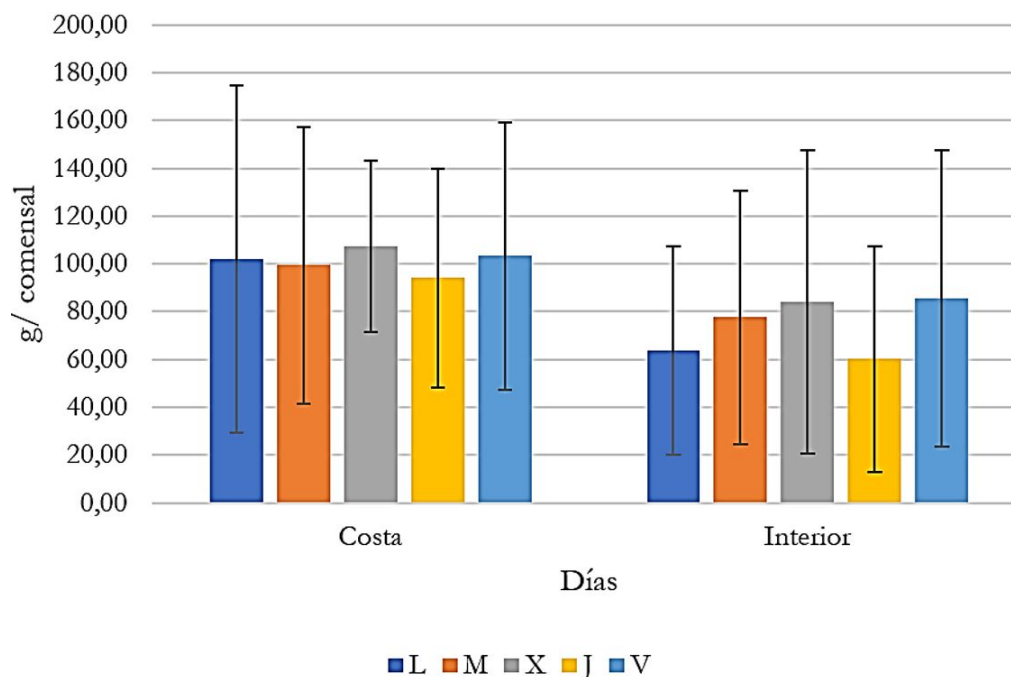

Figure 5. Weekly behavior of average daily waste per location.

In order to identify if the weekly waste behavior in schools located on the coast and on the interior is the same in the regions that make up both groups, two analyses were carried out —one for coast and another for the interior—, of the weekly waste behavior by region (see Figure 6). On the coast, there are no clear differences in the weekly waste behavior between the regions of the north and the Mediterranean-Canary Islands, both presenting a uniform waste behavior in the week. On the other hand, in the interior the differences are clearer; the center presents uniform waste behavior in the week, while the north records the highest waste values on Wednesday and Friday, and the lowest value on Thursday.
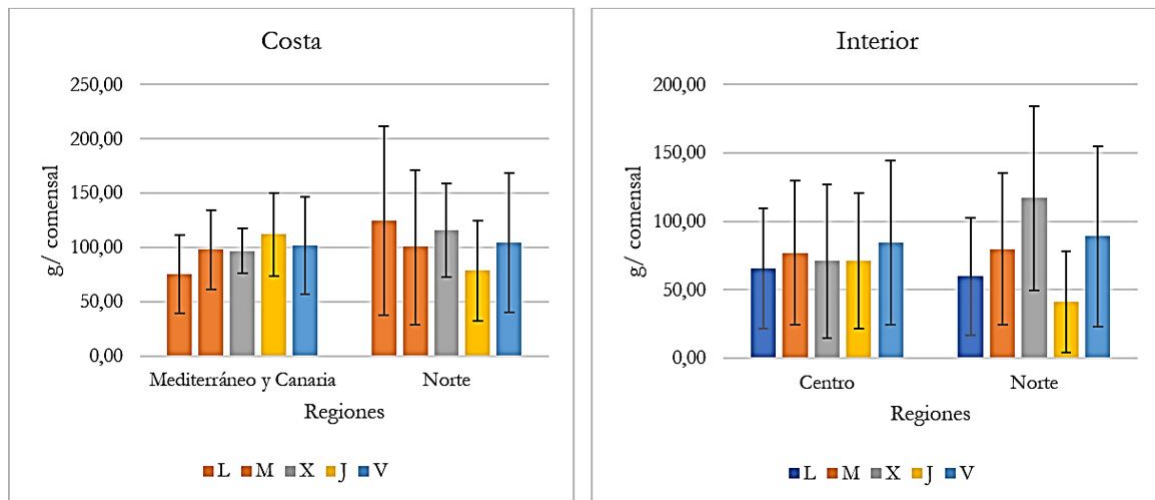
Figure 6. Weekly Average of daily waste behavior (g/diner) according to the location and region.

5.3 Relationship between dish waste and contextual variables at the school level

At the school level, one of the variables analyzed was the type of menu. Figure 7 shows the frequency of each type of menu for the 548 measurements made in the first week, differentiated by regions. In the central region, 3 of the 11 types of menus offered cover half of the measurements analyzed, while in the Mediterranean-Canary region are 4 of 12, and in the north 2 of 10. In the center, the most frequent menus are legumes/meats, followed by rice-pasta/fish and legumes/fish. In the Mediterranean and Canary Islands the menu of rice-pasta/fish is also the most frequent, followed by rice-pasta/meats, mashed potato or cream of vegetables/meats and soup/meats. Finally, the north region, unlike the previous ones, presents less variability in the menu types, being rice-pasta/meats the most frequent menu with 37%, followed by soup/meats.
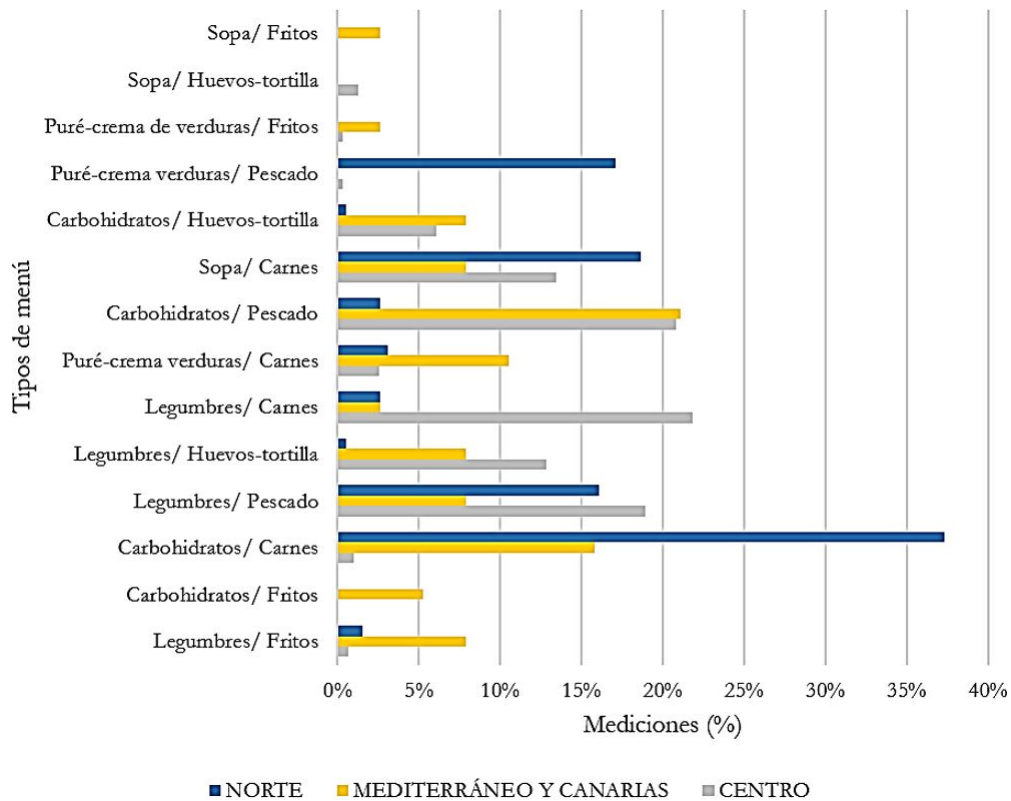
Figure 7. Frequency (%) of each type of menu by region

Note: The frequency of each type of menu refers to the relative amount of times that a type of menu is recorded, considering as total the 548 measurements made in 113 school cafeterias, for one week.

The relationship between the type of menu and the daily average waste per diner varies by region, according to what is shown in Figure 8. For the central region, the menus that offer meat as the main component of the second dish are the ones that produce the most waste, while those that include eggs-tortillas record less waste; about the first course, the biggest waste is generated with rice-pasta, regardless the second course. On the other hand, for the North region the tendency of the waste is marked by the main component of the first dish, being the dishes with legumes the one that produced the most waste, followed by the dishes with rice-pasta, and finally dishes with mashed potato or vegetables cream and soups. Finally, for the Mediterranean region and the Canary Islands there is no clear trend, mainly due to the low number of repetitions per plate in all cases.
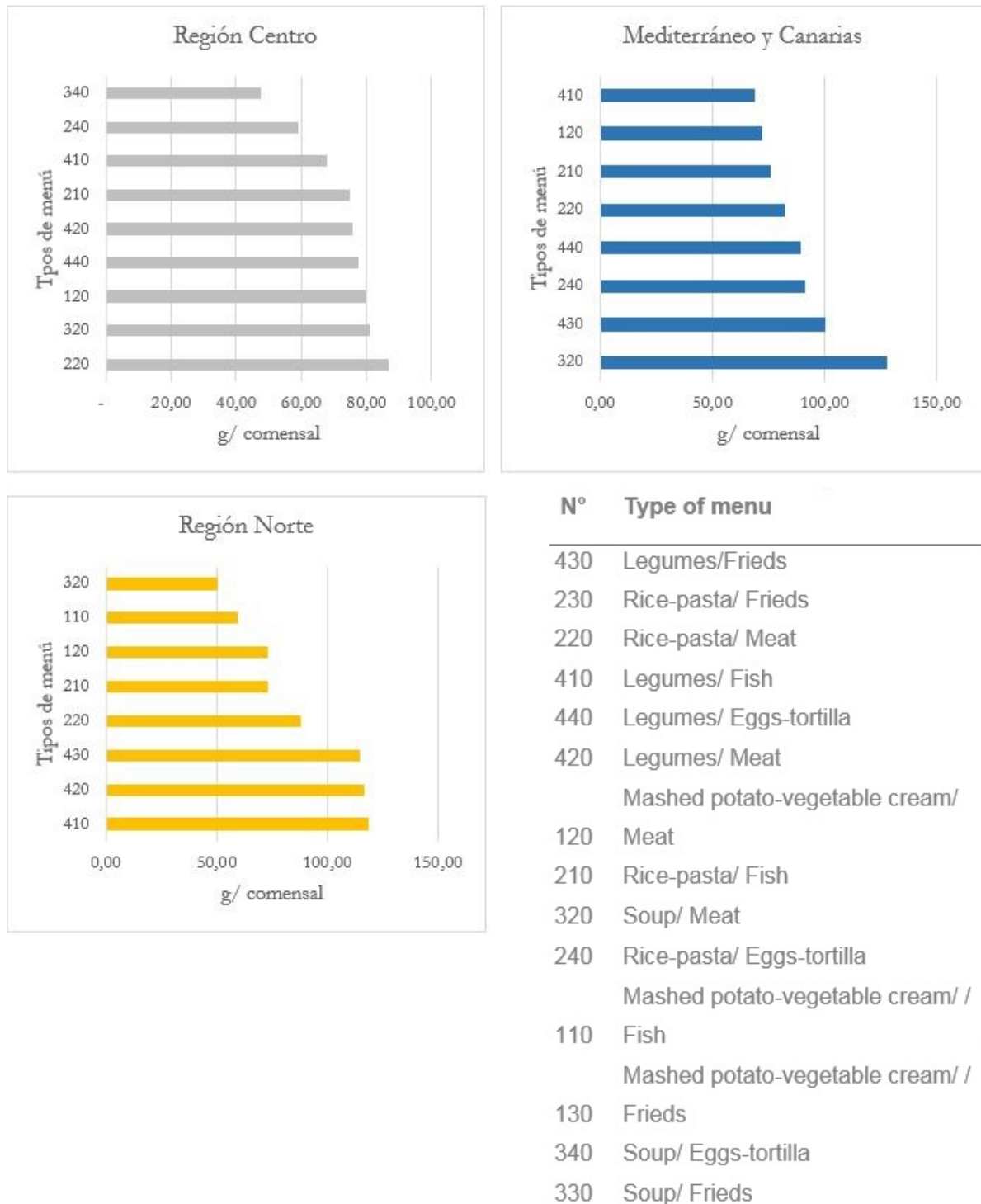
Figure 8. Average daily waste (g/diner) according to the type of menu.

The other variable analyzed was the moment of measurement of the waste, before and after an awareness campaign. For the 63 schools analyzed in the central region, there are significant differences (p-value: 0.00007) between the average waste measured before and after a sensitization campaign (see Figure 9). The data on dish waste, before and after the sensitization campaign, present asymmetric distribution with higher dispersion of the measurements towards the highest values. The average in the first week was 72.67 grams ($\pm$ 45.31) and in the second 57.64 grams ($\pm$ 36.74), indicating a reduction of 20.7 % in the generation of waste.
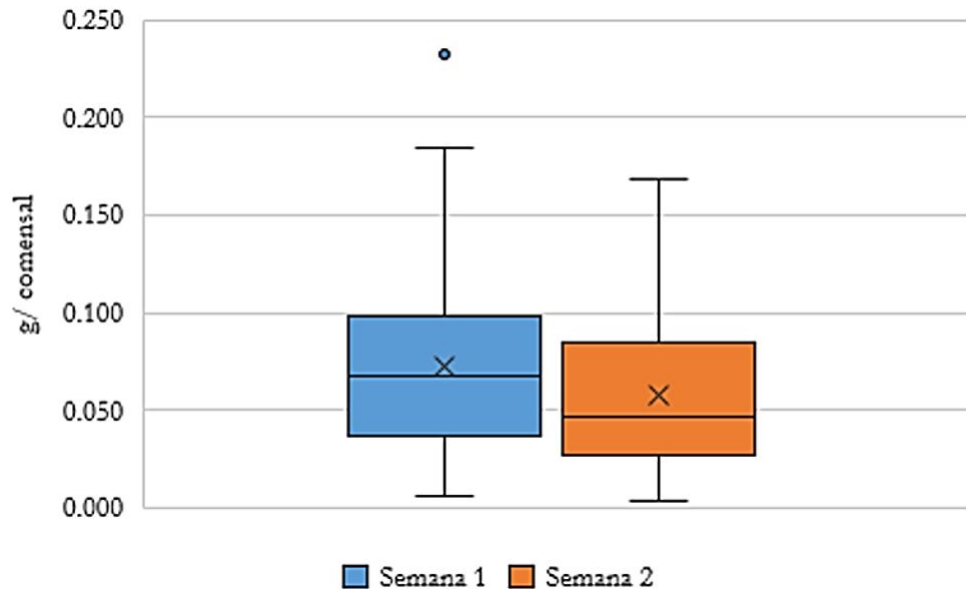

Figure 9. Daily waste average (g/diner) before and after an awareness campaign
Note: see note in Figure 2.

The weekly waste behavior differs depending on the time of measurement. Figure 10 shows that even though the trend of wasting more on Friday is maintained in both weeks, waste is more consistent throughout week two. The variability coefficient of the daily waste compared to the weekly average in week one is 9.81 %, while in week two is 7.52 %.
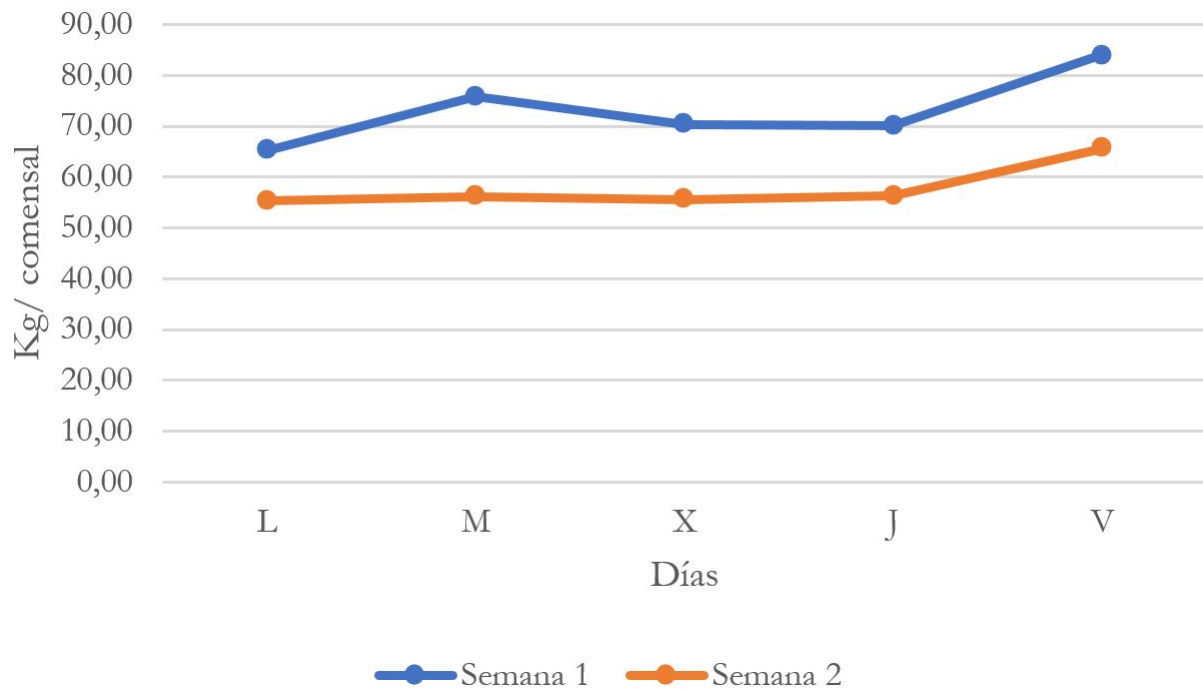
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Figure 10. Weekly behavior of daily waste average, before and after a sensitization campaign.

Generally, the waste generated by each type of menu in the center region tends to decrease from week one to week two, as shown in Figure 11. The biggest reduction in waste is presented in the menus: mashed potato- vegetable cream/meat with 56%, soup/eggs-tortilla with 49% and legumes/eggs-tortilla with 38%. It should be noted that the two types of menu that include fish as a second dish are the only ones that show an increase in the waste from the first to the second week: legumes/fish with 27% and rice-pasta/fish with 2%.
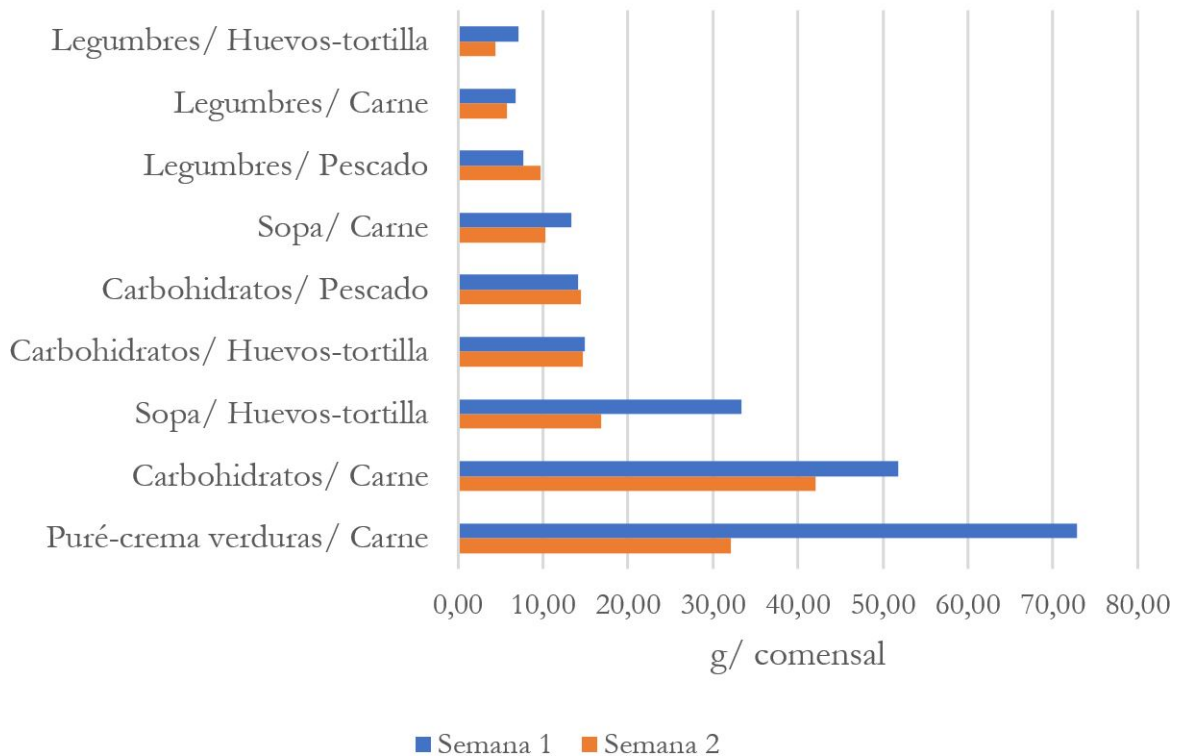
Figure 11. Daily waste average (g/diner) by menu type, before and after the sensitization activities

Taking into consideration the frequency in which the dishes are served (see Figure 12)) before and after the sensitization campaign, it turns out that two of the three most frequent menus —rice-pasta/fish and legumes/fis — are also those that re-gister an increase in waste between week one and two. On the other hand, the three menus that record, the highest decrease in waste according to Figure 11, are not frequently served.
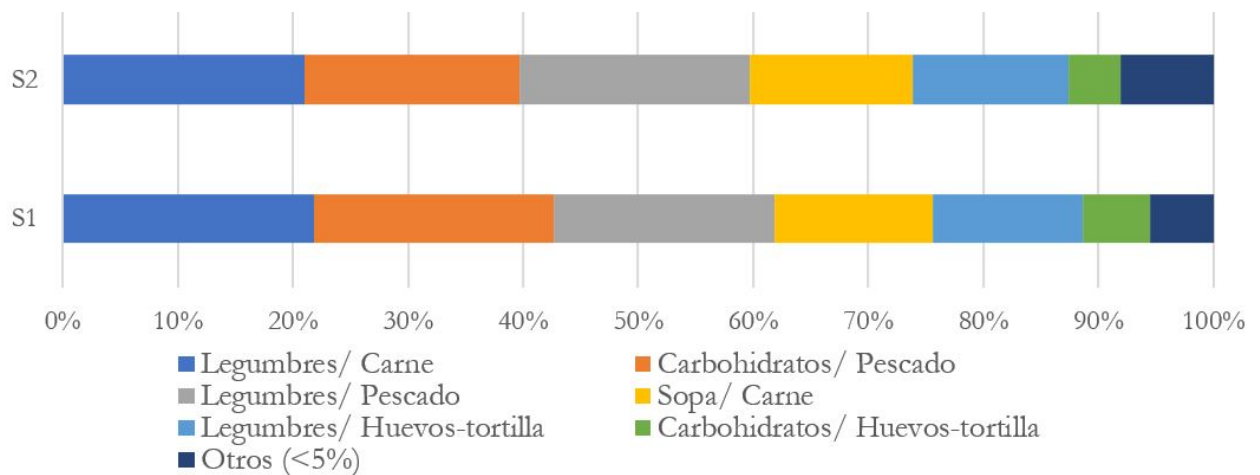

Figure 12. Frequency (% days) of menus before and after awareness activities

6 Discussions

To prevent and/or reduce food waste, Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente (2017) in its strategy More food, less waste indicates that studies are needed to respond to four key questions: How much is wasted, where does waste occur, how it happens and what are the possible causes or conditions of waste. Considering the importance of waste in the restoration sector, this research focuses on the dish waste generated in school cafeterias in Spain. The results obtained provide a first approximation on the quantity and the heterogeneity conditions of this waste from an analysis of the relationship between the dish waste and contextual factors at the level of the territory and the educational centers.

In the analyzed school cafeterias was recorded a daily waste average per diner of 76.62 grams, value that goes into the wide range found in studies carried out in school cafeterias in Spain (Derqui and Agustín, 2016; Derqui and Fernández, 2017; Rodriguez-Tadeo, 2014). It should be noted that this research, unlike the aforementioned studies, has worked with a sample of schools located in different autonomous regions of the Spanish territory, and even though are not representative of the country, provide a more approximate idea to the amount of waste generated in this sector.

Food waste depends on a number of factors that need to be analyzed considering the context. Hebrok and Boks (2017) indicate, in their study of consumer behavior against waste in European countries that little is known about how much of the waste heterogeneity is attributable to contextual factors. This research classified contextual factors in factors linked to the educational center, and factors linked to the territory, and analyzed their relationship with the dish waste generated in school cafeterias. At the territory level, the only variable that showed significant differences in dish waste was the location of the schools, registering higher values of waste in coastal provinces than in provinces of the interior. This research shows that there is a relationship between the dish waste and the location of the schools. However, in order to link the dish waste with behavioral factors associated with the location in the coast or inside, it would be necessary to explore variables of attitude, values and habits against waste, which cause the waste heterogeneity between locations.

At the educational center level, Derqui and Fernández (2017) indicate that the generation of dish waste depends on the receptivity of the diners towards the food. According to Cordingley, Reeve and Stephenson (2011) part of this receptivity depends on behavioral factors, within which are addressed the acceptance degree of the menus and the awareness level of children against the waste. To provide a first approach to these behavioral factors were analyzed the type of menu offered and the presence of awareness activities in schools.

The acceptance degree of the menus has been described by Bartrina et al. (2004). In their study about eating habits of school cafeterias in Spain, is indicated the preference for rice-pasta, and the rejection of vegetables, legumes and fish. In this research, discrimination by regions qualifies the observations of the aforementioned study, and provides evidence of the influence of the territorial context on the acceptance degree of the menu. In the north region it is true that the first dishes with legumes are the ones that generate the most waste. However, in the central region it was found that the menus with meat as a second dish generate more waste than the menus with fish, and that the component that generates the most waste in the first dish are rice-pasta, contrary to the described by Bartrina et al. (2004).

The analysis of the dish waste that considers as territorial variable the region —North, Central and Mediterranean-Canary Islands— did not present significant differences. However, as detailed in the preceding paragraph, this contextual factor shows a relation with the acceptance degree of the menus, and this influences the level of dish waste for each type of menu. In order to obtain clear results with regard to this factor, it is recommended to carry out studies that include more repetitions by type of menu, and that would preferably allow to quantify the waste by type of food, in order to analyze the possible reasons for the greater or lesser acceptance of a menu. To make decisions about the measures that influences this factors, it is important to evaluate other characteristics of the menu, such as the way it is prepared and presented, the temperature the food is served, among others.

The importance of sensitization activities for the creation of awareness is described by Priefer, Jörissen and Bräutigam (2016). The present study found significant differences between the waste measured before and after the sensitization activities for the

central region, indicating that there is a relationship between these activities and the reduction of waste. However, it should be pointed out that in order to establish a relationship between awareness raising and the creation of awareness against waste, other variables of behavior, values and/or habits of individuals should be considered in the face of waste, in medium and/or long term.

In analyzing the relationship between sensitization activities and waste by menu type, it was found that only the menus with legumes and/or fish did not show reduction in waste. The rejection of this type of food, described by Bartrina et al. (2004) could explain this phenomenon, since the creation of consciousness about the waste does not have to influence the preferences by certain type of food.

Finally, when analyzing the relationship between the days of the week and the daily dish waste, there is no clear trend. By including the contextual variables of location and region in the analysis of the weekly behavior of the waste, it is found that only the school cafeterias of the provinces of the interior in the north region present significant differences between the days, which could be explained by the effect of contextual variables that vary depending on the days, such as the type of menu.

It was also found that the weekly behavior of waste after sensitization activities is more uniform throughout the week. This may be due to the relationship of the generation of consciousness on waste and other factors that cause high values of waste some day of the week, compared to the weekly average.

7   Conclusions

This research shows that contextual factors at the level of the educational center and at the level of the territory are closely related to each other, and influence the dish waste. At the territory level it was found that the dish waste between schools located in coastal provinces and provinces of the interior show significant differences. The highest waste values are found in the coast. At the school level, significant differences were also found between the wastes measured before and after the sensitization campaigns, with a reduction in post-campaign waste. Finally, although the dish wastes in the three regions analyzed —center, north, Mediterranean-Canary— do not show significant differences bet-

ween them, analyzing the amount of dish waste recorded by each type of menu, it was found that these values differ according to the region in which the school is located, which gives evidence of the relationship between the region and the acceptance degree or preferences of the students for each type of menu.

To know the effect of these factors on dish waste, it is recommended to analyze behavioral variables that provide more clarity on the relationships between contextual determinants, behavior of individuals or a collective to the waste, and finally the amount of dish waste. The main objective of studying the behavior towards the food waste in school cafeterias is to design reduction and/or prevention measures. For this it is recommended, first of all, to continue exploring variables related to the context, which contribute to explain the variability of the daily average waste data in school cafeterias; and finally, with the identified conditions, to make a model that links the conditions to contextual and individual level to know to what extent each one influences the waste.

References

Bartrina, J. Aranceta, C. Pérez Rodrigo, L. Serra Majem and A. Delgado Rubio. 2004. "Hábitos alimentarios de los alumnos usuarios de comedores escolares en España. Estudio «Dime Cómo Comes»." *Atención Primaria* 33(3):131–139. Online: https://doi.org/10.1016/S0212-6567(04)79373-7.

Buzby, Jean C, Joanne F Guthrie et al. 2002. "Plate waste in school nutrition programs." *Electronic Publications from the Food Assistance & Nutrition Research Program* 36(2):220–238. Online: https://goo.gl/oNxpVK.

Byker, Carmen J., Alisha R. Farris, Michael Marcenelle, George C. Davis and Elena L. Serrano. 2014. "Food Waste in a School Nutrition Program After Implementation of New Lunch Program Guidelines." *Journal of Nutrition Education and Behavior* 46(5):406–411. Online: https://doi.org/10.1016/j.jneb.2014.03.009.

Cazorla, Adolfo, Ignacio De Los Ríos and Miguel Salvo. 2013. "Working With People (WWP) in rural development projects: A proposal from social learning." *Cuadernos de desarrollo*

rural 10(spe70):131–157. Online: https://goo.gl/Fqq5cG.

Cordingley, F, S Reeve and J. Stephenson. 2011. Food waste in schools. Technical report Waste and Resources Action Programme. Online: https://goo.gl/kacM5G.

De los Ríos, I, A Cazorla, S Sastre and C. Cadeddu. 2015. New university-society relationships for rational consumption and solidarity: actions from the Food Banks-UPM Chair. In *Envisioning a future without food waste and food poverty*. Wageningen Academic Publisher. Online: https://goo.gl/DTifaF.

De Los Ríos, Ignacio, Fernando Rodriguez and Cristina Pé. 2015. "Promoting Professional Project Management Skills in Engineering Higher Education: Project-Based Learning (PBL) Strategy*." *International Journal of Engineering Education* 31:1–15. Online: https://goo.gl/hZEJi5.

Derqui, B. and A Agustín. 2016. Estudio piloto para la Medicion y Reduccion del Desperdicio de Alimentos en Comedores Escolares: Auditoria y Autoevaluacion. Technical report Catálogo de Publicaciones de la Administración General del Estado. Online: https://goo.gl/bc6FNX.

Derqui, BelÃ©n and Vicenc Fernández. 2017. "The opportunity of tracking food waste in school canteens: Guidelines for self-assessment." *Waste Management* 69:431–444. Online: https://doi.org/10.1016/j.wasman.2017.07.030.

Engström, Rebecka and Annika Carlsson-Kanyama. 2004. "Food losses in food service institutions Examples from Sweden." *Food Policy* 29(3):203 – 213. Online: https://doi.org/10.1016/j.foodpol.2004.03.004.

Eriksson, Mattias, Christine Persson Osowski, Christopher Malefors, Jesper Björkman and Emelie Eriksson. 2017. "Quantification of food waste in public catering services A case study from a Swedish municipality." *Waste Management* 61:415–422. Online: https://goo.gl/Yn6aoS.

FAO. 2011. Global food losses and food waste - Extent, causes and prevention. In *Food and agriculture organization of the United Nations.* Online: https://goo.gl/Ak6Gwr.

FAO. 2014. Mitigation of food wastage: Societal costs and benefits. Technical report Food and agriculture organization of the United Nations. Online: https://goo.gl/CofuLw.

FESBAL. 2017. Memoria Anual 2017. Technical report FESBAL. Online: https://goo.gl/TL7b4p.

Hebrok, Marie and Casper Boks. 2017. "Household food waste: Drivers and potential intervention points for design – An extensive review." *Journal of Cleaner Production* 151:380 – 392. Online: https://doi.org/10.1016/j.jclepro.2017.03.069.

HLPE. 2014. Food Losses and Waste in the Context of Sustainable Food Systems. Technical report A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome. Online: https://goo.gl/1S1eQF.

Lipinski, B., Hanson C. and Lomax. 2013. Reducing Food Loss and Waste. Creating a Sustainable Food Future. Technical report World Resources Institute. Online: https://goo.gl/XodoaL.

Llorens-Ivorra, Cristóbal, Ilona Arroyo-Ba nuls, Joan Quiles-Izquierdo and Miguel Richart-Martínez. 2017. "Evaluación del equilibrio alimentario de los menús escolares de la Comunidad Valenciana (España) mediante un cuestionario." *Gaceta Sanitaria* . Online: https://doi.org/10.1016/j.gaceta.2017.01.010.

Martins, Margarida Liz, Luís M. Cunha, Sara S.P. Rodrigues and Ada Rocha. 2014. "Determination of plate waste in primary school lunches by weighing and visual estimation methods: A validation study." *Waste Management* 34(8):1362–1368. Online: https://doi.org/10.1016/j.wasman.2014.03.020.

Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente. 2017. *Estrategia más alimento, menos desperdicio 2017 - 2020.* Catálogo de Publicaciones de la AGE. Online: https://goo.gl/SgWqqv.

Papargyropoulou, Effie, Rodrigo Lozano, Julia K. Steinberger, Nigel Wright and Zaini bin Ujang. 2014. "The food waste hierarchy as a framework for the management of food surplus and food waste." *Journal of Cleaner Production* 76:106–115. Online: https://doi.org/10.1016/j.jclepro.2014.04.020.

Parfitt, Julian, Mark Barthel and Sarah Macnaughton. 2010. "Food waste within food supply chains: quantification and potential for change to 2050." *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 365(1554):3065–3081. Online: https://goo.gl/JJuYsJ.

Priefer, Carmen, Juliane Jörissen and Klaus-Rainer Bräutigam. 2016. "Food waste prevention in Europe – A cause-driven approach to identify the most relevant leverage points for action." *Resources, Conservation and Recycling* 109:155–165. Online: https://doi.org/10.1016/j.resconrec.2016.03.004.

Quested, T.E., E. Marsh, D. Stunell and A.D. Parry. 2013. "Spaghetti soup: The complex world of food waste behaviours." *Resources, Conservation and Recycling* 79:43 – 51. Online: https://doi.org/10.1016/j.resconrec.2013.04.011.

Rodriguez-Tadeo, A., Patiño Villeno B. Periago Caston M. J. Ros Berruezo G. & González Martínez-Lacuesta E. 2014. "Evaluando la aceptación de alimentos en escolares; registro visual cualitativo frente a análisis de residuos de alimentos." *Nutrición Hospitalaria* 29:1054–1061. Online: https://goo.gl/LqXbp7.

Secondi, Luca, Ludovica Principato and Tiziana Laureti. 2015. "Household food waste behaviour in EU-27 countries: A multilevel analysis." *Food Policy* 56:25–40. Online: https://doi.org/10.1016/j.foodpol.2015.07.007.

Stenmarck, Âsa, Carl Jensen, Tom Quested and Graham Moates. 2016. Estimates of European food waste levels. Technical report European Commission (FP7), Coordination and Support Action CSA. Online: https://goo.gl/dLF7Bo.

Thyberg, Krista L. and David J. Tonjes. 2016. "Drivers of food waste and their implications for sustainable policy development." *Resources, Conservation and Recycling* 106:110–123. Online: https://doi.org/10.1016/j.resconrec.2015.11.016.

Wilkie, Ann C., Ryan E. Graunke and Camilo Cornejo. 2015. "Food Waste Auditing at Three Florida Schools." *Sustainability* 7(2):1370–1387. Online: https://goo.gl/qUJQbn.

World Resources Institute. 2016. Food Loss and Waste Accounting and Reporting Standard. In *Food Loss + Waste*. Online: https://goo.gl/ERFupF.