Waste Management 114 (2020) 263–273

Contents lists available at ScienceDirect

Waste Management

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

Consumer's food waste in different restaurants configuration: A comparison between different levels of incentive and interaction

Daniele Eckert Matzembacher [a], Pedro Brancoli [b], Laís Moltene Maia [c], Mattias Eriksson [d,*]

[a] Postgraduate Programme in Management, Universidade Federal do Rio Grande do Sul (PPGA/UFRGS), Av. Washington Luis, 855/409, Porto Alegre, Brazil
[b] Swedish Centre for Resource Recovery, University of Borås, 501 90 Borås, Sweden
[c] Industrial Production and Operations Administration Department, FGV/EAESP, Rua Itapeva 474/8th floor, Sao Paulo, Brazil
[d] Department of Energy and Technology, Swedish University of Agricultural Science, Box 7032, 750 07 Uppsala, Sweden

ARTICLE INFO

Article history:
Received 24 February 2020
Revised 4 July 2020
Accepted 7 July 2020
Available online 16 July 2020

Keywords:
Food service
Food waste
Intervention
Restaurant
Waste prevention

ABSTRACT

Reducing food waste is necessary for achieving healthy diets and sustainable food systems due to its negative impacts on resource conservation, food security, and environmental, social and economic costs. This paper aim is to quantify the amount and types of food that is wasted by the consumers in different restaurant configurations. The second aim is to understand the reasons which lead them to waste food and the greenhouse gas emissions associated with the waste. To fulfil the aims, a mixed methodology was used, including primary data collection in restaurants for the quantification of food waste, interviewing consumers and staff, along with calculating the environmental impact from the waste using life cycle assessment. The results show that different incentives and levels of interaction in consumer's choice of food types exert influence on plate food waste. When incentive and interaction are low, the amount of food waste is larger. It is the case of a la carte restaurants. The best performance in the restaurant categories was when both incentive and level of interaction were higher. Buffet where the consumers pay by weight, therefore, is the configuration that generates less food waste on the consumer's plate. The main wasted products are rice and beans, followed by beef, and then other carbohydrates. The life cycle assessment indicated a carbon footprint varying from 128 to 324 g CO_2 eq./plate from the wasted food. The result of the interviews showed that the food waste on the plate is not visible to consumers, since in the majority of cases, they believe that their food waste on the plate in the day of the observation was an exception. There is a large potential to reduce food waste by giving consumers the possibility to influence the serving to get the right portion size. Also, to further emphasize this behaviour by creating incentives for consumers only to serve as much food as they actually eat.

1. Introduction

Along with shifting dietary patterns and improving food production technologies and management, reducing food waste is necessary for achieving healthy diets and sustainable food systems. It is imperative to maintain an equilibrium in planetary boundaries that define a safe operating space for humanity (Karlsson et al., 2018; Springmann et al., 2018; Willett et al., 2019). The drive to target food waste stems from concerns about impacts on resource conservation, food security, environmental, social and economic costs (Campoy-Muñoz et al., 2017; Papargyropoulou et al., 2014; Thyberg and Tonjes, 2016).

United Nations has launched a goal to reduce food waste at the consumer and retail level, and food losses along food supply chain by 50% until 2030 (UN, 2015). Food loss and waste can be defined as a decrease in the quantity or quality of food in the food supply chain. Empirically it considers food loss as occurring along the food supply chain from harvest/slaughter/catch up to distribution, but not including the retail level. Food waste, on the other hand, occurs at the retail and consumption levels (FAO, 2019, p. 14). To prevent food waste, a better understanding of waste patterns is necessary (Eriksson et al., 2018a,b; 2012). It is a prerequisite for tracking progress on reduction targets, analysing environmental impacts, and exploring mitigation strategies (Xue et al., 2017). Although there have been recent studies quantifying food waste, significant challenges remain, such as data inconsistency and a narrow temporal, geographical, and food supply chain coverage (Xue et al., 2017).

Restaurants and food services account for a significant proportion of food waste (Capps et al., 2019), which has been identified as an important unsustainability hotspot (Eriksson et al., 2018a, b; 2020). Silvennoinen et al. (2015) found that about 20% of all food

* Corresponding author.
E-mail address: mattias.eriksson@slu.se (M. Eriksson).

https://doi.org/10.1016/j.wasman.2020.07.014
0956-053X/

handled and prepared in the sector is wasted. Some recent investigations give some information related to food waste in food service. For example, in a study conducted in China in 2018, Wu et al. (2019) found 73.7 g/cap/meal of wasted food in 2018; Ellison et al. (2019) found 69.59 and 84.77 g of waste per consumer in USA; and Eriksson et al. (2017) found an average of 75 g of food waste per plate served in Swedish public catering services; Wang et al. (2017) analysed 3557 tables in 195 restaurants in China. They found 93 g of food waste per capita per meal. They also identified that food waste varies by consumer groups, restaurant categories, and meal purposes. In fact, plate waste is considered one of the major drivers of food waste in many restaurants configuration, such as all-you-can-eat facilities, for example (Thyberg and Tonjes, 2016).

Prevention is most important at the end of the value chain, like in restaurants, where most sub-processes have already taken place (Eriksson et al., 2017; 2018a,b). Potential environmental benefits arise from food waste prevention in the foodservice sector. For example, on average, a 38% decrease in food waste amounts reduces the climate impacts of food waste by 41% and biodiversity impacts by 30%. However, it is important to prioritize the reduction of food categories with high environmental intensity (Beretta and Hellweg, 2019). There is already some knowledge that reducing meat consumption is central to produce sustainable diets because of its high environmental impact (Macdiarmid et al., 2016; Scholz et al., 2015).

In this sense, shedding light on which waste fractions have the most substantial environmental impacts provide information to support the development of strategies and actions to reduce environmental footprint (Brancoli et al., 2017). Sebbane and Costa (2018) also noticed that, regarding food waste in restaurants, there is a sharp discrepancy between stated and actual behaviour, which stresses the need to rely on observational measures to avoid misleading interpretations in self-reported surveys about food waste.

Despite the increasing number of studies identifying FLW reduction as a societal imperative, there is a lack of scientific research testing practical interventions to prevent food waste (Muth et al., 2019; Stöckli et al., 2018). Based on that, this study aims to quantify the amount and types of food that is wasted by consumers in different restaurant configurations. The aim is also to understand the reasons which lead them to waste food and the greenhouse gas emissions associated with the waste. The goal is to identify which restaurant setting can generate less food waste so that the settings can be used as a waste intervention to support the transformation processes toward more sustainable production and consumption systems.

1.1. Theoretical background

For understanding the food waste in different restaurant configurations, this study proposes that two variables need to be analysed: incentive and interaction. Autonomy will be used in this paper as a synonym for interaction. We define incentives as stimuli that motivate or encourage individuals to reduce their food waste. Ravandi and Jovanovic (2019) relate incentives to designing choice environments that encourage guests to avoid taking more food than they need. Saving money is recognized as a key motivator for consumers to reduce food waste (Ellison et al., 2019; Thyberg and Tonjes, 2016). In the absence of financial incentives, consumers care less about what they put on the plate. For example, in all-you-care-to-eat dining restaurants, food waste can be problematic because there is little a monetary incentive to serve less food (Ellison et al., 2019).

However, alternative motivators are needed when the quantity of food and its associated cost are not directly linked in all-you-care-to-eat settings. In this sense, campaigns can produce changes in consumers' beliefs related to food waste, which may be an important first step to achieving behavioural change (Ellison et al., 2019). Reducing plate size in food-service operations also is related to a reduction in plate waste (Ravandi and Jovanovic, 2019). In the incentive category, this study considers that a restaurant can have (1) a fixed price, regardless of the amount of food served (low incentive); or (2) a variable price, charging according to the amount of food that is served (high incentive).

Interaction can be defined as the level of communication or direct involvement with someone or something. For these incentives to be effective, consumer needs to have the option of choice to some extent. Although the literature does not address the issue broadly, existing studies indicate that interaction appears as an important element to the success in interventions to reduce consumer's food waste.

Studies on nudge effects can bring some insights related to the interaction level. Nudging entails any aspect of the choice architecture that predictably alters people's behaviour without forbidding any options or significantly changing their economic incentives (Thaler and Sunstein, 2008). They can be related to changes in the profile of different choices. As an example is the prominence of healthy food in canteens. It is also possible to change which options are the default to influence consumeŕs choice (Bonell et al., 2011).

In the interaction category, this study considers that the customer can (1) select the type and amount of food they want to eat, with the chance of looking and smelling the food during selection process (high interaction); (2) being served by the staff, but still having the possibility to look and smell food during serving process. However, consumers are not allowed to order more food than the predetermined amount, but can request to decrease the quantity or to remove some items (middle-level interaction); (3) choosing between some food options without looking or smelling the food during selection process, and be served by the staff (low interaction).

2. Materials and methods

The study was conducted in the region of São Paulo, Brazil. São Paulo is an important financial global centre, with over 12 million inhabitants. According to Bezerra and Sichieri (2010) and Leal (2010), it is a habit to have lunch outside the home, especially in restaurants on workdays. The region concentrates many different categories of restaurants that can be analyzed according to incentive and interaction, facilitating a contextual basis for comparison. The location was selected especially due to the possibility to investigate the category of restaurants where consumers pay by weight. It is a common practice in Brazil, while in other places, e.g. Sweden, this is a rare practice only found among a few restaurants with a certain profile of sustainability and food waste awareness. To investigate how the restaurant configuration influence the plate waste, and not the awareness of the staff, São Paolo was a suitable location. The use of Brazilian restaurants also provided the opportunity to evaluate the configuration in a steady-state, since the concept was established long before the study and not as a temporary intervention.

2.1. Restaurants categorization

Based on the literature, a categorization of the existing restaurants in the region was done according to the type of incentive and interaction. Three categories were defined: Variable price buffet service; Fixed price buffet/canteen service, Fixed price table service.

Variable price buffet service is the group which provides a higher level of incentive and interaction. It includes buffet per kg restaurants, in which the customer selects the type and amount of food he/she wants to eat, with the possibility of looking and smelling the food during the selection process. Only one plate is used for one consumer, and customers use the same plate for a refill. The consumers serve themselves and have full control of what and how much is served on the plate. The payment is according to the weight of the plate, i.e., the higher the weight the higher the amount paid.

Fixed price buffet/canteen service provides a middle level of incentive and interaction and includes both buffet fixed price (all you can eat) and canteens restaurants. In this study the canteen corresponds to a restaurant maintained by the Municipality of São Paulo, in which the food is sold to city residents and workers in a given region of productive economic activity. During the serving process, Fixed price buffet/canteen service is similar to Variable price buffet service classification. Only one plate is used for one consumer in both in buffet fixed price and canteens restaurants. In the case of buffet fixed price consumers use the same plate for a refill. However, the customers will pay the same price regardless of how much food they choose to put on their plate and the number of times they get served again. Canteen restaurant also have a pre determined and fixed price, but the food is served by the restaurant staff. However, consumers still can look and smell food during the serving process. Customers are not allowed to order more food than the predetermined amount but can request to decrease the quantity or to remove some item. However, the consumers do not have the full control over what is left on the plate, since all requests are interpreted by the staff. It is not possible to have refill in this category.

It is important to mention that canteens and all you can eat buffets have different characteristics with regard to how consumers are served. Consumers at canteens are served a pre-determined amount of food, while consumers at all you can eat buffets can choose the amount of food which is served on the plate. However, both converge when considered together (1) incentive - consumers pay a fixed price, and (2) level of interaction - consumers can look the appearance and smell the food during their choice and both configurations offer the consumers some degree of influence in the amount of food served. It would be possible to separate these services into separate groups of analysis but maintaining them together is important to better understand possible interventions to reduce food waste, as it considers the consumer's option of serving fewer items on the plate (in the case of all you can eat) or ask to remove items from the plate when served by a third person, in the case of canteens.

Fixed price table service is the group which provides the lowest level of incentive and interaction. It includes a la carte restaurants, in which consumers choose between some food options from a menu, however, without looking or smelling the food in the moment of their choice. Based on that, the restaurant's staff prepares and brings food to the consumer's table. The price is fixed, and the food quantity is predetermined, and as a rule, it is not possible to be changed, but the customer may request to withdraw some component of the meal.

More specifically, in the a la carte restaurants investigated, a meal is composed by different items, e.g. rice, beans, meat, etc. Consumers can order, although this is not common, a single item instead of the whole meal. It is also possible to order and pay for additional vegetable servings, deserts, rice, among others. However, at lunchtime, in the restaurants investigated consumers commonly ordered one of the meal selections and the staff explained that small portions are mostly ordered during happy hours or dinner time. The whole meal offers different pre-fixed combinations of items, in which food is served on a big tray with each food item coming in several smaller food trays. For example, one tray for vegetables, one for rice, one for beans, one for potatoes and another for meat and with an empty plate for one consumer (or two plates if the consumers ask to share the meal). The most common is to ask the food for one person. In the cases of the whole menu (one of the meal selections), the numbers and combinations of trays are pre-fixed, and it ranges from 4 to 6 according to the meal chosen in the menu. Consumers can request to withdraw some component, but he/she will pay the same price. Therefore, the total price changes according to the type of meal chosen, but it does not vary according to the quantity/size of the portion, as it is fixed. The consumer serves in his/her plate the food from these small trays. After consumption, this big tray returns to the kitchen with the same smaller trays and plate on which the food was served.

Table 1 summarizes the three categories of the existing restaurants according to the type of incentive and interaction:

2.2. Data collection and analysis

The cases were selected to represent different restaurant's categories according to incentive and interaction levels. Still, the involvement of the restaurants was limited to the ones that volunteered to participate, and therefore no random selection could be applied. Primary data were collected from August 2019 to October 2019. The collection of data about food waste took place over five consecutive representative days, i.e. from Monday to Friday without holidays, including lunch serving in each restaurant, being the data personally collected by researchers to guarantee consistency with methodology and practice. The plate size (diameter) was a factor taken into account when choosing the cases to be studied, as well as the average price charged by the restaurant. Table 2 presents a summary of data collection:

The plate waste, residue left on consumers' plates, was collected after lunch. All food waste from consumer's plate were recorded, except for beverages. As compared to the study conducted by Gustavsson et al. (2011), we have divided food waste into two groups: (a) unavoidable food waste, which encompasses food that is not intended for consumption. It includes bones and peels of fruits and vegetables, and (b) avoidable food waste, which includes foods that are expected to be consumed by humans and are in a safe condition.

The data collection followed the suggestions of The WRI's Food Loss and Waste Accounting and Reporting Standard (World Resources Institute, 2016). To have an accurate data and enable results to be comparable across organizations, a more detailed methodology was applied, following the Tree Structure from Eriksson et al. (2018a,b), noticing that the analysis took place at the consumer level and not in the restaurant kitchen (production process). Based on it, the following categories were defined: (a) catering unit: restaurant, (b) serving unit: the catering unit itself; (c) meal: lunch; (d) process: plate waste; (e) Meal component: salad, main component and desert, (f) food type: unavoidable losses, bakery, fruits and vegetables, carbohydrates, meat, dairy, dessert, and others; (g) food sub-type: fruits and vegetables are sub-divided in potato and others; carbohydrates in beans and rice, and others; meat is sub-divided in chicken, beef, pork, sausages, and fish; and dairy in egg and cheese. Soup was not included as

Table 1
Summary of levels of incentive and interaction for the different restaurants configurations.

	Variable price buffet service	Fixed price buffet/canteen service	Fixed price table service
Incentive	High	Low	Low
Interaction	High	High-Medium	Low

Table 2
Restaurants selected.

Code	Restaurant	Category	Days	Total plates analyzed
R1	Buffet per kg	Variable price buffet service	5	774
R2	Buffet per kg	Variable price buffet service	5	668
R3	Buffet fixed price	Fixed price buffet/canteen service	5	750
R4	Canteen fixed price	Fixed price buffet/canteen service	5	924
R5	A la carte	Fixed price table service	5	642
R6	A la carte	Fixed price table service	5	589

a meal component since it was not consumed/wasted in the analysed restaurants. The research team collected plate waste and separated food into respective bins, which were weighed on a digital scale.

Besides, semi-structured interviews were conducted with consumers to have insights into mechanisms and habits that may or may not aggravate their food waste, and with restaurant's owners, managers and staff about their strategies to prevent and minimize it. In most cases, one owner and one manager were interviewed in each restaurant, as well as all the staff that have contact with consumers. The only exception is restaurant 6 that only one person (manager) was interviewed. Not all restaurants allowed contact with consumers, but it was possible to interview representatives of the three categories of analysis. Even those restaurants that allowed contact with consumers imposed some limitations regarding the interview duration and the questions asked - the owners and managers presumed that it could cause embarrassment to customers and that the interview would take a longer time. As a result, demographics data collection was not allowed in relation to age, income and education level.

The choice of the customers interviewed occurred randomly, taking into account the moments of less customers volume in the restaurant, in order to not disturb the service, as requested by the managers. The majority of interviews took place in moments of low demand and it was possible to interview practically all consumers who generated food waste at these moments. A total of 112 consumers were interviewed in the category "Variable price buffet service", 107 in the category "Fixed price buffet/canteen service", and 105 in the category "Fixed price table service", totalling 324 interviews.

2.3. Data analysis and life cycle assessment

All data were imported into Microsoft Excel version 16.30, where all of the analyses were conducted. A Life cycle assessment (LCA) was also performed to understand the environmental impacts of this wasted food. Food waste fractions that were generated in large amounts were included in the LCA.

The goal of LCA was to estimate the carbon footprint of the food waste generated in different restaurant configurations to identify the hotspots in the system. That is, to understand which food waste fractions contribute significantly to the carbon footprint; and to support the design of effective measures to reduce the global warming potential associated with the wastage of food. The functional unit is the average amount of food waste per plate generated in different restaurants configurations. The system boundaries of this study are cradle to grave, i.e. from the agricultural production until the waste management, here modelled as landfill, since it is the most common method of waste disposal in Brazil. The model for landfill assumed the emissions for maintaining and compacting the landfill as 21 g CO_2e/kg organic waste, in line with the results reported by (Nilsson, 2013). The potential for methane production was calculated assuming literature value for the different categories, based on Tonini et al. (2018). Since organic waste includes a lot of food products with readily available nutrients, it was assumed that half the carbon would be converted to methane released to the atmosphere and the rest oxidised into carbon dioxide in the landfill (Björklund, 1998). It was assumed that the methane produced did not receive treatment like capturing or flaring.

The geographical coverage is Brazil, however, the inventory database used was global average. The impact categories analysed were limited to the global warming potential using the IPCC 2013 GWP 100 years methodology. The inventory for the products included in this study were largely based in global processes from EcoInvent (Weidema et al., 2013) and to a lower extent on the Agri-footprint database (Durlinger et al., 2014). Appendix I describes the composition of each food waste category and the correspondence between the food products and the inventory process in the databases used.

The geographical representativeness of the data is global, since there was a lack of specific Brazilian inventory for many products.

3. Results

The results are exposed according to four different aspects: consumer food waste (plate waste) in different buffet configurations according to the type of incentive and interaction, type and quantity of food wasted generated, environmental impact, and consumer's attitudes and behaviour.

3.1. Plate waste in different buffet configurations

Fig. 1 presents the average amount of plate waste and the share of unavoidable and avoidable food waste per plate in each restaurant analysed, as well as an average per category.

The mass of unavoidable food waste per plate is almost the same across the three levels of incentive and autonomy and it can be related to the meal that a typical citizen chooses to lunch in the country, namely fruits and vegetables, rice, beans, a portion of carbohydrate and meat. The unavoidable food waste found related mostly to meat bones and fruit peels.

Analysing by the categories proposed in the methodology, consumer food waste increases as both incentive and autonomy decrease. The configuration with most incentive and autonomy (Variable price buffet service) had an average plate waste of 23.9 g/plate while the middle alternative (Fixed price buffet/canteen service) had 45.8 g/plate and the configuration with the least incentive and autonomy (Fixed price table service) had 69.8 g/plate.

Variable price buffet service, which comprises buffet per kg, presented the lowest level of food waste per plate compared to other restaurants categories. Most of the consumers interviewed (R1 and R2) didn't make any direct mention of the role of their autonomy. They indicated that the variable price, based on the amount of food they serve on the plates, is an important factor that leads them to be more careful when selecting the quantity of the food to put on their plates.

The importance of the monetary incentive can be well described in the following situation. By rule, dessert is not included in the

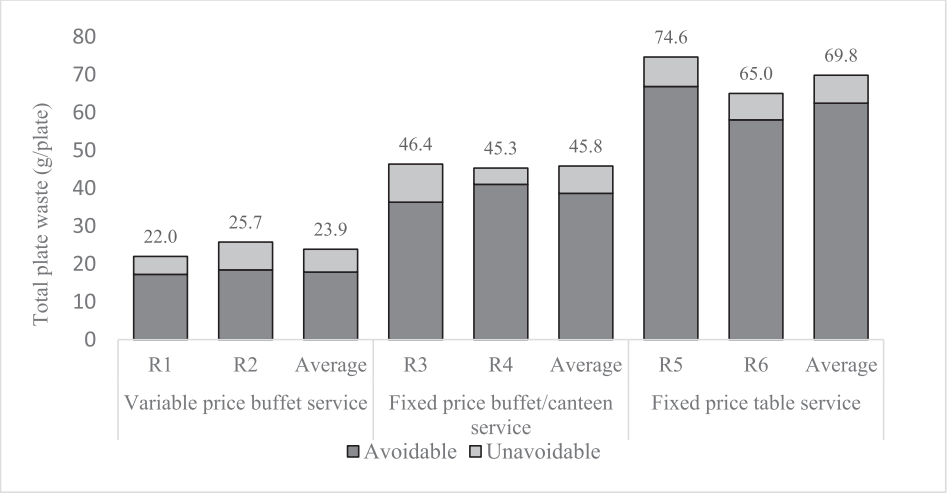

Fig. 1. Average plate waste for each restaurant and the average for each category of restaurant configuration.

meal in R1 and have to be paid separately by the consumer. With this condition, no wastage of desserts was observed. However, if some products are close to expiry, the restaurants make some desert and offer it for free to customers in their buffet service. During this condition, dessert was the most wasted food product during that day. All waste in this category occurred in the days there was free desert. Three different explanations came up for this kind of waste from customers and from restaurant staff: (a) as the dessert was free, customers take it even if they don't want to consume the whole (i.e., just to try it), (b) the taste was very sweet, and (c) the day's temperature was low which made the cold dessert less suitable.

Fixed price buffet/canteen service, which is a category with less autonomy, especially for canteens, which the food is served by staff, and less incentive, since the cost of food waste is absorbed by the restaurant, presented a medium level of food waste per plate comparing to other restaurants categories. All you can eat and canteen restaurants integrates this group. Comparing with Variable price buffet service, they presented 92% more total food waste and 116% more avoidable food waste.

In fact, who pays for the food waste seems to be a relevant factor. The owner of R2 manages two restaurants, one buffet per kg and another all you can eat. He explained that all you can eat buffet are harder to manage comparing to buffet per kg. The all you can eat restaurant has problems with profitability, mainly impacted by costs related to food waste, and for this reason he is analysing whether to maintain or not this configuration. They tried several campaigns and actions to make consumers waste less, without success, since consumers recognise that once they are paying they are entitled to serve themselves as much as they want, even if this results in food waste.

The negative effect of a medium degree of autonomy associated with lack of incentive can be exemplified through R4. In this canteen restaurant, consumers can choose between two different colours of the tray. Orange colour indicates that the customer wants to receive the full portion of food and the yellow tray indicates that the customer wants to receive a smaller portion of food. However, since the price is the same, just a few customers decide to ask for smaller portions, even if they know that they are going to produce food waste. The customers and staff answers to interviews indicate a sensitivity to the non-variance of the price. Since there is no discount for smaller portions, consumers believe they have the right to receive the full portion and waste it, because they are paying for it. The restaurant manager cited previous situations in which they tried to make customers aware of the problem of food waste, and they had the same pattern of response. In the campaigns they have done in the past, they have achieved some immediate results, but they did not last long.

Next, Fixed price table service is the category with the worst performance. Comparing to Fixed price buffet/canteen service, they presented 52% more total and 61% more avoidable food waste. Comparing to Variable price buffet service, they offered 192% more total and 250% more avoidable food waste. This category also presents the worst configuration in terms of autonomy and incentive, since customers do not serve their food and cannot view and smell it while being served, and pay a fixed price.

The explanation of how the food is served in this type of restaurant helps to understand better the volume of food waste by the consumer. For example, Fig. 2 shows a typical meal served to a single client on R5, parmigiana steak. The food delivered to the consumer is distributed in four different trays containing rice and potato, beans, meat and vegetables. Although research on the actual development of portion sizes is limited, it is clear that portion sizes have increased over the past decades (Steenhuis and Vermeer, 2009), which seems to be the case of Fixed price table service restaurant. In addition to causing food waste, according to Rolls et al. (2002), large portions of food may contribute to excess energy intake and higher obesity. Usually, subjects consume 30% more energy when offered larger portions than the smallest ones.

When they have the possibility, many regular customers, who already know the restaurant, ask for the dish to be shared with someone else, but this is not always possible. The restaurant has only one food option that the consumer can choose to receive half a portion and pay less for that. The staff explains that it is not possible to extend to other menu options since it would affect negatively the dynamics of the kitchen work, which needs to be fast and agile. Also, they explain that the costs related to the food waste is already included in the price of the plate.

3.2. Composition of consumer's food waste on different restaurants categories

The composition of food waste in relation to total food waste for each food product is presented in Table 3.

Fig. 3 depicts the composition of food waste/portion (g). It shows that as incentives and autonomy decrease, the share of rice and beans increase and it decreases for meat products. Neverthe-

Fig. 2. Parmegiana steak in R5.

Table 3
Composition of consumer food waste.

Composition of food waste (g/plate)				
Food Products		Variable price buffet service	Fixed price buffet/canteen service	Fixed price table service
Unavoidable		6	7.2	7.4
Bakery		0	1.1	0.3
Fruits and vegetables	Potato	0.2	0.8	0.5
	Others	2.2	4.4	6.5
Carbohydrates	Beans and rice	7	20.9	36.5
	Others	1.8	2.4	8.6
Meat	Chicken	1.2	2.2	1.3
	Beef	3.9	5.4	6.9
	Pork	0.4	0.5	0.6
	Sausages	0.1	0.4	0.1
	Fish	0	0.2	0.2
Dairy		0	0.3	0
Desert		1	0.1	0
Other: Sauce		0	0	1
Total Food Waste		**23.9**	**45.8**	**69.8**
Avoidable Food Waste		**17.8**	**38.6**	**62.4**

less, when analysing the waste composition in mass (Table 3), the wasted mass increases in the majority of the categories as the incentives and autonomy decrease.

The main wasted product in all restaurant configurations were rice and beans, which are usually consumed mixed. It is a relatively cheap food product, consumed daily in Brazil. The use of rice and beans in Brazil has the function of staple food, similar to potatoes in many traditional diets of the Western world (FAO, 2008; Zaheer and Akhtar, 2016). Rice alone is also the staple food through most of Asia and is also important in Africa and Latin America (Gilbert and Morgan, 2010). It is possible to have a large volume of food on the plate at a low price by adding rice and beans, so it gives the idea of a generously served dish. However, most of rice and beans on plates go to waste.

The second most wasted product is from the meat category: beef. The sum of the three categories reaches 11.6% of the total food wasted. Meat is part of a dish consumed daily in the country, in addition to rice and beans. Beef or chicken are the most common meat products consumed, while the consumption of pork is less common. Compared to rice, the economic value of beef is higher. This waste is common to all restaurants categories. The volume changes accordingly with increasing waste in each category. The percentage of meat wasted increases as the incentives and interaction increases. A possible explanation is that when the consumers can choose their food (high level of interaction), they tend to choose more expensive products, such as meat, since they pay by weight and the composition of the plate does not affect the price directly. The opposite happens with rice and beans, which are cheap products, and were observed to have the inverse pattern of meat products, i.e. it has a higher share in the composition of waste plates in restaurants with a low level of interaction. There was no significant change in the percentage composition of fruits and vegetables through the restaurants analysed.

As the volume of food waste increases in 'Fixed price buffet/canteen service' to 'Fixed price table service', a third food waste category becomes more relevant in composition: other carbohydrates. It includes pasta, lasagne, pancake, lentils, etc. The amount of waste in this waste category increases as the incentive, and interaction conditions decrease.

3.3. Carbon footprint

The results from the life cycle assessment indicates that the carbon footprint of plate waste as 128, 222 and 324 g CO_2 eq. for "Variable price buffet service", "Fixed price buffet/canteen service" and "Fixed price table service", respectively (Fig. 4).

Regarding the hotspots, the results in Fig. 4 indicates the meat category as the hotspot in all restaurant configurations is analysed. It represents 57%, 48% and 39% of the total carbon footprint of "Variable price buffet service", "Fixed price buffet/canteen service"

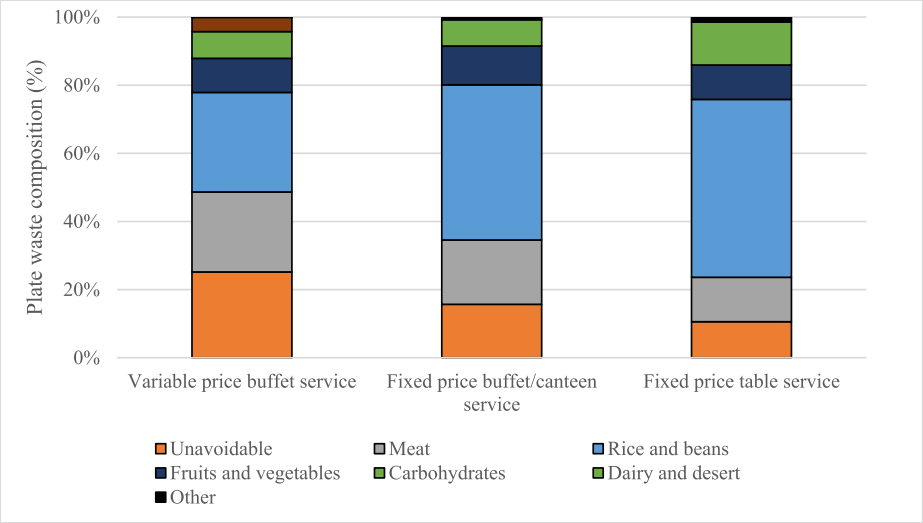

Fig. 3. Composition of plate food waste (%).

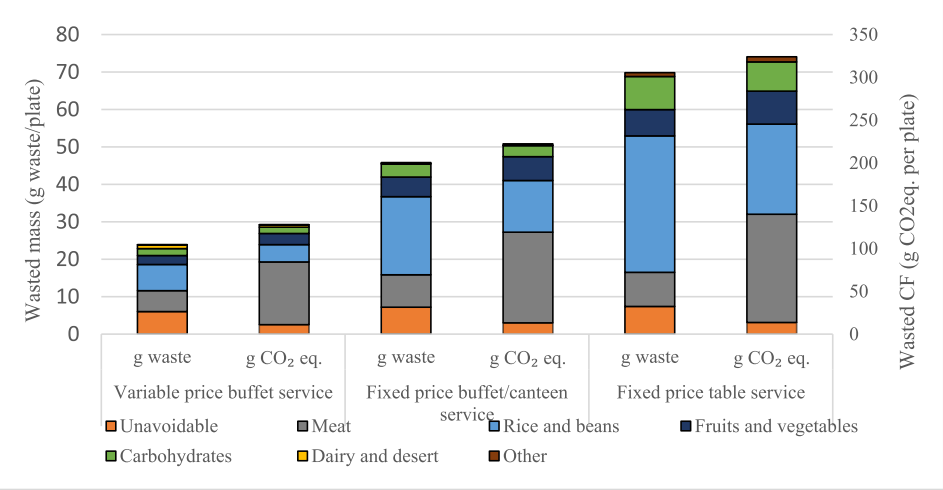

Fig. 4. Wastage mass and carbon footprint of plate waste generation in the investigated restaurant categories.

and "Fixed price table service", respectively, even though its contribution in mass is no bigger than 24% for all restaurant configurations.

The second category with the highest carbon footprint contribution is rice and beans, which accounts for 16%, 27% and 33% of the total carbon footprint of "Variable price buffet service", "Fixed price buffet/canteen service" and "Fixed price table service", respectively. In contrast with the meat category, the mass contribution of the rice and beans category is comparatively higher (29%, 45% and 52% respectively).

3.4. Consumeŕs attitudes and behaviour

There was an interesting situation when consumers were interviewed to understand the reasons that led them to leave leftovers on the plate in that specific situation. A significant number of respondents started the explanation by stating that usually they do not have leftovers on the plate and that moment was an exception.

After this statement, the consumers presented the justification. "Served too much food on the plate" was a justification that increased as consumers' incentive and level of autonomy decreased. This was the justification presented by 43% of consumers in the Variable price buffet service category (greater incentive and autonomy). In contrast, 86% of consumers in the category Fixed price table service (less incentive and autonomy) indicated this reason to their leftovers. The second most common justification presented by consumers was that they "Did not like the taste of some food". This justification was more frequent in the Variable price buffet service (greater incentive and autonomy) and decreased as incentive and autonomy decreased in the other categories. "Cold food" and "The meat was tough" appeared in third and fourth place with less prominence.

Fig. 5 shows the results of the most common justifications per restaurant category.

Finally, a common pattern observed in all restaurant configurations, with more than 90% of customers not asking for a 'doggy bag' to bring the leftovers. Two main justifications given are that: (a) they are at work and that it would not be convenient to carry food or it could interfere with food security, corresponding to 33% of total answers, and (b) that they have no interest to take home the type of food (staples food), corresponding to 67% of total answers.

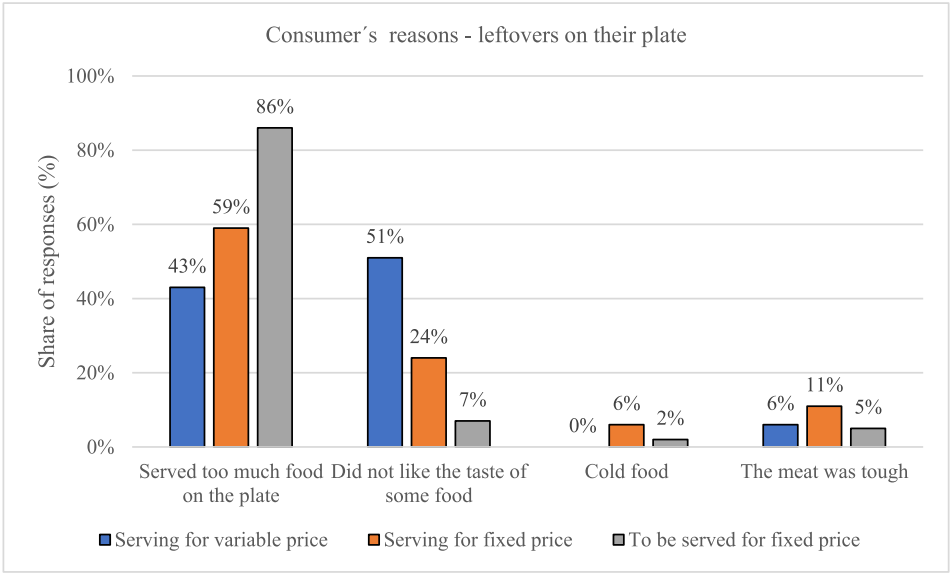

Fig. 5. Display of common justification given by consumers for plate waste generation in the investigated restaurant categories.

4. Discussion

Analysing food waste in different buffet configurations in Brazil shed some light in the gap pointed out by Eriksson et al. (2018a,b; 2012) to better understand waste patterns, and in the gap discussed by Xue et al. (2017) related to geographical and food supply chain coverage. This study identified that different incentive and level of autonomy in consumeŕs choice of food types exert influence on plate food waste. When incentive and autonomy are low (Fixed price table service), the amount of food waste is larger. It is the case of a la carte restaurants. Intermediate incentive and autonomy (Fixed price buffet/canteen service) showed intermediate levels of waste, which is the case of buffet fixed price (all you can eat) and canteens restaurants. High level of food waste in all you can eat configuration was also recognized by Ellison et al. (2019).

The best performance in the restaurant categories was when incentive and level of interaction are higher (Variable price buffet service). Buffet per kg restaurants, therefore, is the configuration that generates less food waste on a consumer's plate. When the customer pays for the amount of food they are serving and can look and smell the food before serving it, they tend to serve themselves smaller portions and generating less plate waste. Changing the restaurant to this kind of configuration is, therefore, a possible food waste intervention for restaurants with other configurations. This information related to which types of interventions are most effective in reducing food waste help to design alternatives along the food supply chain to reach the United Nations objectives and address the negative impacts related to food waste point out by Campoy-Muñoz et al., 2017; Eriksson et al., 2015; Papargyropoulou et al., 2014; Thyberg and Tonjes, 2016. Since restaurants exist in almost all parts of the world, the results should be possible to generalize to other places outside the Sao Paulo region. For example, Malefors et al. (2019) and Eriksson et al. (2019) have included several Scandinavian food services in research, and the plate waste reported is 64 g/plate for restaurants (usually serving a la carte). And, 44 g/plate for hotels (often serving buffet), very similar to the present study despite the geographical distance. However, since the "Variable price buffet service" is a fairly uncommon practice in Scandinavia, there is an obvious potential to reduce the plate waste significantly by introducing a "Variable price buffet service" configuration. Although incentives and interaction are both relevant, consumers seem to be more aware of the monetary incentives. The literature (Ellison et al., 2019; Thyberg and Tonjes, 2016) also recognizes that saving money is a key motivator for consumers to reduce food waste. However, the question of the level of interaction seems not to be recognized by consumers, based on the interviews conducted. Moreover, if only the monetary incentive were decisive for the amount of food waste generated, there would be the same level of food waste among all you can eat, canteen and a la carte restaurants. The results of this research indicate that the combination of monetary incentives and level of interaction can explain different levels of plate waste.

The literature on the topic also seems to overlook this issue, since the closest studies found by the authors, are related to nudge, such as the case of Bonell et al. (2011). No studies analysing such intervention in relation to interaction and food waste were found. Although no studies were found evaluating the level of interaction, there is considerable literature showing that portion size can affect food waste (see Freedman and Brochado, 2010; and Wansink and Van Ittersum, 2013). It is likely that both concepts are related. The observations from this study suggests that the level of interaction is reflected in the portion size, since we found that in restaurants with lower level of consumer interaction the portion sizes are bigger. Moreover, 86% of the consumers interviewed in this category attribute to the large size of portions the reason for their food waste.

Fig. 5 shows that 51% of the customers in the restaurants with higher incentive and level of interaction (Variable price buffet service category) stated "did not like the taste of some food" as the reason for the leftovers on their plate. In contrast, only 7% of the customers in the low incentive and autonomy restaurants (Fixed price table service category) indicated this reason to justify their leftovers. Analysing this data alone could lead to a misconception that looking/smelling is not crucial as an intervention to reduce food waste.

However, it is necessary to consider the findings presented in Fig. 5 combined, and not independently. The results from the interview indicates the amount of food served as the primary cause for food waste in the low incentive and autonomy group, both in quantitative and qualitative terms. This was the main reason

(86% of responses) attributed to consumers' plate waste. The taste of the food corresponded to only 7% of the answers, probably because we asked about the main reason. It is necessary to consider this information together with the responses that there was a factor related to the excess of food served on consumeŕs plate.

Secondly, it would also be expected a higher percentage of responses that "did not like the taste of some food" as the primary reason in the group with higher incentive and level of interaction, as these consumers are expected to serve the food in a quantity close to their consumption. Nevertheless, for the group with higher incentive and level of interaction "served to much food on the plate" appeared in second place as a reason to their plate food. Even with an attractive appearance and smell, the food can be rejected for not having the taste expected.

Finally, it is necessary to separate qualitative and quantitative findings. Even if the reason to all food avoidable waste measured in this study was attributed by consumers to "did not like the taste of some food", the quantity of the food waste generated by the group of low incentive and autonomy is 250% larger comparing to the higher incentive and level of interaction group.

Fig. 6 presents a scheme relating food waste in restaurant configurations:

Fig. 6 show that different incentives and levels of interaction in consumer's choice of food types exert influence on plate food waste. When incentive and interaction are low, the amount of food waste is larger. The best performance in the restaurant categories was when both incentive and level of interaction were higher.

The main result of the interviews showed that the food waste on the plate is not visible to consumers since in the majority of cases, they believe that their food waste on the plate in the day of the observation was an exception. Their behaviour is also not to recover the leftovers, using issues such as food security, transportation and that the food in most cases is staple food, as a justification for their choice. Our results are aligned with the findings from Sebbane and Costa (2018) concerning the discrepancy between stated and actual behaviour. It reflects on methodological questions since a series of studies are based on consumer perceptions and reports. This option may not indicate the reality of food waste and future studies need to take into account the importance of direct quantification and observation by researchers.

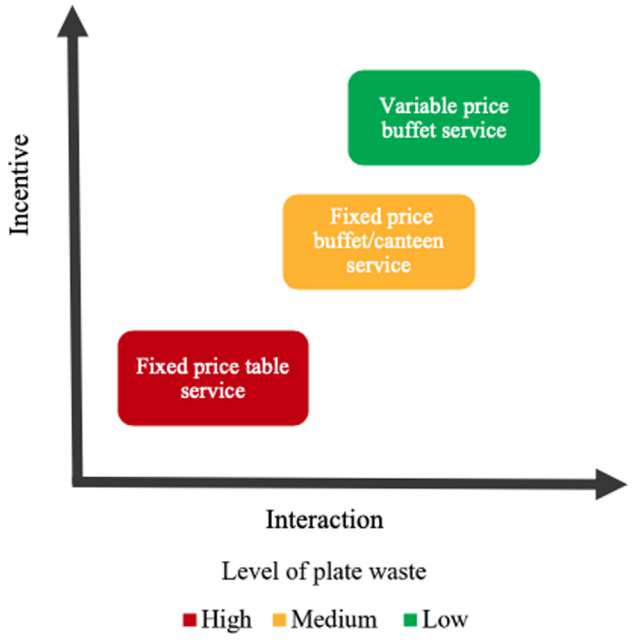

Fig. 6. Food waste according to different restaurant configurations.

In relation to the composition of consumer's food waste, this study analysed both total and avoidable food waste. This differentiation brings more data consistency, a need pointed out by Xue et al. (2017), since it is necessary to understand which fractions can be avoided to design food waste interventions that are more effective. The results found in Brazilian plate waste are lower comparing to previous studies analysing plate waste, even considering general or restaurants' categories, such as Wu et al. (2019) and Ellison et al. (2019). Eriksson et al. (2017) analysed kitchen and plate waste per portion served in public catering services and found an average of 75 g of food waste per guest served, from which 24.7 g (33%) are plate waste. This result is lower than our findings in the category 'Fixed price buffet/canteen service', which are 45.86 g total and 38.63 g avoidable food waste. However, it is important to notice that third parties made their measurement, and there was great variation between kitchens, with total kitchen food waste level ranging from 33 g to 131 g waste per portion served. They also identified differences between restaurants' profile, such as preschools with a lower waste level than schools, much due to the increased portion sizes for older children as reported by Steen et al. (2018). In the present study, restaurant consumers were older than students in school, which maybe might have influenced the level of their plate waste.

In all restaurants categories, the main wasted product is rice and beans, which are usually consumed mixed in Brazil. It is a staple and cheap food product. In a study conducted in China, Wu et al. (2019) also identified staple foods as the most wasted. The results are also consistent with findings from other studies (e.g. Brancoli et al., 2019; Eriksson et al., 2014) describing the correlation between the volume of sales and wasted mass, with the major part of the waste consisting of cheap food sold in large quantities. The volume changes accordingly with each restaurant category. Fixed price table service category look for the customer to be satisfied, since they put a very large quantity of rice and beans on trays, as it is possible to be seen in the photo shown in the results. However, more than half of the rice and beans in the trays end up being thrown away at this category. It is a waste of money and staff labour, beyond the environmental impact. At the buffet, this responsibility is passed on to the customer. As, he decides how much staple food is necessary, as well as the customer pays the cost according to consumption. Besides food waste reduction, offering more autonomy and incentives to customers allows a more adequate cost calculation, resulting in the possibility of offering meals at a more affordable price.

The second most wasted product is from the meat category: beef. It is also part of a dish consumed daily in the country, in addition to rice and beans. From an environmental perspective, this result is relevant, since according to Macdiarmid et al. (2016) it has a strong impact on sustainable diets because due to its high environmental impact. Beretta and Hellweg (2019) highlight the importance of the definition of which categories are most important to reduce food waste. However, it is necessary to take into account not only environmental factors but also economic and social conditions.

Finally, other carbohydrates are a food type which becomes more relevant in the extent to which autonomy and incentives are reduced, i.e., it increases in 'Fixed price buffet/canteen service' and more in the 'Fixed price table service' category. The reasons that lead to this difference were not the focus of this study, but one possibility to be investigated may be related to the amount served compared to the amount consumed, preferences for types of food, or even consumer preference for diets with reduced carbohydrates.

The results from the life cycle assessment indicate that measures aiming the reduction of meat, and rice and beans have the higher potential of decreasing the emission of greenhouse gases. These waste categories account for up to 70% of the climate impact. A simple and effective measure is to reduce the portion size in the a la carte restaurants (Fixed price table service category) and offer a free refill to compensate for the smaller portion sizes to ensure customer satisfaction. It and other preventive measures that increase consumers' incentive and interaction have large potential, especially to reduce the waste of the staple food.

The present study has investigated already existing restaurant configuration, and in some cases, it might not be feasible to change from one configuration to another. However, the results indicate that a shift to a "Variable price buffet service" could save 22–46 g/guest corresponding to 94–196 g CO_2eq./guest. The potential, of course, depending on the present configuration and level of plate waste. The main limitation of the LCA is the lack of country-specific inventory data and consequently the use of global datasets to model the food products wasted in Brazil. Although, this might exert some influence in the results, the hotspots analysis indicates two categories, namely meat, and rice and beans, which are responsible for more than 70% of the greenhouse gasses emissions, indicating that the conclusions are robust for variations in the inventory.

A limitation of this study is that it evaluated a few restaurant units within the same type of restaurant category and that no part of the data collection was random, allowing some inferences to be made about differences among the three types of food services. It was important to allow observation and in-depth assessment of each restaurant. However, future studies could quantitatively explore these different categories to validate the results found, also assessing issues of gender, age, education and income. Studies in other contexts would also add new information. Different types of incentives can be evaluated, such as monetary, plate size (diameter), location, configuration, campaigns, menu information, rewards, etc. Some 'all you can eat' restaurants (Fixed price buffet/-canteen service category) have a fee charged if food is wasted. This is an empirical observation, verified in a few situations in Brazil, in more popular restaurants for which no literature has been found. The waiter observes if there is too much leftover on the consumer's plate. If so, an additional fee is charged (for example, 25% of the total meal value). Future studies could make comparisons between restaurants that do not charge and restaurants that charge the fee to test the effectiveness of this type of intervention. It could be assessed whether, in the case of the waste rate, the level of food waste is close to buffet per kg restaurants (Variable price buffet service). It would also be interesting to make comparisons between the level of waste indicated by consumers and the one measured by researchers. In our findings, we found evidence that when dessert is free, there is an increase in food waste. Future studies could test interventions with free and paid desert and measure the levels of waste in the consumer's plate.

Different demographics for the different services could influence consumeŕs food waste and the reasons for it. Future studies could also explore demographic differences within different incentives and levels of autonomy. It also should be noted that that food preparation waste could vary by type of services, both in food preparation and in possible leftover food at the end of the day. Future studies can assess food waste for both the consumer and the restaurant's service flow, providing a broader view of the issue.

Finally, the possibilities for developing low-cost, low-effort awareness campaigns could be investigated, which can be maintained continuously, since the effects occur relatively faster in comparison with other interventions. This gives the impression that measuring results of interventions only in the immediate moment can give a wrong picture of effectiveness. It is suggested that intervention studies evaluate before, immediately and in long term time after the intervention.

5. Conclusions

Due to the high level of detail in the present case study, it is clear that different restaurant configuration has an influence over the plate waste generation, with a decreased mass of plate waste when incentives and interactions were higher for the consumers. The Variable price buffet service, which has the highest level of interaction with consumers, since they served themselves and, the highest level of an incentive since consumers paid by weight, resulted in a plate waste of 23.9 g/plate. This was lower than the other configurations that generated 45.8 g/plate (Fixed price buffet/canteen service) and 69.8 g/plate (Fixed price table service). The carbon footprint followed the same pattern as the mass of plate waste generated for the different restaurant settings, but since it was, mainly staple food with lower carbon footprint added when the waste increased the differences was smaller in comparison with the mass of the waste. From the interviews, it is clear that the consumers that are served by the staff, to a higher extent, waste food due to a portion that is too large. This is well supported by the waste quantification and indicates that there is a large potential to reduce food waste by creating incentives for consumers to only serve as much food as they want, and to give the consumers the possibility to influence the serving.

Funding

The study received funding from CLIFF-GRADS scholarships for short-term scientific training and research stays on mitigation of greenhouse gas emissions from reduced food loss and waste. CLIFF-GRADS is a joint initiative of the CGIAR Research Program on Climate Change (CCAFS) low emissions development flagship and the Global Research Alliance on Agricultural Greenhouse Gases (GRA). The study was also found through the project "Adding value in resource effective food systems" (AVARE), financed by the Swedish Research Council for Sustainable Development (FORMAS). The funding organizations took no part in the execution of the study or the interpretation of the results. The authors wish to express their gratitude to restaurant staff and guests for participating in the study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.wasman.2020.07.014.

References

Beretta, C., Hellweg, S., 2019. Potential environmental benefits from food waste prevention in the food service sector. Resour. Conserv. Recycl. 147, 169–178.
Bezerra, I.N., Sichieri, R., 2010. Características e gastos com alimentação fora do domicílio no Brasil. Revista de Saúde pública 44 (2), 221–229.
Björklund, A. 1998. Environmental systems analysis of waste management, with emphasis on substance flows and environmental impact.
Bonell, C., McKee, M., Fletcher, A., Wilkinson, P., Haines, A. 2011. One nudge forward, two steps back.
Brancoli, P., Rousta, K., Bolton, K., 2017. Life cycle assessment of supermarket food waste. Resour. Conserv. Recycl. 118, 39–46.

Brancoli, P., Lundin, M., Bolton, K., Eriksson, M., 2019. Bread loss rates in supplier-retailer interface – analysis of risk factors as support for waste prevention measures. Recour. Conserv. Recycl. 147, 128–136.
Campoy-Muñoz, P., Cardenete, M.A., Delgado, M.C., 2017. Economic impact assessment of food waste reduction on European countries through social accounting matrices. Resour. Conserv. Recycl. 122, 202–209.
Capps, O., Ishdorj, A., Murano, P.S., Field, L., Hutto, A., Storey, M., 2019. Waste Not Want Not. Choices 34 (1), 1–8.
Durlinger, B., Tyszler, M., Scholten, J., Broekema, R., Blonk, H., Beatrixstraat, G. 2014, October. Agri-Footprint; a Life Cycle Inventory database covering food and feed production and processing. In: Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector, vol. 2009, pp. 310–317.
Ellison, B., Savchenko, O., Nikolaus, C.J., Duff, B.R., 2019. Every plate counts: Evaluation of a food waste reduction campaign in a university dining hall. Resour. Conserv. Recycl. 144, 276–284.
Eriksson, M., Osowski, C.P., Björkman, J., Hansson, E., Malefors, C., Eriksson, E., Ghosh, R., 2018a. The tree structure—A general framework for food waste quantification in food services. Resour. Conserv. Recycl. 130, 140–151.
Eriksson, M., Malefors, C., Bergström, P., Eriksson, E., Persson Osowski, C., 2020. Quantities and quantification methodologies of food waste in Swedish hospitals. Sustainability 12, 3116.
Eriksson, M., Lindgren, S., Osowski, C.P., 2018b. Mapping of food waste quantification methodologies in the food services of Swedish municipalities. Resour. Conserv. Recycl. 137, 191–199.
Eriksson, M., Osowski, C.P., Malefors, C., Björkman, J., Eriksson, E., 2017. Quantification of food waste in public catering services–A case study from a Swedish municipality. Waste Manage. 61, 415–422.
Eriksson, M., Malefors, C., Callewaert, P., Hartikainen, H., Pietiäinen, O., Strid, I., 2019. What gets measured gets managed, Or does it? – Connection between hospitality sector food waste quantification and reduction. Recour. Conserv. Recycl.: X 4, 100021.
Eriksson, M., Strid, I., Hansson, P.A., 2012. Food losses in six Swedish retail stores: Wastage of fruit and vegetables in relation to quantities delivered. Resour. Conserv. Recycl. 68, 14–20.
Eriksson, M., Strid, I., Hansson, P.-A., 2014. Waste of organic and conventional meat and dairy products: A case study from Swedish retail. Recour. Conserv. Recycl. 83, 44–52.
Eriksson, M., Strid, I., Hansson, P.-A., 2015. Carbon footprint of food waste management options in the waste hierarchy – a Swedish case study. J. Cleaner Prod. 93, 115–125.
FAO - Food and Agriculture Organization of the United Nations, 2019. Committee on World Food Security. Making a difference in food security and nutrition. Available at: http://www.fao.org/cfs/home/about/en/ Retrieved in May, 2020.
FAO. Potato world: production and consumption, 2008. Available from: http://www.fao.org/potato-2008/en/world.
Freedman, M.R., Brochado, C., 2010. Reducing portion size reduces food intake and plate waste. Obesity 18 (9), 1864–1866.
Gilbert, C.L., Morgan, C.W., 2010. Food price volatility. Philosoph. Trans. Roy. Soc. B: Biolog. Sci. 365 (1554), 3023–3034.
Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., Meybeck, A. 2011. Global food losses and food waste. Extent, causes and prevention. SwedishInstitute for Food and Biotechnology (SIK), Box 5401, 40229 Gothenburg (Sweden) and FAO, Viale delle Terme di Caracalla, 00153 Rome (Italy).
Karlsson, J.O., Carlsson, G., Lindberg, M., Sjunnestrand, T., Röös, E., 2018. Designing a future food vision for the Nordics through a participatory modeling approach. Agron. Sustainable Dev. 38 (6), 59.
Leal, D., 2010. Crescimento da alimentação fora do domicílio. Segurança Alimentar e Nutricional 17 (1), 123–132.
Malefors, C., Callewaert, P., Hansson, P.-A., Hartikainen, H., Pietiäinen, O., Strid, I., Strotmann, C., Eriksson, M., 2019. Towards a baseline for food waste quantification in the hospitality sector - quantities and data processing criteria. Sustainability 11, 3541.
Macdiarmid, J.I., Douglas, F., Campbell, J., 2016. Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. Appetite 96, 487–493.
Muth, M.K., Birney, C., Cuéllar, A., Finn, S.M., Freeman, M., Galloway, J.N., Meyer, E., 2019. A systems approach to assessing environmental and economic effects of food loss and waste interventions in the United States. Sci. Total Environ.
Nilsson, H. 2013. Integrating Sustainability in the Food Supply Chain: Two Measures to Reduce the Food Wastage in a Swedish Retail Store.
Papargyropoulou, E., Lozano, R., Steinberger, J.K., Wright, N., Bin Ujang, Z., 2014. The food waste hierarchy as a framework for the management of food surplus and food waste. J. Cleaner Prod. 76, 106–115.
Ravandi, B., Jovanovic, N., 2019. Impact of plate size on food waste: Agent-based simulation of food consumption. Resour. Conserv. Recycl. 149, 550–565.
Rolls, B.J., Morris, E.L., Roe, L.S., 2002. Portion size of food affects energy intake in normal-weight and overweight men and women. Am. J. Clin. Nutrit. 76 (6), 1207–1213.
Scholz, K., Eriksson, M., Strid, I., 2015. Carbon footprint of supermarket food waste. Recour. Conserv. Recycl. 94, 56–65.
Sebbane, M., Costa, S., 2018 Sep. Food leftovers in workplace cafeterias: An exploratory analysis of stated behavior and actual behavior. Resour. Conserv. Recycl. 1 (136), 88–94.
Silvennoinen, K., Heikkilä, L., Katajajuuri, J.M., Reinikainen, A., 2015. Food waste volume and origin: Case studies in the Finnish food service sector. Waste Manage. 46, 140–145.
Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B.L., Lassaletta, L., deVries, W., Vermeulen, S.J., Herrero, M., Carlson, K.M., Jonell, M., Troell, M., DeClerck, F., Gordon, L.J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., Godfray, H.C.J., Tilman, D., Rockström, J., Willett, W., 2018. Options for keeping the food systemwithin environmental limits. Nature 562, 519–525.
Steen, H., Malefors, C., Röös, E., Eriksson, M., 2018. Identification and modelling of risk factors for food waste generation in school and pre-school catering units. Waste Manage. 77, 172–184.
Steenhuis, I.H., Vermeer, W.M., 2009. Portion size: review and framework for interventions. Int. J. Behav. Nutrit. Phys. Activity 6 (1), 58.
Stöckli, S., Niklaus, E., Dorn, M., 2018. Call for testing interventions to prevent consumer food waste. Resour. Conserv. Recycl. 136, 445–462.
Thaler, R., Sunstein, C., 2008. Nudge: Improving Decisions about Health, Wealth, and Happiness. Yale University Press, Yale CN.
Thyberg, K.L., Tonjes, D.J., 2016. Drivers of food waste and their implications for sustainable policy development. Resour. Conserv. Recycl. 106, 110–123.
Tonini, D., Albizzati, P.F., Astrup, T.F., 2018. Environmental impacts of food waste: Learnings and challenges from a case study on UK. Waste Manage. 76, 744–766.
UN, 2015. Sustainable development goals. [Online]. Available: https://www.un.org/sustainabledevelopment/sustainable-consumption-production/.
Wang, L.E., Liu, G., Liu, X., Liu, Y., Gao, J., Zhou, B., Cheng, S., 2017. The weight of unfinished plate: A survey based characterization of restaurant food waste in Chinese cities. Waste Manage. 66, 3–12.
Wansink, B., Van Ittersum, K., 2013. Portion size me: Plate-size induced consumption norms and win-win solutions for reducing food intake and waste. J. Expe. Psychol.: Appl. 19 (4), 320.
Weidema, B.P., Bauer, C., Hischier, R., Mutel, C., Nemecek, T., Reinhard, J., et al. 2013. Overview and methodology: Data quality guideline for the ecoinvent database version 3.
Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Murray, C.J.L., 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets fromsustainable food systems. Lancet 393 (10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4.
World Resources Institute, 2016. Food Loss and Waste Accounting and Reporting Standard.
Wu, Y., Tian, X., Li, X., Yuan, H., Liu, G., 2019. Characteristics, influencing factors, and environmental effects of plate waste at university canteens in Beijing, China. Resour. Conserv. Recycl. 149, 151–159.
Xue, L., Liu, G., Parfitt, J., Liu, X., Van Herpen, E., Stenmarck, Å., Cheng, S., 2017. Missing food, missing data? A critical review of global food losses and food waste data. Environ. Sci. Technol. 51 (12), 6618–6633.
Zaheer, K., Akhtar, M.H., 2016. Potato production, usage, and nutrition—a review. Crit. Rev. Food Sci. Nutr. 56 (5), 711–721.