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Exploring the economic and environmental effects of food waste in Uruguayan households

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Abstract: *Food-waste reduction could provide significant benefits in the transition towards more sustainable agri-food systems. Households account for a significant share of total food waste, both in emerging and industrialized countries. In Latin America and the Caribbean region, lack of data has been acknowledged. The present study explores household food waste in Uruguay, an emerging country, through food-waste diaries. Data from 142 households provided an estimate of food-waste quantity and composition comparable to those reported in developed countries. The economic value of food wasted monthly represented 11 per cent of the average per capita food expenditure. In terms of environmental impact, the average carbon footprint of household food waste was 0.15 tonnes of CO_2 per person per year. These results highlight the need to develop communication campaigns and interventions to raise awareness of the multiple impacts of household food waste in Uruguay.*

Keywords: household food waste; quantification, diaries, environmental impact, economic value

Introduction

Reducing food waste is a global challenge that needs to be overcome in the transition towards inclusive and sustainable food systems (Swinburn, 2019; Keck, 2021; UNEP, 2021). This transition demands changes in production, consumption, trade, and governance (Ruben et al., 2021). The Food and Agriculture Organization (FAO) has estimated that around one-third of food produced globally is lost or wasted every year (Gustavsson et al., 2011). The socioeconomic and environmental impact associated with food waste turns the issue into a sustainability problem of

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considerable dimensions (Foley et al., 2011; Garnett, 2014; Principato et al., 2019). Food-waste reduction has the potential to improve food security, reduce pressure on natural resources (including water, land, and energy), and mitigate adverse environmental impacts (Kummu et al., 2012; Eriksson et al., 2014; Buonocore et al., 2018; Skaf et al., 2019). In this sense, achieving food-waste reduction could be considered a stepping-stone towards sustainable consumption (Evans et al., 2017).

Food is lost or wasted along different steps of the food supply chain; however, several studies have pointed out that the retail supply chain and households have the largest share of waste (Parfitt et al., 2010; Stenmarck et al., 2016; Alexander et al., 2017). The first Food Waste Index report of the United Nations Environment Programme (UNEP) estimates that food waste from households, retail, and the food-service sector amounts to 931 million tonnes each year, of which roughly 60 per cent originates at the household level (UNEP, 2021). Focusing on household waste streams becomes particularly relevant considering that the later in the supply chain a product is wasted, the greater its environmental and economic impacts. Resources invested cumulate along the food pathway, from early stages (production, processing, distribution) to household waste (Scherhaufer et al., 2018; Muth et al., 2019). Taking action to reduce food waste in the last stages will help to reduce adverse impacts upstream as well (Read et al., 2020). In terms of climate change, food lost or wasted generates about 8 per cent of the total anthropogenic gas emissions (EC, JRC/PBL, 2012). According to the FAO (2013), the highest carbon footprint of wastage occurs at the consumption phase (37 per cent of the total). Food loss and waste entails the direct or indirect loss of resources used along the food supply chain.

Earlier research has pointed out differences in food-waste distribution along the food supply chain between emerging and industrialized countries, identifying the first stages of the food supply chain (agricultural production, post-harvest activities, processing, and manufacturing) as main contributors to food waste in the former, whereas the last stages (retail, food service, and consumption) have the highest share in the latter (Gustavsson et al., 2011; Stenmarck et al., 2016). However, recent estimates for household food waste (UNEP, 2021) that take into account the existing limitations on robust data available in some regions paint a different portrait. According to UNEP (2021), there is no evidence of different levels of per capita food waste for high-income, upper middle-income, and lower middle-income countries (there is insufficient data for low-income countries). Dou and Toth (2021) analysed consumer food waste primary data published globally that included a small number of studies (six out of 332) from South America. Their findings also suggested no correlation between household food waste and per capita gross national income (GNI).

Several studies have acknowledged the existing data gap in Latin America and the Caribbean region regarding food waste (Porpino, 2016; Xue et al., 2017; Cattaneo et al., 2021) along with the need to establish a baseline through reliable measurement tools as a stepping-stone towards UN Sustainable Development Goal 12.3, i.e. halving food waste and reducing food loss by 2030. Scarce data has been identified for household food waste for four countries in the region: Belize, Brazil, Colombia, and Mexico (UNEP, 2021).

The present study focuses on household food waste in Uruguay. Uruguay is characterized as an emerging high-income level country in the Latin American region, with a high degree of urbanization, a high human development index (World Bank, 2022), and westernized diets, all of which have been associated with high levels of consumer food waste (Thyberg and Tonjes, 2016). Thus, household food waste is expected to be a significant issue in the country. Insights on consumers' perception of household food waste have been gathered through several studies (Aschemann-Witzel et al., 2019, 2020; Ferro et al., 2022). However, quantification efforts are incipient. In order to address the issue at a national level, in the context of resource constraints, food-waste policy-making and interventions should rely on robust data, prioritizing efforts on those sectors with the highest impact (Cattaneo et al., 2021).

Food-waste diaries along with waste compositional analysis are considered valuable tools for measuring and tracking progress against targets (Food Loss and Waste (FLW) Protocol, 2016; van Herpen et al., 2016; Commission for Environmental Cooperation (CEC), 2019). Even though evidence in the literature (Høj, 2011; van Herpen, van der Lans et al., 2019; Quested et al., 2020) suggests that the former underestimates household food waste, it allows quantification of all disposal routes and provides useful insights as to the reasons for wasting food. An increased understanding of the underlying factors driving food waste could support the development of policies, campaigns, and interventions tailored to different target groups. Furthermore, the data collected allows other calculations to be performed, such as estimating the environmental impact and the financial cost associated with household food waste.

The food-waste issue has received limited attention in the public agenda in Uruguay. The present study seeks to provide evidence on the multiple dimensions of household food waste through the use of food-waste diaries. Raising awareness of the dimensions of food waste and the social, economic, and environmental impact at the household level could help position the issue at a societal level. The findings can contribute to supporting future public waste-prevention campaigns and other interventions aimed at tackling the issue, both at the national and regional level.

Materials and methods

Participant recruitment and sample

Recruitment took place through Facebook and Instagram adverts targeted at adult Uruguayan users (aged 18 years or older), posted by the institutional Facebook account of the research group authoring the study. Those who were interested in participating were redirected to an online questionnaire where they were asked to provide their contact information if they were interested in keeping a record of the food they threw away at home during a one-week period. From a total of 530 participants, 232 participants indicated their interest in completing the food-waste diary.

Quotas for region of residence (capital city vs. rest of the country), household size, and the presence of children in the household were set to represent the distribution

Table 1 Participants' sociodemographic characteristics (n = 142)

Variable	*Sample description*
Region	50% Montevideo, 50% rest of the country
Socioeconomic status	Low: 9%, medium: 49%, high: 42%
Household size	16% single, 41% two-person, 43% three or more people
Children in household	30% yes, 70% no

of the Uruguayan population according to these characteristics. The final sample consisted of 159 participants, of which 142 completed the task (Table 1). Consumers with high socioeconomic status were overrepresented whereas those with low socioeconomic status were underrepresented.

Food-waste diary

The food diary distributed for data collection was based on the food diary designed by the Waste and Resources Action Programme (WRAP, 2012). Participants were asked to record the food they discarded at their homes over a seven-day period. They provided a detailed description of the type and quantity of food discarded, the reasons why, and the discard route (waste bin, organic waste bin, kitchen sink, home compost, fed to animals). Diaries were sent via mail along with a set of measuring cups that participants could use to measure the quantity discarded (optional). Upon completion, participants were given the chance to win vouchers worth US$100. Data collection took place in October and November 2020.

Data analysis

Diary data regarding items discarded were first coded into food categories, assigning items to one or more product categories, adapted from the codes proposed by van Herpen, van Geffen et al. (2019). In the case of complete meals, the main ingredients were assigned separately to the corresponding category. Reported food waste amounts were converted into weight estimates in grams, as recommended by van Herpen et al. (2016). Considering that reported amounts of food waste differed across participants and product categories (spoons, handful, slices, pieces), a reference table with the standard weight of products reported in different units to those on the list was generated.

For each household, the amount of food per category wasted in total and for each of the food categories was calculated by adding up the weight of the individual discarded items. The total amount of food waste was expressed per person by dividing household food waste by the number of people in the household. A descriptive analysis of the dataset was carried out. Average and median amounts of food waste per household per week and per capita per week were estimated.

The contribution of different food categories to household food waste and the contribution of food waste to the different disposal routes were calculated for each household. The percentage of the amount of food wasted corresponding to each category or disposed of through different routes for each household was calculated. Data were summarized using average percentages.

Reasons for wasting food were coded by the authors using content analysis based on inductive coding (Krippendorf, 2004). Responses were grouped into categories and the frequency of mention of each category and the average contribution to the total amount of food wasted by the households were calculated. Quotes for the identified reasons were selected for illustrative purposes and translated into English.

A t-test was used to evaluate the existence of differences in the amount of food wasted (expressed as a logarithm) and the percentual contribution of food categories and reasons for food waste between households with high and low/medium socioeconomic status. A 95% confidence level was considered.

In order to estimate the economic value of food waste, the retail price of each wasted food item (expressed in US dollars) in December 2020 was considered based on national data (Instituto Nacional de Estadística (INE), 2021; Ministerio de Economía y Finanzas (MEF), 2021; Unidad Agroalimentaria Metropolitana (UAM), 2021). The total economic value of household food waste was calculated as the sum of the retail price of each wasted food item, divided by the number of people in the household. The contribution of each food category to the economic value of food waste, expressed as a percentage, was calculated for each household.

The environmental impact of food waste was assessed in terms of three environmental indicators: carbon (g CO_2 eq.), water (litres), and ecological footprints (gm^2). The environmental database compiled with these indicators for foods and culinary preparations consumed in Brazil was used for calculations (Garzillo et al., 2019). The first and second indicators, related to greenhouse gas emissions and the use of water, respectively, were calculated within the International Organization for Standardization (ISO) 14044 life cycle assessment framework (2006), whereas the third indicator was an aggregate index generated from the Global Footprint Network (n.d.) methodology. For each household, the carbon, water, and ecological footprint of food waste was estimated as the sum of the footprints of each discarded item, divided by the number of people in the household. The contribution of each food category to the carbon, water, and ecological footprint was calculated for each household and summarized as average values.

Results

Households wasted between 210 g and 11,994 g of food per week, indicating a large variation in food-waste generation rates across households. The distribution of household food waste was left-skewed (Figure 1). The distribution of household food waste per capita per week was also left-skewed (not shown), resulting in an average value (1,045 g) markedly higher than the median (724 g). The average amount of food wasted by households corresponded to 54.3 kg per person per year whereas the median corresponded to 37.6 kg per person per year.

One-person households had a higher household food waste per capita per week than households composed of two or more people (1,968 g vs. 876 g). Regarding socioeconomic status, the amount of food wasted by households with a high socioeconomic status did not significantly differ from those with a low/medium socioeconomic status ($p = 0.675$).

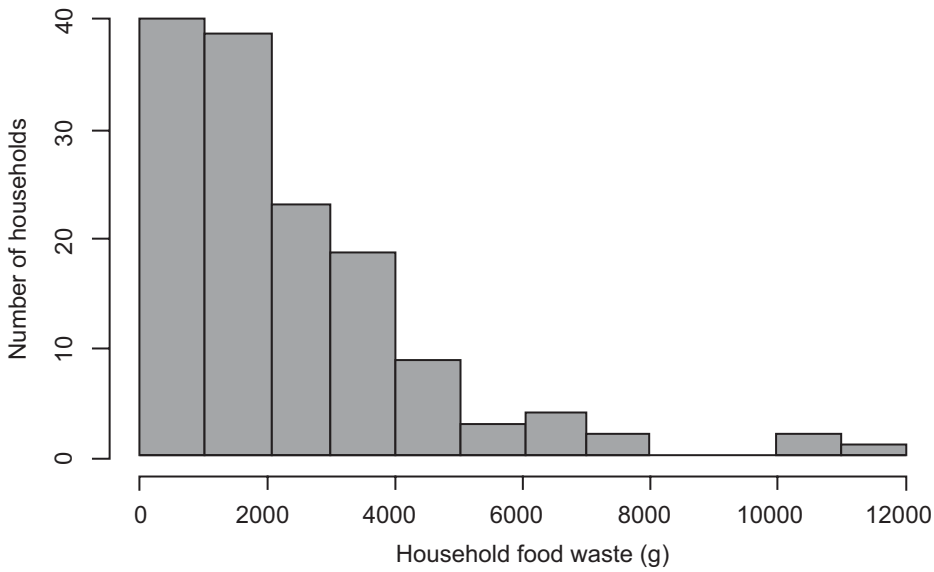

Figure 1 Distribution of weekly food waste generated by households (n = 142)

The most important disposal route of food waste for the households was the waste bin, which accounted for an average of 41.8% (weight by weight (w/w)) of the total food waste. The organic waste bin accounted for 12.1% (w/w). In addition, 16.8% (w/w) of food wasted by the households was discarded into the sewer, whereas 17.2% and 12.1% (w/w) was used as animal feed or for home composting, respectively.

Composition of household food waste

The composition of household food waste was analysed at the level of specific categories (Table 2). Fresh vegetables and fruit were the main categories disposed of, both in terms of percentage of households reporting disposal and quantity wasted per person per week. As shown in Table 2, fresh vegetables and fruit accounted for an average of 26.3% and 15.9% of the total amount of food wasted, respectively. Bread, rice, bakery products, meat, and milk also represented food categories frequently disposed of, being disposed of by more than 50% of the participating households and accounting for an average of 4.4% to 6.9% of the total household food waste (Table 2).

Socioeconomic status significantly influenced the contribution of three categories to the total amount of food wasted by households. The average contribution of fresh fruit and cheese to food waste was significantly larger (p = 0.030 and p = 0.031, respectively) in households with high socioeconomic status compared to those with low/medium socioeconomic status (19.5% vs. 13.2% and 1.5% vs. 0.4%, respectively). The opposite trend was found for pasta, which had a significantly (p = 0.005) higher contribution to the food wasted by households with a low/medium socioeconomic status (4.7% vs. 1.8%).

Table 2 Composition of household food waste by food category

Category	*Percentage of households reporting disposal of foods within the category (%)*	*Average quantity wasted per person per week (g)*	*Average percentage of the total amount of food wasted by the households (%)*
Fresh vegetables	94.4	256.8	26.3
Fresh fruit	83.9	178.9	15.9
Bread	67.1	52.5	5.5
Rice	65.0	54.4	6.1
Bakery products	62.9	50.7	4.9
Meat	58.0	58.9	4.4
Milk	51.0	111.8	6.5
Pasta	44.8	37.6	3.5
Non-alcoholic and alcoholic beverages	44.8	50.8	4.8
Coffee or tea	44.1	46.7	4.3
Eggs	36.4	14.2	1.3
Cookies, cereal bars, chocolate, and sweets	32.9	15.8	1.4
Non-fresh vegetables	30.8	18.1	1.6
Potatoes	30.1	26.7	2.2
Potato products (e.g. fries, chips, precooked potatoes)	28.7	11.9	1.2
Yogurts and custards	28.7	27.9	1.7
Bread toppings (e.g. cold meat slices, jam, marmalade, cream cheese)	28.0	10.5	0.9
Cheese	27.3	8.9	0.9
Soups and sauces	27.3	35.7	2.6
Legumes (e.g. lentils, beans, chickpeas)	21.0	12.8	1.3
Fish	21.0	12.4	0.8
Oil, butter, spices, and salt	16.8	7.1	0.8
Cereals (muesli, granola, oat)	14.0	3.7	0.4
Savoury snacks	7.7	1.1	0.1
Other (non-fresh fruit, meat substitutes)	3.5	5.0	0.5

Reasons underlying household food waste

Reasons underlying household food waste were explored using an open-ended question for each food item listed as disposed in the food diary. Food spoilage during storage was the most frequently given reason for disposing of food for the participating households, accounting for 46.4% of the total amount of food wasted (Table 3). The average contribution of two categories to food waste significantly differed between households with high and low/medium socioeconomic status. Regarding parts of foods as inedible had a higher contribution to food waste in households with a high socioeconomic status (14.8% vs. 7.4%, $p = 0.033$), whereas the opposite trend was found for animal feeding (0.0% vs 2.4%, $p = 0.040$).

Participants stated that they discarded fresh foods, processed products, and leftovers from culinary preparations because they perceived them to be spoilt or expired. Most of them referred to perceivable sensory characteristics of spoilt products (e.g. appearance, odour), whereas a minority referred to storage time or expiration date. This reason was one of the most frequently given for all food categories (Figure 2) but had the highest contribution for disposal of fresh fruit (60%), non-fresh vegetables (54%), cheese (63%), soups and sauces (53%), fresh vegetables (43%), bread (46%), and bread toppings (44%).

Quantity-related problems and hedonic-related reasons shared a similar contribution to food waste. As shown in Table 3, quantity-related problems during food preparation or serving accounted for 9.2% and 9.6% of all food waste, respectively. The contribution of quantity-related reasons varied greatly across food categories. Preparing or serving too much food had a higher contribution to food waste for categories consumed as a side dish (e.g. rice (52%), potato products (63%), potatoes (38%)), pasta (52%), meat (40%), and beverages (coffee and tea (40%), milk (32%), alcoholic and non-alcoholic beverages (31%)) (Figure 2).

Meanwhile, hedonic-related reasons for food disposal were responsible for an average of 19% of the total amount of food wasted. Regarding food parts as inedible or inappropriate for a specific preparation emerged as a relevant reason for disposing of food, particularly fresh fruit and vegetables (Figure 2). Participants stated that they regarded some parts of fruits and vegetables (e.g. fruit skins, chard stems, beetroot leaves) as inedible. In the case of fruit and vegetable skins and peels, some participants mentioned pesticides as one of the motives underlying their decision to discard them. This reason accounted for 18.8%, 18.7%, and 14.7% of the total amount of fresh fruit, potatoes, and fresh vegetables disposed of by the households. Rejection of specific parts of foods also emerged for other food categories, such as bread crusts, meat fat, and chicken skins. In other categories, participants also discarded parts of foods they regarded as inedible in the context of a specific food preparation. For example, they mentioned discarding fruit pulp after preparing juice or flavoured water or throwing away spices used for preparing tomato sauce (e.g. bay leaves). In addition, disliking specific foods or being unwilling to eat/drink them contributed to an average of 8.5% of the total food waste. Quality-related problems also emerged as a reason for food disposal, contributing to 6.7% of the total amount of food waste.

Table 3 Reasons for wasting food in the participating households (n = 142)

Reason	*Examples of quotes*	*Frequency of mention (%)*	*Average contribution to household food waste (%)*
Spoilt/expired during storage	'They [carrots] were hidden in the refrigerator drawer and weren't good to eat', 'It was stored for too long in the fridge [tomato sauce]', 'Too many days in the fridge. The smell was disgusting and I didn't want to eat it [lentil stew]', 'It expired [milk]'	31.7%	46.4%
Served too much	'I served myself too much and as it wasn't much I didn't keep it [rice with vegetables]', 'We served too much on the plates [chicken dish]'	15.5%	9.2%
Cooked/prepared too much	'I cooked too much [leek]', 'Leftovers of seasoned salad', 'I miscalculated the portions, visitors came and there was leftover [rice]'	11.7%	9.6%
Regarded as inedible	'We don't eat that part [leaves of beetroot]', 'I peel them [tomatoes] for preparing salad', 'We don't eat the peel and skin of fruits and vegetables. We throw them away because they may have pesticides [carrot]'	11.6%	10.5%
Dislike/unwilling to eat	'My son didn't like it [bell pepper]', 'It got cold [tea]', 'I bought a new brand ... Disgusting flavour, smell, and appearance [Bouillon cube]', 'We didn't want to drink more [coconut milk]'	9.5%	8.5%
Accident	'It fell on the floor while serving [grated carrot]', 'It fell in the sink [onion]', 'It was burnt [egg]'	7.6%	6.1%
Bad quality	'When cutting [onion], the centre was rotten', 'It was soft [tomato]', 'No gas [carbonated beverage]', 'Too hard [meat]'	5.7%	6.7%

(Continued)

Table 3 Continued

Reason	*Examples of quotes*	*Frequency of mention (%)*	*Average contribution to household food waste (%)*
Small leftovers from food preparation or package	'Breadcrumbs [bread]', 'What is left in the package [yogurt]', 'Oil left at the bottom of bowl full of salad'	4.4%	1.5%
Animal feeding and other non-food uses	'We shared with the dogs [beef stew]', 'I used it to water the plants [sparkling mineral water]'	2.4%	1.6%

Participants reported throwing away foods when finding specific defects at the time of food preparation (Table 3). As shown in Figure 2, this category was particularly relevant for fresh vegetables (15%) and fresh fruit (14%).

Accidents during food preparation or serving were the sixth most frequent reason for food disposal, accounting for 6.1% of the total amount of food wasted by the households (Table 3). This category had the largest contribution for disposal of savoury snacks (50%) and the second largest for bakery products (23%). Other reasons, such as small leftovers from food preparation or packages and animal feeding, played a minor role in the disposal of the foods recorded in the food diary (Table 3). As shown in Figure 2, leftovers from packages were more relevant for some specific categories, such as those that were easily broken (e.g. crackers, bakery products) or viscous foods (e.g. yogurts, oil), accounting for 13% to 19% of the total amount of food wasted.

Economic value of household food waste

The economic value of the food wasted by households ranged between US$0.4 and US$233.3 per week, which corresponded to an average of US$25.5 per household per week and a median of US$6.6 per household per week. When expressing the economic value per person, results showed that the amount of food wasted in the households corresponded to an average of US$11.3 per person per week and a median of US$3.0 per person per week. This is equivalent to a median of US$2.0 per person per month or US$143.6 per person per year. The average monthly value of the food wasted by the households per person corresponded to 45.5% of the value of the basic food basket used to evaluate poverty in Montevideo, the capital city of Uruguay, in December 2020 (US$98.7 per person per month). No significant differences in the economic value of household food waste were found between households with a high and low/medium socioeconomic status ($p = 0.223$).

Table 4 shows the distribution of the economic value of food waste in the participating households per food category. As shown, fresh vegetables and fruit had the highest contribution, in agreement with their relevance in terms of frequency and quantity. Bread, meat, and bakery products were also relevant categories in terms of economic impact, comprising 7.6%, 7.3%, and 7.5% of the economic impact

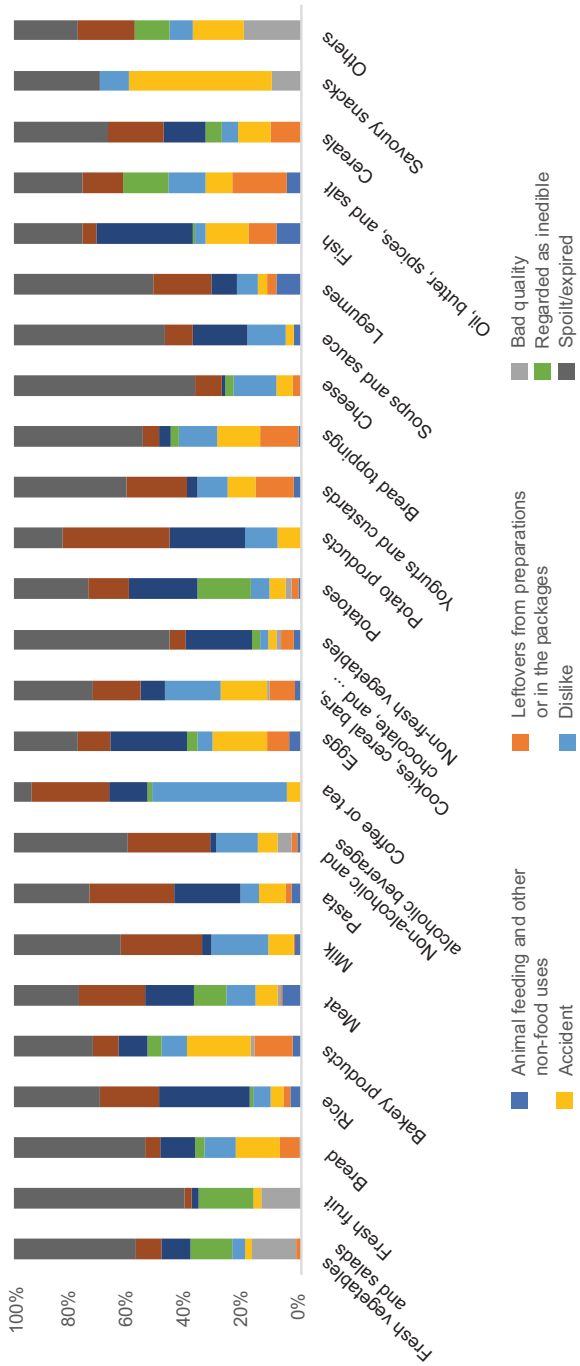

Figure 2 Contribution of the identified reasons for food waste to the amount of food disposed per category

Table 4 Average percentage of the economic value of food waste per food category

Category	*Average contribution to the economic value of food waste (%)*
Fresh vegetables	29.5
Fresh fruit	10.8
Bread	7.6
Rice	2.2
Bakery products	7.3
Meat	7.5
Milk	2.1
Pasta	3.7
Non-alcoholic and alcoholic beverages	3.8
Coffee or tea	0.7
Eggs	1.6
Cookies, cereal bars, chocolate, and sweets	1.4
Non-fresh vegetables	1.9
Potatoes	1.2
Potato products	0.7
Yogurts and custards	1.1
Bread toppings	2.0
Cheese	2.9
Soups and sauces	5.7
Legumes	1.5
Fish	2.2
Oil, butter, spices, and salt	0.7
Cereals	1.0
Savoury snacks	0.2
Others	0.6

of household food waste, respectively (Table 4). Although soup and sauces only contributed to 2.6% of the total amount of food wasted by the households, they accounted for 5.7% of the economic value of food waste. On the contrary, the contribution of rice and milk was higher in terms of economic value than in terms of quantity (cf. Tables 2 and 4).

Environmental impact of household food waste

The environmental impact of household food waste was estimated using carbon, water, and ecological footprints. The average carbon footprint of household food waste was estimated to be 2,905 g CO_2 per person per week or 0.15 tonnes of CO_2 per person

per year (median values 1,405 g CO_2 or 0.07 tonnes of CO_2, respectively). The average water footprint of household food waste was estimated to be 3,006 L H_2O per person per week or 156 m^3 H_2O per person annually (median values 1,484 L H_2O or 77 m^3 H_2O, respectively). Finally, the ecological footprint was estimated to be 17.6 m^2 of global land per person per week. On an annual basis, the food wasted by the participating households corresponded to 915 m^2 of land usage per person (median values 8.6 m^2 or 447 m^2, respectively).

Meat was the largest contributor to the environmental impact of household food waste. As shown in Table 5, meat contributed to an average of approximately one-fourth of the carbon, water, and ecological footprint of household food waste, although it only accounted for 4.4% in weight (Table 5). Fresh vegetables and fruit were also relevant contributors to the environmental impact of food waste, although their contribution to the amount of food wasted was much higher.

Discussion and conclusions

Interest in household food waste has rapidly increased in the last decade, motivated by its socioeconomic and environmental burden (FAO, 2019; Withanage et al., 2019). However, research on the quantity, composition, and impacts of household food waste in emerging countries is still scarce (Oláh et al., 2022). The present research intends to contribute to filling this gap in knowledge by exploring household food waste in Uruguay, an emerging Latin American country.

Estimation of the amount of food wasted by Uruguayan households

The amount of food wasted by the households participating in the study was similar to that reported by other studies conducted in developed countries (e.g. Silvennoinen et al., 2014; van Dooren et al., 2019; von Massow et al., 2019; Herzberg et al., 2020). Based on median values, the per capita food waste generated by the households was estimated to be 37.6 kg per year. This value is within the lower end of the range of household food waste per capita reported by Monier et al. (2011) for European households (25–133kg per capita per year). The estimated quantity of household food waste is also similar to more recent estimations in developed countries: 27.5 kg per person per year in Italian households (Gaiani et al., 2019), 30.4 kg per person per year in Dutch households (van Dooren et al., 2019), 44.6 kg per person per year for German households (Herzberg et al., 2020), and 57.2 kg per person per year for households from Guelph, Canada (von Massow et al., 2019). This result suggests that household food waste should be regarded as a primary source of food waste in both developed and emerging countries, contrary to what has previously been hypothesized (Boulet et al., 2021). This can be explained by the characteristics of modern food-provisioning practices, which are not only characteristic of affluent societies (Roodhuyzen et al., 2017). In line with this result, socioeconomic status did not have a significant effect on the amount of food wasted by the households.

Table 5 Average percentage of the environmental footprint of the food wasted per food category

Category	*Average contribution to carbon footprint (%)*	*Average contribution to water footprint (%)*	*Average contribution to ecological footprint (%)*
Fresh vegetables and salads	12.9	15.8	1.6
Fresh fruit	8.3	9.5	11.1
Bread	5.6	4.1	5.9
Rice	4.3	2.8	6.5
Bakery products	7.5	4.1	5.8
Meat	28.2	23.8	23.3
Milk	4.9	5.1	6.7
Pasta	2.1	1.7	2.6
Non-alcoholic and alcoholic beverages	2.4	1.6	3.1
Coffee or tea	0.7	8.2	6.8
Eggs	2.9	2.4	2.9
Cookies, cereal bars, chocolate, and sweets	1.1	1.6	1.0
Non-fresh vegetables	1.4	1.9	1.8
Potatoes	0.8	1.2	2.1
Potato products	0.7	0.7	0.9
Yogurts and custards	2.5	1.4	1.4
Bread toppings	3.2	2.3	2.6
Cheese	3.5	2.3	2.3
Soups and sauces	2.4	2.8	3.8
Legumes	0.9	1.2	0.0
Fish	1.6	2.1	4.5
Oil, butter, spices, and salt	1.1	2.4	2.8
Cereals	0.4	0.4	0.2
Savoury snacks	0.1	0.2	0.1
Others	0.7	0.4	0.3

Composition of food waste

Fresh fruits and vegetables were the most frequent contributors to food waste, in agreement with previous studies reporting that this category accounts for the highest level of food waste at the household level (Edjabou et al., 2016; Hanssen et al., 2016; Conrad et al., 2018; De Laurentis et al., 2018; Gaiani et al., 2018; Giordano et al., 2019; van Dooren et al., 2019; von Massow et al., 2019; Herzberg et al., 2020). The amount of fresh vegetables and fruit wasted by the households corresponded to an average of 257 g per person per

week and 179 g per person per week, respectively. This represents a highly relevant waste of valuable nutrients (Augustin et al., 2020).

Bread and bakery products, rice, meat, and milk were also frequently discarded by the households, which matches results from a previous consumer survey conducted in Uruguay (Aschemann-Witzel et al., 2019), as well as reports from developed countries (e.g. Edjabou et al., 2016; Hanssen et al., 2016; Gaiani et al., 2018; Giordano et al., 2019; van Dooren et al., 2019). Liquid foods, such as milk, non-alcoholic and alcoholic beverages, and coffee and tea, contributed to an average of 15.6% of the total amount of food wasted by the households. This stresses the importance of not excluding these foods from the quantification of household food waste, as is commonly done in methodologies based on solid waste audits (Withanage et al., 2021).

The contribution of fresh fruit to household food waste was higher in households with a high socioeconomic status compared to those with a low/medium socioeconomic status, whereas the opposite trend was found for pasta. These results match differences in the consumption of these food categories with socioeconomic status (Bove and Cerruti, 2008).

Reasons underlying household food waste

Spoilage during storage was identified as the main reason for food waste, which corresponds to the previous literature (Parizeau et al., 2015; Gaiani et al., 2018; von Massow et al., 2019; Herzberg et al., 2020). A previous qualitative study showed that this type of food waste is usually regarded as unavoidable by Uruguayan citizens (Ferro et al., 2022). However, it should be highlighted that spoilage during storage is not the actual cause of food waste; rather, it is the consequence of household food-provisioning practices, such as poor planning, inadequate storage, and purchasing or preparing an excessive quantity of food (Roodhuyzen et al., 2017; Boulet et al., 2021). In this regard, accessibility of stores, store supply, appropriate packaging sizes, technical appliances to optimize food storage at home, and lifestyle are aspects that should also be considered (Ferro et al., 2022). Most responses referred to perceivable food deterioration, whereas expiration dates were hardly mentioned. This contrasts with other studies where expiration date labels were frequent reasons for food disposal (van Boxstael et al., 2014; Gaiani et al., 2018). Spoilage was the most frequently mentioned reason for discarding all food categories, although it was mentioned more often for fresh foods and leftovers. Previous studies have shown that people frequently store leftovers for future circumstances that do not arrive (Cappellini and Parssons, 2012; Farr-Wharton et al., 2014; Ferro et al., 2022).

Behavioural drivers of food waste were also acknowledged by participants. Quantity-related problems, such as serving or preparing too much food, were the second most frequently given reason for food disposal, which matches previously reported tendencies to over-prepare and over-serve food (Porpino et al., 2015; Block et al., 2016; Ferro et al., 2022). Research in the area of nutrition has shown that people tend to underestimate the size of large portions (Young and Nestle, 1995). This effect has been reported to be particularly relevant for liquid and amorphous foods (e.g. rice, pasta), which matches the fact that quantity-related reasons were more relevant for

the amount of food wasted within the categories rice, potatoes, pasta, and beverages. In addition, cultural aspects related to the value attached to providing an abundance of foods within Latin cultures (Freyre, 2002) may encourage people to prepare and serve too much food, contributing to food waste. In this sense, a 'good provider' identity has recently been associated with an increased likelihood of food waste in social settings (Aschemann-Witzel et al., 2020).

Regarding parts of foods as inedible emerged as a relevant contributor to food waste, accounting for 10.5% of the total amount of food disposed of by the households participating in the study. The contribution of this reason largely differed across categories, being most relevant for fresh fruit, potatoes, and fresh vegetables. This is aligned with results of studies conducted in European countries, which reported that stalks, leaves, skins, and seeds could represent one quarter of the waste of fruits and vegetables generated by households (De Laurentis et al., 2018). However, perceptions of edibility are highly heterogeneous as they depend on socio-cultural factors (Nicholes et al., 2019). According to WRAP (2009), food waste can be regarded as possibly avoidable when it corresponds to foods and beverages that some people consume and others not (e.g. beetroot leaves) or that can be eaten or not depending on how they are prepared (e.g. potato skins). Therefore, strategies to encourage citizens to include perceived inedible parts of fruits and vegetables can contribute to reducing the waste of nutritionally valuable foods. Such strategies should aim at shifting social norms, increasing awareness of the social and environmental consequences of fruit and vegetable waste, and providing skills for using perceived inedible parts in culinary preparations (Gallagher et al., 2022).

Reasons denoting unavoidable food waste, such as home accidents, quality problems, or small leftovers in packages or from food preparation, only represented a minority of the amount of food disposed of by the households. This suggests the importance of implementing multifaceted strategies to trigger behavioural changes to reduce household food waste in Uruguay.

Economic and environmental impact of household food waste

The median economic value of monthly household food waste per person corresponded to 12.0% of the value of the basic food basket used to evaluate poverty in Montevideo, the capital city of Uruguay (US$98.7 per person per month in December 2020), or 11% of the average food expenditure (US$113 per person per month in December 2020). This value is aligned with results from a recent study conducted in Guelph, Canada, which showed that the economic value of the food wasted by Canadian households was equivalent to 16% of their average expenditure on food (von Massow et al., 2019).

From an environmental perspective, the results from the present work show that household food waste is a relevant contributor to global warming, water loss, and inefficient land use. The estimates of the carbon footprint, water footprint, and ecological footprint of household food waste are comparable with those reported by previous studies conducted in developed countries, such as Canada (von Massow et al., 2019), the UK (Cooper et al., 2018), and the USA (Muth et al., 2019).

The environmental impact of food waste was unevenly distributed over food categories. Meat accounted for approximately one quarter of the environmental impact of food waste despite its relatively small contribution to the amount of food wasted by the households (4.4%). Meat and fish have been identified as the largest contributors to the environmental impact of household food waste in Canada and the UK (Cooper et al., 2018; von Massow et al., 2019). This result matches recent studies showing that emissions from agricultural production and food consumption are mostly caused by red-meat consumption (Stoll-Kleemann and O'Riordan, 2015; Romanello et al., 2021).

Implications for the development of strategies to reduce household food waste in Uruguay

The results from the present study provide evidence of the multidimensional impacts of household food waste in Uruguay. This stresses the importance of considering reducing food waste at the consumer level as a key component of multifaceted strategies for reducing and preventing food waste in the country, as previously discussed for Brazil, another emerging Latin American country (Henz and Porpino, 2017).

Although Uruguayan citizens tend to perceive their household food waste as unavoidable (Ferro et al., 2022), reasons underlying household food waste were mostly avoidable as they were related to food-provisioning practices in relation to food planning, preparation, serving, and consumption. Stancu et al. (2016) concluded that promoting changes in these food-related routines has the potential to reduce household food waste. Individuals seem to focus on food spoilage during storage without identifying actions that they could have implemented to prevent disposal (Schmidt and Matthies, 2018). Individuals rely on rationalization to reduce the adverse psychological state caused by food waste (Beauvois et al., 1993; Elliot and Devine, 1994). This psychological state acts as a barrier to engaging in food waste-prevention behaviours. In addition, using household food waste to feed pets or for home composting, which accounted for 29.3% of the food waste, may act as another barrier for engaging in prevention behaviours as these disposal routes are usually positively perceived (Neff et al., 2015; Porpino et al., 2015; Block et al., 2016).

Taken together, these results suggest the need to introduce communication campaigns to create cognitive dissonance regarding household food waste, such as raising awareness of the gap between actual and intended behaviour (Abraham et al., 2010; Freijy and Kothe, 2013). Dissonance-based interventions have been reported to be effective in encouraging changes in different health, environmental, and social behaviours (Freijy and Kothe, 2013), including household food waste (Pelt et al., 2020). Campaigns targeting household routines and information campaigns have been reported to be effective, yet evidence is limited (Reynolds et al., 2019). In particular, framing household waste as an economic and sustainability problem may contribute to promoting food waste-prevention behaviours among different segments of the population, as they are usually disregarded by Uruguayan citizens

(Ferro et al., 2022). The results from the present study provide data to develop communication campaigns aimed at raising awareness about the economic and environmental impact of household food waste in the country.

Limitations

Despite the insights gained from the results of the present study regarding household food waste in Uruguay, there are limitations that should be taken into account. From a methodological point of view, diaries underestimate levels of household food waste (Quested et al., 2020). Among the reasons for underestimation, selection bias is a factor to be considered relevant in this case, since participants who agreed to complete the diary may have been those already concerned with the issue and already carrying out food waste-prevention strategies. Other reasons for underestimation, such as not recording all the food wasted or wasting less food during the study period, along with inaccuracies regarding the conversion to weight from the approximations recorded by participants, have been signalled as potential drawbacks. However, the detailed information provided as to the types of food most frequently discarded, the reasons why, and the routes of disposal set grounds for future design of communication strategies and intervention measures.

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