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Consumers' perceptions and behavior toward food waste across countries

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Abstract

Food waste has become a global issue that has received increased attention. Food waste at the household level is a major source of food loss in developed countries. While culture is an important factor shaping people's behavior, comparison of food waste behaviors across countries and regions are still limited. This study uses primary data covering the US, Canada, the UK, and France to understand and compare consumers' food waste behaviors. While we found some common drivers for food waste behavior appliable to all countries, such as age, eating away from home, and using expiration dates, we confirmed that consumers behave significantly different across countries. For example, personal factors such as employment status, household size, and environmental concerns are only found significant in certain countries. Similarly, while convenience-driven consumers tend to waste more across countries, only European consumers who are price and advertising conscious tend to increase their food waste frequency. Moreover, many well-known food waste prevention actions, such as making a shopping list, preserving and freezing food, and being willing to consume leftovers, only appear to work in certain countries.

Keywords: culture, food consumption, food waste, fruit and vegetables waste
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1. Introduction

Food waste has become a significant global issue among industry stakeholders, consumers, and policy makers. Studies show that about one third to one half of all produced food is wasted along the food supply chain (FAO, 2019). Food waste can cause significant environmental problems due to wasted natural resources and greenhouse gas emissions associated with food production and has become a challenge for the sustainability (FAO, 2019). The United Nations has developed an agenda to adopt 17 sustainable development goals (SDGs) in 2015 to end poverty, project the planet, and ensure prosperity for all (UN, 2015). One of the goals (SDG 12) seeks to halve global food waste at retail and consumers levels, as well as to reduce food loss during production and supply. While food loss in developing countries mostly occurs at the early stages of the supply chain (e.g. production, harvesting, transport, storage and processing activities), consumers play a critical role in food waste in developed countries (Aschemann-Witzel *et al.*, 2017). Stenmarck *et al.* (2016) estimated 53% of the total EU food waste comes from private households. Buzby *et al.* (2014) estimated that a total of 31% of food is wasted in the US, including 21% by consumers and 10% by producers. As consumers are a great contributor to food waste, it is essential to examine and understand the factors influencing food waste related consumer behaviors to help policy makers develop more effective strategies to reduce food waste.

An increasing number of studies on the drivers of food waste emerged in the last decade, although it remains as a relatively new topic with the need for further research, especially at the household level (Aschemann-Witzel *et al.*, 2018). Research has shown that a range of factors influence food waste at the consumer level, including consumer characteristics, shopping and consumption behavior, product attributes, labeling, packaging, and marketing strategies (e.g. Jorissen *et al.*, 2015; McCarthy and Liu; 2017; Quested *et al.*, 2013; Sinvennoinen *et al.*, 2014; Visschers *et al.*, 2016). However, while culture is an important factor shaping behavior, few studies have explored the impact of culture on food waste related behaviors. Comparison across countries is usually conducted within European countries and is limited. Whether the findings in one country or region can be appliable to others is questionable and needs more research.

Moreover, food waste related behaviors can be food specific (Aschemann-Witzel *et al.*, 2015; Wilson *et al.*, 2017). For example, fresh fruit and vegetables account for a large share of the food wasted. Nearly half of the food wasted by households in Europe are fresh fruit and vegetables (Laurentiis *et al.*, 2018). Such findings are not surprising because fresh fruit and vegetables are highly perishable and more likely to become inedible and be discarded. At the same time, fresh fruit and vegetables are relatively cheap products such that consumers could throw away spoiled products carelessly (Laurentiis *et al.*, 2018). Although the waste level of fresh fruit and vegetables is high in households, it has not received much attention from researchers.

The objective of this study is to explore and compare the key factors influencing consumers' food waste at a household level across countries and regions. To achieve this goal, we surveyed consumers in the US, Canada, the UK, and France to collect information on consumer's frequency of food waste, personal characteristics, shopping and consumption behaviors, perceptions and knowledge related to food waste. In this study, we focus on the waste of fresh fruit and vegetables within households in each country due to the high share of them in the food wasted. We contribute to the literature by providing a comprehensive comparison of consumer behavior across countries from planning to final consumption phases. Our study confirms that consumer's food waste behaviors are significantly different across countries, suggesting that policies for reducing food waste need to be country-specific and the strategies found effective in one country are not necessarily useful in others. Our findings provide a global perspective on the food waste problem and insights into developing more effective strategies to reduce food waste.

2. Theoretical framework

Consumers do not have an innate desire to waste food, instead, food waste is a result of multiple behaviors related to food management. Similar to previous research that categorized food waste behaviors into several stages (Quested *et al.*, 2013; Van Geffen *et al.*, 2020), our study developed a conceptual framework that

breaks down the food management behaviors into planning, purchasing, storing, and consuming (Figure 1). In each of these phases, there is an opportunity for food waste that may be impacted by personal factors, such as culture, demographics, lifestyle, and perceptions. The literature has found various factors influencing food waste behaviors in different countries and regions, and several researchers (e.g. Quested *et al.*, 2013; Secondi *et al.*, 2015) have provided a good review of the work on food waste. Key factors influencing food-waste behavior identified in prior research and used to provide the basis of our model are shown in Table 1. These factors were also categorized into different food management phases based on our conceptual framework.

Personal factors play an important role in shaping consumer behaviors to drive or prevent food waste in all stages of food management. Regarding lifestyles, Chakona and Shackleton (2017) stated that households that eat together at home reduce food waste. McCarthy and Liu (2017) and Bravi *et al.* (2020) reported that higher frequency of eating outside the home increased food waste. Additionally, individuals with higher environmental consciousness produce less waste (Diaz-Ruiz *et al.*, 2018). While demographics are difficult to change, understanding the relationship between demographics and food waste could lead to tailored solutions as these factors have significant impacts on people behavior. For example, women were found to waste more food than men when they are responsible for grocery shopping, and households with kids tend to produce more food waste (Jorissen *et al.*, 2015; Sinvennoinen *et al.*, 2014). Some studies indicated that young people waste more food than older people (Jorissen *et al.*, 2015; Quested *et al.*, 2013), however, studies also found younger people are more likely to purchase suboptimal products (De Hooge *et al.*, 2017), and they are increasingly aware of the importance of recycling and the negative consequences of food waste (Zepeda and Balaine, 2017). Larger households produce more total waste than smaller ones, but larger households waste less on a per capita basis (Jorissen *et al.*, 2015; Silvennoinen *et al.*, 2014). In addition, studies found that individuals with higher education and income tend to waste more, while individuals living in rural area produce less waste (Marangon *et al.*, 2014; Secondi *et al.*, 2015).

Planning what to buy is the start of the journey of food products within a household, and food waste related behaviors start before the food enters the household. Studies have shown that making a shopping list and checking food levels in the refrigerator before shopping can reduce the likelihood to purchase too much food and prevent food waste (Quested *et al.*, 2013).

Shopping behaviors in stores can also influence people's food waste levels. Consumers' unwillingness to purchase suboptimal products and their preference for freshness increase food waste (Aschemann-Witzel *et al.*, 2015; De Hooge *et al.*, 2017). Discounts offered by retailers may encourage consumers to buy more than they need, but the impact of special offers on food waste is not clear. While some studies found that people who buy special offers waste more (Radzyminska *et al.*, 2016), others found the opposite (Jorissen *et al.*, 2015; Silvennoinen *et al.*, 2014).

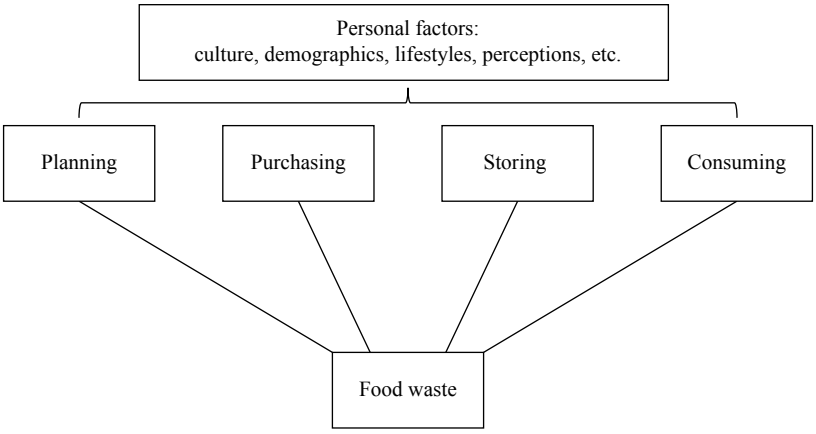

Figure 1. Conceptual framework.

Table 1. List of selected research on food-waste factors.

Authors	Country	Key factors influencing food waste behaviors	Corresponding proposed food management phrases
Stefan *et al.* (2013)	Romania	Planning routines, shopping routines, intention not to waste food	Food planning phase, food shopping phase, personal factors
Marangon *et al.* (2014)	Italy	Attitudes about food waste, age, income	Personal factors
Sinvennoinen *et al.* (2014)	Finland	Household size, gender, attitudes about food waste, price sensitivity	Personal factors
Jorissen *et al.* (2015)	Italy and Germany	Demographics (household size, age), shopping habits (shopping facility, shopping frequency)	Personal factors, food shopping phase
Secondi *et al.* (2015)	EU-27 countries	Living areas, education level, sorting practices, attitudes about food waste	Personal factors
Chakona and Shackleton (2017)	South Africa	Behaviors (food preparation, food storage, eating at home), demographics (household size, living areas)	Personal factors, food storing phase, food consuming phase
De Hooge *et al.* (2017)	Northern European countries	Demographics (nationality, age), environmental concern, perceived food waste, engaging in shopping and cooking	Personal factors
McCarthy and Liu (2017)	Australia	Lifestyle (value organic food and vegetarianism), eating out habit, knowledge on expiry dates	Personal factors, food consuming phase
Zepeda and Balaine (2017)	United States	Environmental concern, awareness of food waste	Personal factors
Diaz-Ruiz *et al.* (2018)	Spain	Shopping behavior (using a shopping list), waste prevention habits (reuse, repair, use own bag), environmental concern	Food planning phase, personal factors phase
Aschemann-Witzel *et al.* (2018)	Uruguay	Gender, age, price-orientation, convenience-orientation	Personal factors, food shopping phase
Bravi *et al.* (2020)	UK, Spain, Italy	In-store behavior, use of leftover, food management at home, planning and checking behavior, eating out habit	Food planning phase, food shopping phase, food consuming phase, food storing phase, personal factors

Another stage that impacts food is food storage. Knowledge of how to properly store food can prolong the time food can be eaten safely and reduce food waste (Van Geffen *et al.*, 2020).

Regarding people's consumption behavior, consumption of leftovers can directly reduce household food waste (Bravi *et al.*, 2020; Van Geffen *et al.*, 2020). However, consumers' perception of health risks and the loss of quality and freshness are major barriers for leftover consumption (Visschers *et al.*, 2016). Additionally, the way used by consumers to determine whether food is no longer edible affects their food waste behavior. For example, expiration date labeling has been criticized as misleading consumers and causing edible food to be thrown away (McCarthy and Liu, 2017; Wilson *et al.*, 2017).

The factors affecting food waste behavior in each stage used in this study are summarized in Table 2. The illustration of each variable is presented in next section and the framework is used in each country and to compare the results and identify any culture effects on food waste.

Table 2. Variable definitions and summary statistics.

Variable description	Definition	US		Canada		UK		France	
		Mean	St.dev.[1]	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Personal factors									
Age	Age=years of age	49.70	14.92	51.22	15.44	50.85	14.46	48.47	15.28
Kid	Kid=1 if live with children, 0=otherwise	0.42	0.49	0.35	0.48	0.45	0.50	0.41	0.49
Employment status	Job=1 if full-time or part-time employed, 0=otherwise	0.58	0.49	0.59	0.49	0.64	0.48	0.62	0.49
Environmental concerns	Env=1 if agree that food waste causes environmental burden, 0=otherwise	0.48	0.50	0.70	0.46	0.75	0.43	0.90	0.30
Health status	Health=1 if feel healthier than peers, 0=otherwise	0.37	0.48	0.37	0.48	0.35	0.48	0.34	0.47
Food neophobia	Newfood=1 if afraid to eat new food, 0=otherwise	0.21	0.41	0.17	0.38	0.19	0.39	0.20	0.40
Dinning away from home	Dineaway=1 if eat dinner away from home at least once a week, 0=otherwise	0.51	0.50	0.37	0.48	0.28	0.45	0.24	0.43
Household size	HHsize=1,…,6 and more	2.65	1.39	2.43	1.26	2.68	1.20	2.50	1.24
Planning									
Shopping list	List=1 if plan shopping with a shopping list, 0=otherwise	0.76	0.43	0.76	0.43	0.69	0.46	0.76	0.43
Shopping									
Price	Price=1 if important, 0=otherwise	0.89	0.31	0.89	0.32	0.86	0.35	0.81	0.39
Convenience to consume	Conv=1 if important, 0=otherwise	0.70	0.46	0.60	0.49	0.63	0.48	0.41	0.49
Freshness	Fresh=1 if important, 0=otherwise	0.97	0.16	0.98	0.13	0.97	0.18	0.98	0.14
Organic	Organic=1 if important, 0=otherwise	0.40	0.49	0.31	0.46	0.29	0.45	0.55	0.50
Advertising	Adv=1 if important, 0=otherwise	0.15	0.35	0.13	0.33	0.12	0.33	0.13	0.34
Locally produced	Local=1 if important, 0=otherwise	0.61	0.49	0.73	0.44	0.58	0.49	0.79	0.41

Table 2. Continued.

Storing									
Knowledge to store food	Storage=1 if usually freeze/preserve food, 0=otherwise	0.67	0.47	0.77	0.42	0.73	0.44	0.82	0.39
Consuming									
Willingness to eat leftovers	Leftover=1 if willing to eat leftovers, 0=otherwise	0.94	0.25	0.92	0.27	0.82	0.38	0.91	0.29
Expiration date	Expdate=1 if use expiration date label to know food is inedible, 0=otherwise	0.36	0.49	0.35	0.48	0.20	0.40	0.22	0.41
Smell	Smell=1 if use smell to know food is inedible, 0=otherwise	0.73	0.45	0.74	0.44	0.68	0.47	0.60	0.49
Appearance	Appear=1 if use appearance to know food is inedible, 0=otherwise	0.91	0.29	0.92	0.28	0.90	0.30	0.82	0.39
Taste	Taste=1 if use taste to know food is inedible, 0=otherwise	0.41	0.49	0.41	0.49	0.41	0.49	0.43	0.50

[1] St.dev = standard deviation.

3. Methods and data

3.1 Survey and measures

An international survey was developed and translated into English and French. Respondents from the US, Canada, the UK, and France were recruited from online panels provided by a major panel firm.[1] The survey started with several screening questions, which narrowed the respondents to female primary grocery shoppers, at least 20 years of age, from households whose income is in the top 70% of their respective country. Respondents were then asked questions regarding food shopping behaviors, such as factors influencing their purchasing decisions, shopping stores, and average weekly spending. The respondents were also asked about lifestyle and personal habits, including self-reported health status, frequency of exercise, habits of eating away from home, making shopping list, and knowledge of storing food properly. Several food-waste specific questions were asked in this section. Additional demographic questions were asked at the end of the survey. As previous studies have indicated that female shoppers and high-income households usually produce a higher rate of food waste, our sample might report a higher-than-average food waste rate of each country.

To measure consumer's waste of fresh fruits and vegetables, the survey asked respondents to rate 'How often do you throw away fresh fruit/vegetables that are no longer edible?' (1=never, 2=rarely, 3=sometimes, 4=often). Respondents also reported the reasons that cause fresh fruit and vegetables to spoil at home. Demographics include country of residence, age, household composition, employment status, household size, and living areas. Respondents reported how often they purchase a dinner away from home, as frequency of eating away from home is expected to be positively associated with the frequency of food waste. Information about attitude towards food was collected through questions about willingness to eat new foods and whether

[1] The survey was part of a larger research project, which targeted respondents in the US, Canada, the UK, and France to understand food consumption behaviors. The respondents screening criteria were imposed to obtain the target group by the project. The data used in this study were collected through this project.

or not they feel healthier than their peers. In addition, respondents indicated if they agree that food waste causes environmental burden. These questions were used to capture the effects of personal factors from the conceptual framework.

To understand respondents' food management and related waste behaviors during each stage information was collected from planning to final food consumption. Respondents rated their agreement (1=strongly disagree, 5=strongly agree) on statements regarding if they use a shopping list to plan shopping ahead and whether they know how to freeze/preserve food properly. Regarding the shopping stage, respondents were asked to rate the importance of factors influencing their shopping choices using a 5-point Likert scale. The considered attributes include price, convenience to consume, freshness, organic, locally produced, and advertising. Additionally, we asked respondents to indicate whether they are willing to eat leftovers. Respondents also reported the factors they used to make judgements about whether food is no longer edible (e.g. appearance, smell, taste, and expiration date labeling). Summary statistics of the variables are displayed in Table 1 and sample characteristics are presented in Table 3.

3.2 Model

To analyze the relationship between food waste behavior and personal factors, an ordered probit model was used in each country. The dependent variable is coded using the self-reported frequency of throwing away inedible fresh fruits and vegetables (1=never, 2=rarely, 3=sometimes, 4=often). The independent variables are summarized in Table 1 and used to predict the probabilities of different food waste frequency levels.

Table 3. Descriptions and frequency of demographic variables.

Variable	Description	US (n=1,098)	Canada (n=1,003)	UK (n=1,150)	France (n=1,110)
Age	20-29	11.84%	12.70%	11.91%	16.31%
	30-39	20.67%	23.50%	19.48%	18.20%
	40-49	20.40%	18.83%	21.30%	18.74%
	50-59	22.04%	19.12%	20.00%	18.74%
	60 and over	25.05%	24.84%	27.30%	28.29%
Household status	Live alone	22.76%	25.92%	14.70%	23.78%
	Live with others no children	35.09%	39.08%	39.91%	34.95%
	Live with children	42.16%	35.00%	45.39%	41.26%
Education	Lower education (high school or lower)	23.21%	19.44%	26.78%	15.76%
	Intermediate education (technical or associate or equivalent)	31.10%	32.50%	21.91%	21.08%
	Higher education (university graduate or higher)	45.42%	46.76%	50.96%	62.16%
Marital status	Single	20.44%	23.83%	16.00%	19.06%
	Married	57.67%	57.03%	70.87%	67.93%
	Other	21.88%	19.14%	13.13%	13.00%
Employment	Unemployed	5.17%	2.89%	3.48%	3.96%
	Employed full-time	46.42%	43.47%	41.74%	53.87%
	Employed part-time	11.51%	15.95%	22.09%	8.11%
	Other	36.90%	37.09%	32.52%	34.05%
Living area	Urban	26.32%	46.26%	23.30%	37.03%
	Suburban	52.27%	35.69%	53.13%	27.21%
	Rural	21.42%	18.05%	23.57%	35.77%

The specification of the model can be expressed as follows:

$$y_i = x_i\beta + \varepsilon_i \quad (1)$$

Where y_i defines a latent variable representing the level of food waste by individual i, x_i is a vector of characteristics describing individual i, and β is a set of parameters to be estimated. The latent variable can be represented as:

$$y_i = \begin{cases} 1, & y_i \le k_1 \\ 2, & k_1 \le y_i \le k_2 \\ 3, & k_2 \le y_i \le k_3 \\ 4, & k_3 \le y_i \end{cases} \quad (2)$$

Where k represents the threshold boundaries for each category. Therefore, the probability of observing $y_i = m$ is:

$$Probability\ (y_i = m) = F(k_m - x_i\beta) - F(k_{m-1} - x_i\beta)$$

Where F has a normal distribution (Greene, 2000).

4. Results

4.1 Consumer profiles across countries

The survey was launched in end of April and completed in May 2019, with a total of 1,098 completes from the US, 1,003 completes from Canada, 1,150 completes from the UK, and 1,110 completes from France. Over 40% of respondents in the US, the UK, and France reported living with children, compared to 35% in Canada. Over 45% of respondents in US and Canada and over half of respondents in Europe hold are university graduates. Nearly 46% of Canadian and 37% of French respondents lived in urban areas, while over half of the US and UK respondents lived in suburban areas.

On average, across all countries, 16% of respondents reported that they never throw away fresh fruit or vegetables. French consumers were most likely to report they never threw away fresh fruit or vegetables, with 32% of French respondents selecting this category. An average of 52 and 28% of respondents reported they discard inedible fresh fruit or vegetables rarely and sometime, respectively. About 5% of respondents admitted that they often throw away fresh fruit or vegetables that no longer edible (Figure 2). Among surveyed countries, the US has a slightly higher percentage of respondents self-reporting that they often throw away inedible fruit and vegetables and France has the lowest. While respondents may tend to underreport how often they waste food, this provides a relative comparison across countries.

Regarding the reasons that cause fresh fruit and vegetables to spoil at home, the most common reason for respondents in North America and Europe is 'It spoiled more quickly than expected', including about 62, 59, 65 and 58% of US, Canadian, UK, and French respondents, respectively (Figure 3). Over 40% of the US and Canadian consumers agreed that 'bought too much' is one of the reasons they threw away fresh fruit and vegetables.

UK respondents reported the lowest percentage (68.9%) of using a shopping list, while over 75% of respondents in other countries reported that they use a shopping list. A relatively lower percentage of US respondents (66.9%) reported that they know how to preserve food properly compared to respondents from Canada (77.5%), the UK (73.2%), and France (81.5%). US respondents also reported the lowest percentage (47.7%) of believing food waste would damage the environment, consistent with Neff *et al.* (2015) that environmental concerns ranked last among motivations to reduced food waste in the US. Over 70% of respondents in other countries believe that food waste causes an environmental burden. Additionally, over half of US respondents

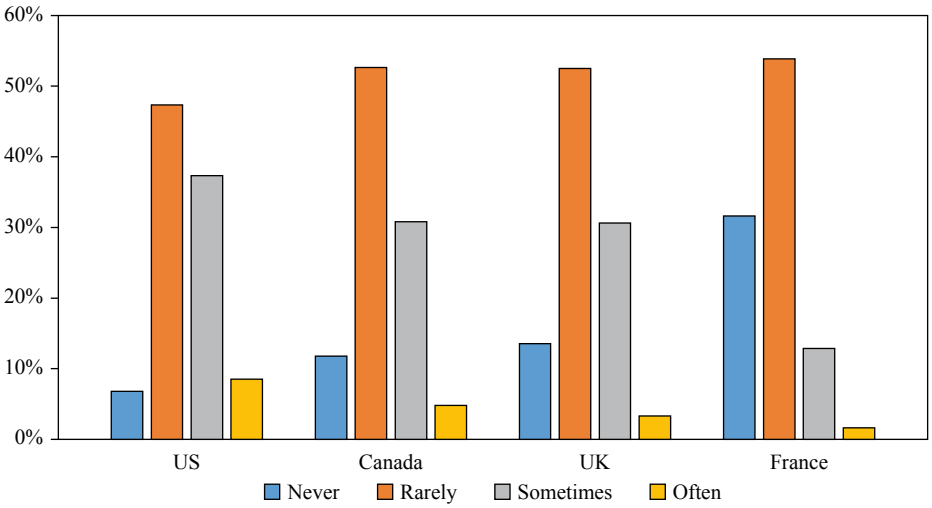

Figure 2. Frequency of food waste by country.

reported that they eat dinner outside the home at least once a week, whereas the percentage is much lower in other countries (Canada 37.3%, UK with 28.1%, and France 24.2%).

4.2 Estimated results from the ordered logit model

Results from the ordered probit model are presented in Table 4. Some similarities are found across countries and are consistent with previous research. For example, our study found that older people tend to waste food less frequently than younger people, which is consistent with Quested *et al.* (2013) and Jorissen *et al.* (2015). Eating away from home has been found to increase the frequency of food waste (Bravi *et al.*, 2020; McCarthy and Liu, 2017). Also, the usage of expiration data to determine whether the food is no longer edible is also positively related to food waste frequency in all four countries (McCarthy and Liu, 2017; Wilson *et al.*, 2017). In addition, we found that using appearance to tell whether the food is spoiled increases food waste frequency across countries.

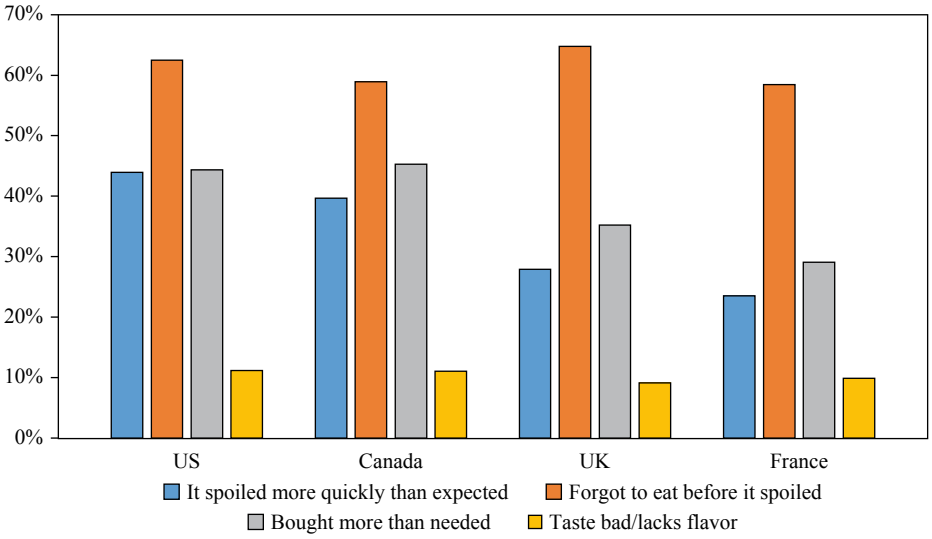

Figure 3. Reasons cause fresh fruit and vegetables to spoil at home.

Table 4. Ordered logit model results.[1]

Variable	US		Canada		UK		France	
	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
Intercept	2.53***	0.65	1.58***	0.33	0.88***	0.25	0.90***	0.32
Personal factors								
Age 26-38 vs 18-25	-1.11*	0.60	0.35**	0.14	-0.06	0.14	-0.04	0.16
Age 39-54 vs 18-25	-1.20**	0.60	-0.04	0.12	-0.02	0.12	-0.19	0.16
Age 55+ vs 18-25	-1.48**	0.60	0.10	0.11	-0.44***	0.11	-0.35**	0.16
Kid	-0.21**	0.10	0.20*	0.11	0.26***	0.10	-0.02	0.11
Job	0.12	0.07	0.15**	0.08	0.18**	0.08	0.10	0.09
Env	-0.04	0.07	-0.10	0.08	-0.29***	0.08	0.09	0.12
Health	-0.18**	0.07	-0.30***	0.08	-0.37***	0.07	0.00	0.08
Newfood	0.13	0.08	0.27***	0.10	0.15*	0.09	0.40***	0.09
Dineaway	0.22***	0.07	0.37***	0.08	0.44***	0.08	0.15*	0.09
Hhsize	0.07**	0.04	0.02	0.04	0.02	0.04	0.05	0.04
Food management stages								
List	-0.18**	0.08	-0.21**	0.09	-0.07	0.07	-0.11	0.08
Price	0.04	0.11	0.10	0.12	0.33***	0.10	0.23**	0.09
Conv	0.19**	0.08	0.24**	0.08	0.12*	0.07	0.02	0.07
Fresh	0.19	0.22	-0.52*	0.28	-0.08	0.20	-0.27	0.25
Organic	-0.08	0.07	0.10	0.08	-0.02	0.08	-0.03	0.08
Adv	0.08	0.10	0.02	0.11	0.31***	0.12	0.16	0.11
Local	-0.12*	0.07	-0.05	0.09	-0.13*	0.07	-0.19**	0.09
Storage	-0.17**	0.07	-0.11	0.09	-0.09	0.08	-0.26**	0.09
Leftover	-0.18	0.14	-0.24*	0.14	0.00	0.10	-0.26**	0.12
Expdate	0.19**	0.07	0.26***	0.08	0.40***	0.09	0.17**	0.08
Smell	-0.05	0.08	-0.10	0.09	-0.02	0.08	-0.10	0.07
Appear	0.20*	0.12	0.30**	0.13	0.30***	0.11	0.28**	0.09
Taste	0.18**	0.07	-0.18**	0.08	-0.24***	0.07	-0.01	0.07

[1] *, **, and *** indicate significance at 10, 5 and 1% level, respectively.

However, we also found many differences in people's food waste behaviors across countries. For example, having kids has a significant negative impact on US consumers' food waste behavior but has a significant positive impact on UK consumers. Interestingly, we noticed studies in European countries (e.g. Sinvennoinen *et al.*, 2014) have showed a similar positive relationship between having kids and food waste behavior, while one study in the US (Neff *et al.*, 2015) reported that the leading motivations for waste reduction in US households were saving money and setting an example for children.

Having a full-time job increases food waste frequency in Canada and the UK but not in the US or France. Similar results reported by WRAP (2007) found that respondents with high food waste tended to be those with full time work in the UK. While our results indicate that larger household size is likely to discard fresh fruit and vegetable more frequently, this is only significant in the US. In addition, concerns about environment only significantly reduces food waste frequency in the UK.

We also tested some factors not often considered in previous studies, including health status and food neophobia. Respondents who self-reported healthier than peers tend to discard food significantly less frequently in all countries but France. The fear of eating new food also increases food waste frequency significantly in Canada and France.

In terms of food management stages, making a shopping list before going to stores is found to reduce food waste frequency significantly in North America but not in European countries. Prioritizing price and advertising while shopping increases the frequency of food waste in European countries. Focusing on the attribute of convenience to consume increases the food waste frequency in the US and Canada and the UK. Prioritizing freshness decreases the frequency of food waste in Canada, and preferring local products significantly decreases food waste frequency in all countries but Canada. These results are similar to Aschemann-Witzel *et al.* (2018) who sampled Uruguayan consumers and reported that price and convenience-oriented consumers wasted more, while value conscious consumers wasted less.

Regarding storing skills, respondents that know how to preserve or freeze food tend to throw away food less frequently in the US and France. Interestingly, willingness to consume leftover food only significantly decreases food waste frequency in France and Canada, whereas it was expected to be significant in all countries. Besides using expiration dates and appearance, relying on the taste to determine whether food is spoiled significantly decreases the waste frequency in Canada and the UK.

5. Conclusions

Food waste has become a global issue that has received increased attention in the past decade. Food waste at the consumer level is currently a major source of food loss in developed countries. To understand consumers' food waste related behaviors and identify key influencers to control food waste in households is very important to improve sustainability in the food system. While recent research lacks comparison of food waste behavior across countries and regions, this study contributes to the literature by providing a comprehensive investigation on consumers' food waste related behaviors across countries focusing on fresh fruit and vegetables using novel multi-country data.

Our study confirms that age, eating outside of home, and using expiration dates and appearance to determine whether food is spoiled increases the frequency of food waste, and such findings are applicable to all countries. Additionally, we found significant differences across countries, implying an important role played by culture in food waste behavior. For example, having kids tends to reduce the food waste frequency among US respondents but increase for those in the UK. This might because American parents have a strong motivation to reduce food waste to set a good example for children (Neff *et al.*, 2015), but more studies are necessary to test this in other countries. Also, several significant factors driving or preventing food waste reported by previous research, such as full-time employment, household size, and environmental concerns are only significant in some countries but not in others, driving home the importance of not over-generalizing results from one country to another.

This study finds evidence that shopping factors influence the food waste level at home. Price and advertising conscious consumers, as well as convenience-driven consumers, tend to have a higher level of food waste. However, such results are only applicable in certain countries. Moreover, some well-studied food waste prevention actions, including making a shopping list, preserving and freezing food, and being willing to consume leftovers, do not have the same level of effectiveness across countries.

Other factors found to influence food waste include self-view of health status and food neophobia. We found that respondents who consider themselves healthy tend to waste less in the US, Canada, and the UK, and respondents who are afraid of eating new food tend to waste more in Canada, the UK, and France.

Our study indicates that researchers and policy makers should consider culture when developing strategies and policies to reduce food waste in their countries. In other words, it is essential to understand that an effective food waste reducing policy needs to be country-specific to adjust the different food waste behaviors of consumers in different countries. The successful experience in one country or region is not necessarily appliable to other countries or regions. Research and policies should focus on each country or region individually. In addition, our study focuses on fresh fruit and vegetables as the targeted commodity when

asking respondents to answer food waste related questions, because this is a major food waste category. Therefore, more studies using multi-country data and exploring other food categories are needed to confirm the findings in this study as well as previous research.

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