



Consumer knowledge and behaviors regarding food date labels and food waste



Melissa Kavanaugh, Jennifer J. Quinlan*

Department of Nutrition Sciences, College of Nursing and Health Professions, Drexel University, 1601 Cherry St., Philadelphia, PA, 19102, USA

ARTICLE INFO

Keywords:

Food date labels
Food waste
Consumer waste
Food safety

ABSTRACT

Food date labels are commonly used by the food industry despite not being well understood by consumers. Consumers may mistakenly believe that food label dates are meant to convey information about a food's safety, but in many instances label dates are set by the food producer to indicate quality or freshness. Label date confusion may, therefore, contribute to household food waste, a growing social, economic, and environmental problem. Limited research has examined the impact food date labels may have on consumer food waste. The objective of this research was to determine consumer knowledge regarding three common food date labels and their meanings, and whether knowledge was related to food waste behaviors. An online survey of 1042 adults in the U.S. determined their use and knowledge of food date labels as well as their propensity to waste food as defined by disposing of food which would likely still be safe for consumption. The majority of respondents (81.6%) reported using food date labels. Only 57.4%, however, correctly identified what "best by, use by" meant, while 68.1% and 79.7% correctly identified the definitions of "expiration date" and "sell by date", respectively. Respondents who correctly defined "best buy, use by" were less likely to throw food away if it had passed its "use by" date or was a shelf stable food without a visible date and were more likely to identify the "expiration date" as the only reason to throw away a food. The findings indicate that consumer education around the least understood food date label, "best by, use by" may help to reduce consumer food waste.

1. Introduction

Food waste, which can be defined as discarding food that would otherwise be fit for human consumption, represents both an environmental and social concern (Buzby, Wells, & Hyman, 2014). Globally, 1.3 billion tons of food is lost per annum (FAO, 2019). Fresh water and other natural resources used to produce food are also squandered when suboptimal produce is not brought to market or leftovers end up in the trash bin (Buzby et al., 2014; Hall, Fuo, Dore & Chow, 2009). In the United States, it is estimated that approximately 30 million acres of land and almost 4.2 trillion gallons of water each year are misused as a result of wasted food (Conrad, Niles, Neher & Roy, 2018). Moreover, food waste represents a missed opportunity to feed the more than 820 million people (49 million of which reside in the U.S.) experiencing some level of food insecurity (Buzby et al., 2014; FAO, 2019).

Food waste has increased precipitously in recent years, with per capita estimates in the United States ranging from 1249 to 1400 kilocalories left uneaten each day (Buzby et al., 2014; Hall, Guo, Dore, & Chow, 2009; Newsome et al., 2014). Food waste may occur at various points in the supply chain; however, the overwhelming majority of

losses occur at the consumer level (Newsome et al., 2014). Perishable items such as fruits, vegetables, dairy and meat are the most likely to be wasted (Conrad et al., 2018; Jorissen, Pfeifer & Barautigam, 2015; Neff, Spiker, & Truant, 2015; Parfitt, Barthel, Macnaughton & 2010). End users may discard food for various reasons including, over purchasing of food and not using food in a timely manner, as well as improper use of food date labels (Aschemann-Witzel, de Hooge, Amani, Bech-Larsen, & Oostindjer, 2015; Davenport, Qi, & Roe, 2019; Parfitt, Barthel, & Macnaughton, 2010; Porpino, Parente, & Wansink, 2015; van Boxtael, Devlieghere, Berkvens, Vermeulen, & Uyttendaele, 2014).

In the United States, date labeling is not federally mandated for most food products, which has left many (but not all) states to adopt some form of date labeling system under the guidance of the Uniform Open Dating Regulation of the National Institute of Standards and Technology (Newsome et al., 2014). Some food date labels commonly used in the U.S. include: "sell by," "use by" and "best if used by/before." All of these label dates are determined by the manufacturer and are meant to convey information about a product's quality or freshness and not a product's safety from a microbial standpoint (USDA, 2019). Consumers may not understand these label date definitions, and

* Corresponding author.

E-mail address: jjq26@drexel.edu (J.J. Quinlan).

therefore may use food date labels to evaluate food safety, thus discarding a food that has passed its label date or rejecting a food in the absence of a date label in order to avoid foodborne illness (Davenport et al., 2019; Newsome et al., 2014; Qi & Roe, 2016; Toma, Costa & Thomspon, 2017). Other consumers may realize that they are not at risk for microbial infection, but still may reject a suboptimal food, citing health as their primary concern (Wansink & Wright, 2006). This underscores the need for consistency of food date labels (from state to state) as well as consumer education regarding food date labels and food waste. Following a published report documenting the degree of household food waste in the United Kingdom, WRAP (Waste and Resources Action Programme) launched the “Love Food Hate Waste Initiative,” and subsequently reported a 21% decrease in consumer food waste between 2007 and 2012 (Quested, Ingle, & Parry, 2013).

In the United States, consistent use and application of date labels may represent an important opportunity to reduce household food waste, provided consumers understand their intention. Many consumers report using food date labels when making purchasing and consumption decisions despite evidence that these labels are not well understood (Davenport et al., 2019; Kosa, Cates, Karns, Godwin, & Chambers, 2007; Toma, Costa Font, & Thompson, 2017; van Boxstael et al., 2014). To date, few studies have explored both food date label understanding and food waste behaviors (Kosa et al., 2007; Toma et al., 2017; van Boxstael et al., 2014). Therefore, the purpose of the research reported here was to (1) to determine to what extent food date labels, commonly used in the U.S., are understood by consumers and (2) to determine to what extent knowledge (or lack thereof) is associated with food waste.

2. Materials and methods

2.1. Survey development and administration

A nine question survey was developed utilizing and modifying questions previously reported in the literature (Lyndhurst, 2017; Toma et al., 2017; van Boxstael et al., 2014). The survey was developed to determine how often consumers look at dates on food labels and their knowledge regarding three common food date labeling terms (“best by/ use by”, “sell by” and “expiration” dates) and what they mean (Table 1). Additionally, questions were included to determine how consumers identify the quality of foods, and their practices with regard to determining edibility of food products and reasons for throwing food away. Finally, a screening question was included to ensure participants were actually engaged in the survey.

The survey was administered online from April 12 to 13, 2019 via SurveyMonkey™. Responses were purchased from SurveyMonkey utilizing the SurveyMonkey™ Contribute member pool. The Contribute member pool consists of individuals who have registered with SurveyMonkey™ and provided their gender, birth date (month and year), household income and zip code. They then earn credits for completing surveys and redeem them for rewards or donations to participating charities. The survey was targeted to Contribute members over 18 years old throughout the United States with the goal of obtaining a sample representative of the U.S. population.

Table 1
Desired response options to knowledge questions.

Food date label	Correct response option
“best by/use by”	indicates when the food is its freshest/peak quality
“sell by”	indicates the last day the product should be sold and should be replaced on the food store shelves
“expiration date”	indicates the food cannot be consumed after this date because it is unsafe to eat

Table 2
Comparison of the distribution of age, gender and income level between the U.S. population and the data sample.

Characteristic	US Population ^{a,b}		Data Sample	
	2018			
	n	(%)	n	(%)
Gender				
Men	123,638	(48.7%)	474	(45.5%)
Women	130,130	(51.3%)	567	(54.4%)
Age groups				
18-29	54,019	(21.3%)	265	(25.4%)
30-44	63,414	(25.0%)	242	(23.2%)
45-60	67,832	(26.7%)	344	(33.0%)
> 60	68,503	(27.0%)	190	(18.2%)
Income category				
\$0-\$9999	66	(24.9%)	75	(7.2%)
\$10,000-\$24,999	54	(20.5%)	121	(11.6%)
\$25,000-\$49,999	64	(24.3%)	248	(23.8%)
\$50,000-\$74,999	37	(13.9%)	169	(16.2%)
\$75,000-\$99,999	18	(6.6%)	129	(12.4%)
\$100,000-\$124,999 ^c	15	(5.6%)	79	(7.6%)
\$125,000-\$149,999 ^c			38	(3.6%)
Over \$150,000	11	(4.2%)	95	(9.1%)

^a Source: U.S. Census Bureau (2018) & (2019).

^b Data presented in thousands.

^c Income categories combined in US Census reporting.

2.2. Statistical analysis of the data

The data was analyzed using IBM SPSS Statistics Version 25 for Mac. Chi-square analysis was performed to look for differences in food date label knowledge and food date label use as well as differences in food waste behaviors between age and gender groups. Chi-square analysis was also used to investigate differences in food waste behaviors based on knowledge of food date labels by consumers. A p-value of less than 0.05 was considered significant for all analyses.

3. Results

3.1. Demographic data

In total, 1065 participants completed the questionnaire, 23 were excluded based on an incorrect screener question answer, leaving 1042 participants included in analysis. Women represented 54.4% of study respondents and men 45.5%, which is fairly consistent with census estimates of the U.S. adult population (Table 2). Our sample population was generally representative of what is seen in the U.S. population with respect to age, however, with respect to income, the lowest income categories were slightly under represented while the highest earners were over represented when compared to the general population.

3.2. Food date label usage and knowledge

Examination of food date label usage and knowledge found that food date label usage was high across all age and gender groups, with 81.6% of respondents indicating that they either often or always look at food label dates (Table 3). With respect to knowledge of what different

Table 3
Selected survey response options by demographic category (n = 1042).

Response Options	Male (n = 474)	Female (n = 567)	18–29 years (n = 265)	30–44 years (n = 242)	45–60 years (n = 344)	> 60 years (n = 190)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Often or always looks at food date labels	376 (79.3%)	473 (83.4%)	214 (80.8%)	207 (85.5%)	276 (80.2%)	152 (80.0%)
Correctly identified “best by, use by” date	251 (53.0%)*	346 (61.0%)*	152 (57.4%)	130 (53.7%)	199 (57.8%)	116 (61.1%)
Correctly identified “sell by” date	369 (77.8%)	461 (81.3%)	215 (81.1%)**	187 (77.3%)**	262 (76.2%)**	166 (87.4%)**
Correctly identified “expiration date”	320 (67.5%)	390 (68.8%)	216 (81.5%***)	185 (76.4%***)	203 (59.0%***)	106 (55.8%***)
Would consume a box of cereal with no “best before” date	347 (73.2%)	381 (67.2%)	198 (74.7%)	165 (68.2%)	229 (66.6%)	136 (71.6%)
Would consume an opened food past “use by” date	272 (57.4%)	291 (51.3%)	153 (57.7%)	126 (52.1%)	172 (50.0%)	112 (58.9%)
Past “expiration date” is the only reason to throw away food	116 (24.5%)	163 (28.7%)	90 (34.0%)**	70 (28.9%)**	78 (22.7%)**	41 (21.6%)**
Reported using the food date label to assess edibility of a food product	336 (70.9%)	410 (72.3%)	202 (76.2%)*	183 (75.6%)*	228 (66.3%)*	133 (70.0%)*

Note. ***p < 0.001; **p < 0.01; *p < 0.05.

food date labels meant, significantly more women than men knew what the “best by, use by” date meant (p = 0.022). This was the only significant difference between genders, though correct identification of the “sell by” date approached significance (p = 0.054); again, a higher percentage of women supplied the appropriate response. The oldest and youngest respondents (i.e. 18–29 and over 60 years) were more likely to know what “sell by” meant when compared with the respondents 30–60 years old (p = 0.005). Older participants (45 years and above) were less likely to correctly identify the meaning of “expiration date” (p < 0.001).

3.3. Food waste behaviors

The majority of participants reported that they would consume a box of cereal with no food date label (70%) while fewer (54.1%) would consume a food that had been opened longer than recommended on the label (i.e. when a label indicates a food should be eaten within a certain time period after opening). Younger participants were more likely to cite the “expiration date” as the only reason (with respect to date labels) to throw away a food (p = 0.009). The majority (71.6%) of participants reported using food date labels to assess edibility of food products, with young adults being the most likely to use the label date to assess edibility (p = 0.016) (Table 3).

3.4. Differences in food waste behaviors according to food date label knowledge

Consumer likelihood to potentially waste food by throwing it away because it was opened longer than recommended on the label or did not have a date label was compared with their knowledge of food date labels to determine whether more knowledgeable consumers were less likely to waste potentially edible food. Respondents who knew the correct definition of the “best by/use by” label were less likely to throw away food opened longer than recommended on the label and were more likely to know that past the “expiration date” would be the (date label related) reason to throw away a food (Table 4). Respondents who knew the correct definition of either the “sell by” or “expiration” date were less likely to consume a food opened longer than recommended on the label, but were more likely than respondents who did not know the correct definition, to know that the “expiration date” would be the only (label date related) reason to throw away a food. Participants were placed into three “knowledge” categories based on responses to the three questions regarding what different labels meant. Those supplying three, two or one/zero correct responses to the knowledge questions were considered “very knowledgeable,” “somewhat knowledgeable” and “not knowledgeable”, respectively. Thirty-seven point two percent of participants were very knowledgeable, 34.3% were somewhat

knowledgeable and 28.5% were non knowledgeable with respect to food date label definitions (Table 5). Those that were very knowledgeable were more likely to correctly identify that the expiration date was the only (label date related) reason to throw away a food.

3.5. Reasons for consumer food waste/disposal

The majority of respondents (82.3%) cited smelling and looking at a food product as a means to determine edibility (data not shown). Burning or ruining food during preparation was cited as a common reason for food disposal/waste (63.6%). Most respondents (58.3%) would throw away a food that had not gone bad, but “wasn't worth the risk.” Only 21.2% of participants indicated that they would preserve aging food by freezing it. Participants also had the opportunity to provide open ended responses when asked which factors they thought related to food waste in their household or which factors would make them likely to throw away a food. Again, respondents cited using their senses as well as the label date. Participants also mentioned not using food in a timely manner as a potential cause of food waste. In other words, food was wasted because they either bought too much or forgot about the food once it was purchased.

4. Discussion

4.1. Food date label use and understanding

A main objective of this research was to understand to what extent food date labels are understood by consumers. Data indicates that while a majority of respondents do use food date labels, far fewer consumers understand their meaning. Only 37.2% of respondents in our study knew the meaning of all three food date labels versus 81% of respondents who reported either often or always looking at label dates. These results are consistent with previous reports indicating high food date label use juxtaposed with limited understanding (Aschemann-Witzel et al., 2015; Davenport et al., 2019; Kosa et al., 2007; Qi & Roe, 2016). Of the three food date labels presented as part of our study, the “best by, use by” date was the least well understood. Similarly, Kosa et al. reported that many participants incorrectly identified the “use by” label date; however, many more participants supplied the incorrect answer according to their investigation (over 80%) (Kosa et al., 2007) when compared to our sample (42.6%). This disparity may be sample specific or may indicate increased consumer understanding of food labels over the past decade. With the exception of infant formula, the “use by” date is set by the product's manufacturer to indicate when a food is at its peak quality (USDA, 2019), but it is possible that the “use by” date is misinterpreted to mean that a food shouldn't be “used” after that date. That is in fact the “use by” label date's meaning as it pertains to

Table 4
Differences in food waste behaviors according to correct responses to individual knowledge questions.

Response Options	Knowledge Questions		
	Correctly identified best by/use by	Correctly identified sell by	Correctly identified expiration date
	n = 598 ^a	n = 830 ^a	n = 710 ^a
	n (%)	n (%)	n (%)
Would consume a box of cereal with no “best before” date	446 (74.6%) ^{b*}	583 (70.2%)	487 (68.6%)
Would consume an opened food past “use by” date	350 (58.53%) ^{b*}	436 (52.53%) ^{c*}	361 (50.85%) ^{c*}
Past “expiration date” is the only reason to throw away a food	192 (32.1%) ^{b*}	235 (28.3%) ^{b*}	218 (30.7%) ^{b*}

a Total n = 1042.

b * p < 0.05 – Respondents who correctly answered the knowledge question were more likely to choose the response option than those who incorrectly answered that knowledge question.

c * p < 0.05 – Respondents who correctly answered the knowledge question were less likely to choose the response option than those who incorrectly answered that knowledge question.

Table 5
Food waste behaviors according to knowledge category.^a

Response Options	Knowledge Category		
	Very Knowledgeable	Somewhat Knowledgeable	Not Knowledgeable
	n = 388	n = 357	n = 297
	n (%)	n (%)	n (%)
Would consume a box of cereal with no “best before” date	283 (72.9%)	247 (69.2%)	199 (67.0%)
Would consume a food opened longer than the recommended time to use by if opened	209 (53.9%)	187 (52.4%)	168 (56.6%)
Past “expiration date” is the only reason to throw away a food	143 (36.9%)*	85 (23.8%)*	51 (17.2%)*

Note. *p < 0.001.

^a Very Knowledgeable: 3 knowledge questions correct; Somewhat Knowledgeable: 2 knowledge questions correct; Not Knowledgeable: 0 or 1 knowledge questions correct.

infant formula (USDA, 2019). As part of the same investigation previously mentioned, Kosa and colleagues found that many consumers identified the “use by” date as a measure of food safety, which incidentally, is the correct definition for those residing in the European Union (Kosa et al., 2007; Toma et al., 2017). The inconsistent application of the “use by” label date between countries and even within the United States is potentially problematic and underscores the need to streamline its definition.

There appear to be some differences in knowledge between demographic categories. Significantly more women than men knew the meaning of the “best by, use by” date and more women also knew the meaning of the “sell by” date though this comparison did not achieve significance. Conversely van Boxstael et al. reported no significant differences in knowledge between men and women, although they did find that more women than men used the label date to assess edibility (van Boxstael et al., 2014). As part of our analysis, younger participants were more likely to understand the meaning of the “expiration date,” whereas the youngest and oldest participants had a better understanding of the “sell by” date. The factors driving these differences are unclear, but disparities in food date label understanding as a function of age have been reported elsewhere, with some conflicting results. Toma et al. reported an inverse relationship between age and knowledge, whereas van Boxstael and associates found that younger age was associated with a lower level of understanding (Toma et al., 2017; van Boxstael et al., 2014). Finally, Kosa and colleagues reported an S-shaped relationship where those 18–45 and 60–69 years of age were more likely to correctly identify the “sell by” date when compared to those 45–59 and above 70 years old (Kosa et al., 2007); these research results are similar to our report with respect to the “sell by” label date but are not entirely comparable because the age categories are different.

4.2. Food waste behaviors

A second goal of this study was to determine to what extent lack of understanding of food date labels is related to food waste behaviors. We found that the highest level of knowledge (i.e. 3 knowledge questions answered correctly) corresponded with the respondent knowing that the “expiration date” was the only date label related reason to throw away a food. Similarly, participants who correctly identified the definition of the “best by/use by” date were less likely to report food waste behaviors. Toma and colleagues found a significant association between knowledge and behavior but reported that higher comprehension was associated with an increase in food waste behaviors in the EU, which was opposite of what was expected (Toma et al., 2017). Older respondents were more likely to throw away food that had passed the “best by, use by” or “sell by date.” This result stands in opposition to several studies finding age to be inversely related to food waste behaviors (Aschemann-Witzel, Jensen, Jensen, & Kulikovskaja, 2017; Broad, Lieb, Rice, Neff, Spiker, Schklair & Greenberg, 2016; Stancu, Haugaard & Lahteenmaki, 2016; Toma et al., 2017). Younger adults were more likely to report assessing edibility according to the label date, which seems inconsistent with reduced food waste. However, it was not specified which label date was being used to assess edibility in the question, so it is possible that younger consumers were referring to their use of the expiration date to determine whether to consume a food product.

Finally, only 21% of respondents reported freezing aging food in order to preserve it, a method known to stop bacterial growth and keep food safe. This may be an area for consumer education that could lead to a reduction in food wasted by consumers.

As with our analysis, the majority of recent investigations have been survey-based (Davenport et al., 2019; Jorissen, Pfieler, & Brautigam, 2015; Kosa et al., 2007; Neff et al., 2015; Stancu, Haugaard, & Lähteenmäki, 2016; Toma et al., 2017; van Boxstael et al., 2014).

Surveys are easy to administer but are limited when it comes to assessing food waste behaviors because respondents may be likely to underreport their true propensity to waste food. For example, as part of a survey administered by Jorissen and associates, over a quarter of respondents claimed not to waste any food at all (Jorissen et al., 2015), which seems unlikely. Neff et al. also reported a similar tendency of participants to underreport food waste in their household (Neff et al., 2015). To that end, there may be a need for observational or “real time” research studies that would take reporting bias out of the equation. Additionally, research in this area has examined consumers understanding with respect to food labels in general. Consumers understanding and behaviors with respect to food labels and specific types of food has not been examined. Future research should examine whether consumer's attitudes and adherence to food date labels differs for different food categories (i.e. dairy vs. raw meat vs. produce).

4.3. Conclusions

With few exceptions, food date labels are not federally regulated and most are not meant to serve as a proxy for food safety (Newsome et al., 2014; USDA, 2019). Despite their intention, food date labels are often misunderstood and this may result in food unnecessarily being discarded. Even when food date labels are understood, the tendency to waste a food based on its label date may persist. The results of this research indicate that the respondents would throw away a food that had passed its “best before,” (29.8%), “use by” (50%) or “sell by” date (21.4%). Additionally, more than half of the respondents (58%) would throw away a food that appeared to be edible, but in their assessment “wasn't worth the risk,” which implies that consumers may actually practice the food safety recommendation “if in doubt, throw it out” at the expense of safe, edible food. This highlights the challenge to food and food safety professionals to keep consumers safe but limit the growing problem of food waste. Of all the food date labels utilized in the United States, the “best by/use by” date seems to be the most confusing to consumers. Consumer education regarding the meaning of “best by/use by”, combined with messages to use freezing to preserve food where appropriate, may ultimately empower consumers to waste less safe, edible food.

Funding

This work was supported by the Department of Nutrition Sciences, College of Nursing and Health Professions of Drexel University.

CRedit authorship contribution statement

Melissa Kavanaugh: Data curation, Formal analysis, Writing - original draft. **Jennifer J. Quinlan:** Conceptualization, Methodology, Resources, Writing - review & editing.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Acknowledgements

The authors would like to thank Chwen-Ling Huang, Ye Ji Lee, Emily Lim and Briana Walsh for their assistance on this project.

References

Aschemann-Witzel, J., de Hooge, H., Amani, P., Bech-Larsen, T., & Oostindjer, M. (2015).

- Consumer-related food waste: Causes and potential for action. *Sustainability*, 7, 6457–6477. <https://doi.org/10.3390/su7066457>.
- Aschemann-Witzel, J., Jensen, J. H., Jensen, M. H., & Kulikovskaja, V. (2017). Consumer behaviour towards price-reduced suboptimal foods in the supermarket and the relationship to food waste in households. *Appetite*, 116, 246–258.
- van Boxtael, S., Devlieghere, F., Berkvens, D., Vermeulen, A., & Uyttendaele, M. (2014). Understanding and attitude regarding the shelf life labels and dates on pre-packed food products by Belgian consumers. *Food Control*, 37, 85–92. <https://doi.org/10.1016/j.foodcont.2013.08.043>.
- Broad Leib, E., Rice, C., Neff, R., Spiker, M., Schklair, A., & Greenberg, S. (2016). Consumer perceptions of date labels: National survey. Harvard food law and policy clinic. Retrieved from https://www.comunicarseweb.com/sites/default/files/consumer-perceptions-on-date-labels_may-2016.pdf, Accessed date: 13 December 2019.
- Buzby, J. C., Wells, H. F., & Hyman, J. (2014). The estimated amount, value and calories of postharvest food losses at the retail and consumer levels in the United States. *U.S. Department of Agriculture, Economic Research Service*, 121 a-33.
- Conrad, Z., Niles, M. T., Neher, D. A., Roy, E. D., Tichenor, N. E., & Jahns, L. (2018). Relationship between food waste, diet quality and environmental sustainability. *PLOS One*, 13(4), e0195405. <https://doi.org/10.1371/journal.pone.0195405>.
- Davenport, M. L., Qi, D., & Roe, B. E. (2019). Food-related routines, product characteristics and household waste in the United States: A refrigerator-based pilot study. *Resources, Conservation and Recycling*, 150, 1–16. <https://doi.org/10.1016/j.resconrec.2019.104440>.
- Food and Agricultural Organization of the United Nations (2019). Food loss and food waste. Retrieved from <http://www.fao.org/food-loss-and-food-waste/en/>, Accessed date: 10 October 2019.
- Food and Agricultural Organization of the United Nations (2019). The state of food security and nutrition in the world. Retrieved from <http://www.fao.org/state-of-food-security-nutrition/en>, Accessed date: 11 October 2019.
- Hall, K. D., Guo, J., Dore, M., & Chow, C. C. (2009). The progressive increase of food waste in America and its environmental impact. *PLoS ONE*, 4(11), e7940. <https://doi.org/10.1371/journal.pone.0007940>.
- Jorissen, J., Pfeifer, C., & Brautigam, K. R. (2015). Food waste generation at household level: Results of a survey among employees of two European research centers in Italy and Germany. *Sustainability*, 7, 2695–2715. <https://doi.org/10.3390/su7032695>.
- Kosa, K. M., Cates, S. C., Karns, S., Godwin, S. L., & Chambers, D. (2007). Consumer knowledge and use of open dates: Results of a WEB-based survey. *Journal of Food Protection*, 70(5), 1213–1219.
- Lyndhurst, B. (2017). Food behaviour consumer research: Quantitative phase. Retail Programme - food waste: Final report. Retrieved from <http://www.wrap.org.uk/sites/files/wrap/Food%20behaviour%20consumer%20research%20quantitative%20jun%202007.pdf>, Accessed date: 13 December 2019.
- Neff, R. A., Spiker, M. L., & Truant, P. L. (2015). Wasted food: U.S. Consumers' reported awareness, attitudes and behaviors. *PLoS One*, 10(6), e0127881. <https://doi.org/10.1371/journal.pone.0127881>.
- Newsome, R., Balestrini, C. G., Baum, M. D., Corby, J., Fisher, W., Goodburn, K., et al. (2014). Applications and perceptions of date labeling of food. *Comprehensive Reviews in Food Science and Food Safety*, 13, 745–769. <https://doi.org/10.1111/1541-4337.12086>.
- Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365, 3065–3081. <https://doi.org/10.1098/rstb.2010.0126>.
- Porpino, G., Parente, J., & Wansink, B. (2015). Food waste paradox: Antecedents of food disposal in low income households. *International Journal of Consumer Studies*, 39, 619–629. [10.1111/ijcs.12207](https://doi.org/10.1111/ijcs.12207).
- Qi, D., & Roe, B. E. (2016). Household food waste: Multivariate regression and principal components analysis of awareness and attitudes among U.S. Consumers. *PLOS One*, 11(7), e0159250. <https://doi.org/10.1371/journal.pone.0159250>.
- Quested, T., Ingle, R., & Parry, A. (2013). Household food and drink waste in the United Kingdom 2012. Retrieved from <http://www.wrap.org.uk/sites/files/wrap/hhfdw-2012-main.pdf>, Accessed date: 16 October 2019.
- Stancu, V., Haugaard, P., & Lähteenmäki, L. (2016). Determinants of consumer food waste behaviour: Two routes to food waste. *Appetite*, 96, 7–17.
- Toma, L., Costa Font, M., & Thompson, B. (2017). Impact of consumers' understanding of date labelling on food waste behavior. *Oper Res Int J*. <https://doi.org/10.1007/s12351-017-0352-3>, Accessed date: 5 October 2019.
- U.S. Census Bureau. (2018). PINC-11. Income distribution to \$250,000 or more for males and females. Retrieved from <https://www.census.gov/data/tables/time-series/demo/income-poverty/cps-pinc/pinc-11.html>.
- U.S. Census Bureau. (2019). American fact finder annual estimates of the resident population by single year of age and sex for the United States: April 1, 2010 to July 1, 2018 population estimates. Retrieved from <https://factfinder.census.gov/aces/tables/services/jsp/pages/productview.xhtml?src=bkmk>.
- U.S. Department of Agriculture. (2019). Food product dating. Retrieved from <https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/food-labeling/food-product-dating/food-product-dating>.
- Wansink, B., & Wright, A. O. (2006). “Best if used by...” how freshness dating influences food acceptance. *Journal of Food Science*, 71(4), S354–S357. <https://doi.org/10.1111/j.1750-3841.2006.00011.x>.