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Household food waste behaviors of participants in a municipal community compost program

SPECIAL SECTION
Community-Based Circular Food Systems

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Abstract

Food waste is a critical problem in the U.S. and globally. Most household food waste is landfilled, with just a small proportion composted. Household food waste accounts for a substantial amount of the food waste problem, but because it occurs in the privacy of people's homes, we have a limited understanding of it, hindering our ability to create policies or programs to address the issue. Community composting programs have the potential to reduce the amount of landfilled food waste and convert it into a valuable resource. One strategy to address this gap is citizen science, whereby the public is trained to collect data and participate in the research cycle. This technique is particularly useful for answering research questions in real-world conditions to which researchers typically do not have access, such as individuals' daily lives and activities in their homes. The purpose of this study was to gain a baseline understanding of the amount of food waste individual households contribute to a community compost program, the primary reasons people generate food waste, the types of pack-

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Conflict of Interest
The authors declare that they have no conflicts to disclose.

aging households typically discard, and individuals' knowledge, attitudes, and beliefs about food waste and the impact that a community-based compost program has on their lives. Participants in a community-based compost program in Florida have positive attitudes and beliefs about reducing food waste, but they have a less positive perception of the value judgments of influential people in their social circles (i.e., social norms) regarding food waste. Participants have limited confidence that they can reduce their food waste. Community-based compost program participants indicate that the program has increased their awareness of food waste, reduced their waste, and increased their appreciation of community-based circular food systems (CB-CFS), i.e., systems that support community well-being while minimizing environmental harm and resource depletion. This study highlights the value of a community-based compost program for diverting food waste from individual households, increasing knowledge, and changing resident attitudes and behaviors related to food waste. Our findings suggest that key behavioral variables, such as self-confidence, may support individual ability to reduce food waste, and that participation in an community composting program may bolster self-confidence and increase the likelihood that individuals reduce household food waste. We recommend that stakeholders interested in developing a community composting program conduct feasibility assessments and provide education to program participants.

Keywords
citizen science, food waste, compost, community food systems, circular food systems

Introduction and Literature Review

With roughly one-third of the food produced for human consumption wasted or lost globally, an estimated 1.3 billion tons annually (Vilariño et al., 2017), food waste is increasingly recognized as a critical global problem. This recognition led to the United Nations Sustainable Development Goal (SDG) 12: Responsible Consumption and Production as part of 17 global SDGs established in 2015 to meet critical environmental, social, and economic objectives by the year 2030 (United Nations, 2015). SDG 12.3, a sub-objective for SDG 12, specifically targets reducing food waste in retail and consumer operations by half by 2030 (United Nations, 2015). In the U.S., food is the least recovered municipal waste material, for which households are responsible for roughly 40% (Pai et al., 2019). Household food waste studies have found that households waste roughly 32% of the food purchased (Yu & Jaenicke, 2020). The majority of household food waste (66%) is landfilled, and only

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4% is composted (U.S. Environmental Protection Agency, 2023). The EPA estimates that each household produces 337.9 pounds of food waste per year, roughly 6.5 pounds per week (EPA, 2023). While there are various estimates of the amount of food wasted by individual households, many of these estimates come from extrapolations from aggregate data, due to the complexity of collecting data at the household scale (von Massow et al., 2019). Recent proposals to reduce household food waste have therefore included calls for the more robust and consistent "internal monitoring" of household/consumer-level food waste *amounts* (i.e., the quantified assessment of food waste by household), as well as of the *drivers* or *constraints* associated with household members' efforts to reduce their waste (Pateman et al., 2020). These calls require that members of the public are engaged as prospective agents of change, capable of helping researchers monitoring food waste and of better understanding factors that contribute to it.

Drivers of Household Food and Packaging Waste

With the identified need for research on household-level food waste behaviors, existing literature has highlighted some significant potential factors. While Qi and Roe's (2016) analysis of food waste awareness and attitudes among U.S. consumers revealed a moderate degree of guilt associated with food waste—and an associated feeling reported by respondents that they could do more to reduce waste—consumers also feel there are direct practical benefits from discarding food in certain situations. For example, approximately 70% of respondents agreed that throwing away food that is past "sell by" or "use by" dates on product packaging can reduce the risk of foodborne illness for themselves or family members. Additionally, 60% agreed that discarding uneaten food is necessary to ensure meals taste fresh (Qi & Roe, 2016). While there may be incongruity between what current food labels mean in terms of food safety and what consumers *perceive* they mean, these findings nevertheless demonstrate that concern about foodborne illness and retaining food freshness is a potential driver of U.S. households' food waste behavior. (Qi & Roe, 2016). Households with children are more likely to waste food, in part due to children generating food waste (e.g., by burning food in preparation), taste preferences (i.e., "picky eaters"), and parental difficulties with estimating portion sizes (Kansal et al., 2022).

Parizeau et al.'s (2015) Canadian household survey similarly found that consumers felt guilty not only about wasting food, but also about using and discarding recyclable and non-recyclable food packaging. Respondents asserted that individuals (as opposed to food manufacturers or government structures) were primarily responsible for reducing both types of waste, suggesting a degree of self-efficacy and perceived control in carrying out waste reduction behaviors (Parizeau et al., 2015). Respondents identified key drivers of both food and food packaging waste, including limited awareness about the social, economic, and environmental impacts of waste, limited knowledge of ways to implement strategies to reduce waste, and time and lifestyle conflicts—particularly for individuals with children in the household (Parizeau et al., 2015). These dynamics point to the need for further understanding of the conditions that facilitate or inhibit food waste behaviors, as well as of how individuals conceptualize their agency in making meaningful changes at home.

Assessing Household Food Waste Through Citizen Science

While household food waste is a large problem in the U.S., it is a difficult phenomenon to monitor directly because it occurs in the privacy of homes. Citizen science, a participatory research method that enlists community members as scientists to collect data at a scale that would not be possible for researchers on their own (Ebitu et al., 2021), has the potential to overcome this barrier. Citizen science is especially useful for collecting data in real-world conditions to which researchers typically do not have access (Pollard et al., 2017). Household food waste, a critical issue for which there is little directly measured data, is a good example of an issue that may be more effectively studied with the help of citizen scientists (Breitenmoser et al., 2024; Pateman et al., 2020). Citizen science methodology can be beneficial not just for collecting data, but also for understanding participants' underlying perspectives and beliefs that are respon-

sible for their behavior (Pateman et al., 2020).

While citizen science is a valuable methodology for gaining a deeper understanding of household food waste, it has been noted that the "yuck" factor associated with sorting through messy and rotting foods creates a significant barrier to the direct measurement of food waste (Roe, 2021, p. 22). Additionally, as with the application of citizen science in other areas, the implementation of citizen science to assess household food waste can be logistically demanding, requiring significant training and coordination with participants that places high demands on research team members, expense (financial reimbursements of participants' time is a common feature), and potential data fidelity issues (Pateman et al., 2020). The presence of these and other challenges (e.g., funding sources may not routinely award citizen science-based food waste proposals due to limited empirical evidence of their value) may explain the limited number of citizen science-based studies of household food waste. However, the current lack of citizen science approaches in this domain presents an opportunity for researchers interested in food waste and circular food systems to utilize citizen science methods (Pateman et al., 2020).

Community Composting Programs: Opportunities and Challenges

Community composting programs may represent an avenue to engage prospective citizen scientists to monitor household food waste or integrate community perspectives on the subject more broadly (Benyam et al., 2018; Christie & Waller, 2019; Pierini et al., 2021). The programs require a local network of private and public non-profit sector actors to provide and operate "distinct collection and processing equipment, such as a set of trucks dedicated to food waste collection, and transfer stations that are able to hold sufficient food waste before being hauled to a treatment facility" to successfully divert residential food waste (Pai et al., 2019, p. 2). This model differs from traditional centralized collection and diversion services that operate at a particular economy of scale at municipal, county, and regional levels. More than 350 U.S. communities have adopted community composting programs (also referred to as residential food scrap collection programs), nearly all in California and Washington (Yepsen, 2015). Curbside collection of separated food scraps (with compost-appropriate food waste picked up by service providers in buckets in front of homes) is the most common format for these programs, in communities such as Palo Alto, California; Boulder, Colorado; and Oak Park, Illinois (Pai et al., 2019). Community composting programs have been found to have ecological, economic, and social benefits as compared with both backyard composting and centralized composting programs, including the localized reuse of "finished" organic matter (i.e., compost), the source-separation of food scraps (which has been shown to reduce waste), and the potential to stimulate small-scale enterprises (Pai et al., 2019).

Key barriers to implementing community composting programs include logistical constraints on finding suitable stakeholders, sites, and participants (i.e., inappropriate or insufficient "social infrastructure"), and data constraints about food waste "flow" disaggregated to a neighborhood or household level (Pai et al., 2019). Inadequate knowledge of the volume of waste generated by specific neighborhoods and/or households limits a community's capacity to strategically plan for and develop a community composting program (Katpatal & Rama Rao, 2010). Another crucial challenge is the limited research on current program participant knowledge, attitudes, and beliefs toward such programs, as well as their ability to reduce their food waste through participation (Wu et al., 2019). However, some studies have explored attitudes toward and willingness to participate in community or residential curbside composting programs (Antone & Hellwinckel, 2021; Niles, 2020).

Antone and Hellwinckel's (2021) survey of neighborhood residents in Knoxville, Tennessee invited to pick up free compost during a localized shortage due to the pandemic demonstrated that the majority of respondents were very supportive of a community composting program that serviced their neighborhood, and 94% were willing to save and sort home food scraps to be picked up for composting. Most respondents were also willing to volunteer at a community composting operation, and a slim majority indicated they would be willing to pay, within a certain range, for a five-gallon

bucket of finished compost produced by the operation (Antone & Hellwinckel, 2021). A survey of rural residents in Vermont found a moderately low willingness to participate in curbside compost collection and an even lower willingness to pay for such a service, as both backyard composting and/or feeding food scraps to pets or livestock were engrained food waste management practices in the area (Niles, 2020).

While community composting feasibility studies have been conducted to assess salient challenges and highlight model programs (Pai et al., 2019; Platt et al., 2014), research on knowledge, attitudes, and beliefs of existing community composting program resident participants is sparse in the academic literature, demonstrating a gap and opportunity (Wu et al., 2019). Prior research on citizens' perspectives on community composting initiatives has been done outside the U.S., in Australia, Argentina, and Italy, for example (Benyam et al., 2018; Bruni et al., 2020; Christie & Waller, 2019; Pierini et al., 2021). These studies assessed citizens' socioeconomic status, their understanding of and attitudes toward how household food waste was generated, and the attitudinal impacts of participating in a community composting initiative (Bruni et al., 2020; Christie & Waller, 2019; Pierini et al., 2021).

While valuable insights have been generated, certain elements of current or prospective participant views remain underexamined. Bruni et al. (2020) acknowledged participant willingness to join community composting programs and identified cost of joining as a key determinant of actual sustained participation, but did not explore participant knowledge, attitudes, or beliefs beyond that. An assessment of apartment resident participation in a communal on-site composting initiative demonstrated increased awareness of food waste and impacts on other psychosocial metrics such as increased motivation to engage in green, nature-based, and community-oriented thinking and action, though the authors cautioned that the case study results were limited and more research was warranted (Christie & Waller, 2019). Pierini et al. (2021) evaluated citizens' existing knowledge and willingness to engage in specific pro-environmental food waste management behaviors, such as sorting food scraps prior to disposal, but did not directly assess broader attitudes or beliefs.

Because of the specific foci and geographic settings of these studies, we contend that our study represents a novel area of research. Our emphasis on utilizing a citizen science approach to elicit knowledge, attitude, and belief—as well as collecting empirical household food waste data—from participants in an innovative Southeastern curbside community compost initiative is one modest step toward better understanding the potential function and impact of comparable programs in the U.S.

Study Context

While food waste experts agree that reducing the overall quantity of food waste is paramount, composting food that would otherwise be sent to a landfill is an important opportunity to model the concept of circular food systems or circular food economies, in which resources generated or used during production, distribution, consumption, and disposal are repurposed for productive use, and are therefore not lost or wasted (EPA, 2023). Various models of composting municipal food waste—often involving collaboration between local governments, private waste operators, nongovernmental organizations, and community members—have been shown to align with circular economy principles that advocate for the regeneration of communities by recycling, reusing, refurbishing, and remanufacturing material resources and incorporating sustainability issues into local policy initiatives (Mihai et al., 2022). To effectively develop and scale up community composting programs, we need a better understanding of the amount of compostable food waste produced by households—distinct from other sources such as restaurants or retailers—and the attitudes, beliefs, and perceptions of participants in U.S. residential food waste composting programs. Therefore, the purpose of this study was to assess the volume of household food waste generated by the City of Gainesville, Florida's community composting program participants, and the primary reasons for that waste. We additionally strived to better understand participant knowledge, attitudes, and beliefs about food waste, their discard behaviors involving food-related packaging, and their perceptions of the overall impact of the community composting program.

The City of Gainesville has set a goal to be 90% zero waste by 2030, and 100% zero waste by 2040 (Hanna, 2023). To help achieve these goals, ordinances to reduce consumption, increase recycling, and improve food diversion opportunities have been enacted. In 2021, the City of Gainesville initiated a pilot program for residential curbside collection of separated food scraps, partially funded by a U.S. Department of Agriculture (USDA) Community Compost and Food Waste Reduction grant, with the city contributing funds as well (Vargas, 2020). The purpose of the pilot program is to determine the feasibility of community composting collection programs and to gauge interest in participating in alternative waste recovery programs. The program will provide valuable data to help the city determine what zero waste initiatives to pursue in the future. The program started with 200 participants who deposit their compostable food waste into buckets picked up weekly by a local composting company, Beaten Path. Program participants place a five-gallon bucket containing their compostable food waste outside their homes each Tuesday. Beaten Path picks up their full buckets and drops off clean five-gallon buckets. These participants each contribute about seven pounds of food waste each week (City of Gainesville, 2023). The composting company also composts food waste from restaurants and residents outside the pilot program areas, who pay for the service. Beaten Path sells the compost to gardeners and farmers who use it as a soil amendment. Between 2021 and 2023, the pilot program diverted over 58.50 tons of food waste from landfills, and reduced greenhouse gas emissions by 36.69 $MTCO_2E$ (metric tons of carbon dioxide equivalent) (City of Gainesville, 2023). In 2024, the program expanded to enroll another 200–230 more participants in an expanded range of neighborhoods (Gainesville Zero Waste News, 2023).

Methods

Recruitment

Two phases of data were collected. In October of 2021 and March 2024, surveys were distributed to all participants of the curbside compost pilot program (200 and 430, respectively). In March 2024, the research team recruited citizen scientists from the participants in the curbside compost program. A total of 107 Gainesville residents signed up to participate in the citizen science study and received project materials.

Citizen Science Data Collection

Enrolled participants received a 2-gallon compost bin, a digital scale, and an instructional guide, which included a visual guide of different types of food packaging to help them report on the types of packaging they discarded. We sought to mitigate the above-mentioned "yuck factor" (Roe, 2021, p. 5) by having participants record the total weight of daily food waste, rather than separating and weighing each type of food wasted. They received a daily log sheet to record the total weight of the discarded food, types of discarded packaging, and the reasons they discarded food on that day. At the end of each day the citizen scientists weighed their total food waste in pounds. They were given a list of reasons that food may have been discarded and were asked to note each day if food had been discarded for any of those reasons, with an "other" category to write in any other reason food had been discarded. Similarly, participants were given a list of types of packaging and were asked to record if they had discarded any that day. Citizen scientists recorded only waste produced within the household. Because the purpose of the study was to assess food waste in relation to a residential curbside compost program, we focused on waste produced in homes, which would be part of the residential food waste stream, rather than waste that would be in the business or restaurant waste streams.

The research team provided the citizen scientists with a pre-recorded video to explain how to record data, and the research team also hosted a live training and question and answer session the evening before data collection began. For a two-week period in April 2024, the citizen scientists recorded their food waste data. At the end of the data collection period, the citizen scientists received a prerecorded video instructing them how they would transfer the data from their log sheets into the online survey. The research team then hosted a live training and question and answer ses-

sion the evening of the last day of data collection, the day before they were asked to provide the data back to the research team. At the end of the two weeks, they received a survey via an online survey platform (Qualtrics). Upon completing the data collection and survey, participants were provided US$150.00 in compensation for their time and effort via electronic Amazon gift cards (eCards).

Citizen Science Instrumentation

The research team developed a survey to collect information about participant demographics, food waste data, and their knowledge, attitudes, and beliefs about household food waste. The questions about knowledge, attitudes, and beliefs were based on Ajzen's (1985) Theory of Planned Behavior (TPB). TPB asserts that an individual's behavior is preceded by an intention to act, that the intention to act is influenced by the person's attitudes toward the behavior (i.e., whether the person sees the behavior as positive or negative), subjective norms (i.e., the person's perceptions of social pressures or expectations about the behavior), and the person's perceived control over the behavior (i.e., their belief in their ability to perform the behavior successfully) (Ajzen, 1985). We also asked about their experiences in the curbside compost program, including what year they joined and whether they had received compost from Beaten Path. The survey also included Likert-type agreement questions (1=*Strongly Disagree* to 5=*Strongly Agree*) about perceptions of the impact of participating in the program: e.g., "I have increased awareness of food waste"; "I have reduced my household food waste"; and "I have increased appreciation for circular food systems (or 'closing the loop')." The survey questions matched the data collection logbook in which participants entered their citizen science data for each day—the total weight of food discarded, the reasons they discarded food, and the types of packaging they discarded.

An expert panel of food waste researchers and practitioners reviewed an initial draft of the survey for face and content validity, that is, its perceived relevance to and representativeness of the subject matter and appropriateness and usefulness for target respondents (Creswell & Plano Clark, 2017). The survey was revised based on this review, yielding the final instrument that was given to participants. This research was approved by the University of Florida Institutional Review Board (IRB # ET00019640).

Data Analysis

We generated descriptive statistics for the data using the statistical software package SPSS. To produce the final frequency, mean, and standard deviation rates for the "daily weight of food composted," "reasons for food discard," and "types of packaging discarded" variables, we computed respective variables over the 14-day waste logging period.

Results

The 2021 survey received 120 responses (60% response rate), and the 2024 survey received 84 responses (20% response rate). In total, 84 respondents completed the citizen science study (79% study completion rate), generating data on the demographic and household characteristics of participants in the City of Gainesville's curbside compost pilot program.

Citizen Scientists

Table 1 displays the demographics of the citizen scientist respondents. Most of our sample had a graduate or professional degree (61.9%) and were employed full-time (58.3%), reflecting county-level U.S. Census data in terms of employment (Alachua has a 59.9% employment rate), but disproportionately representing advanced-degree earners, as only 28.9% in the county have graduate or professional degrees according to 2023 American Community Survey estimates (U.S. Census Bureau, 2023a; U.S. Census Bureau, 2023b). Most participants were between 40–59 (41.7%), and the vast majority identified as White (97.6%) and not Hispanic or Latino (89.3). Most households consisted of two adults (79.8%), with a near-even split between those with and without children living at home (51.2% and 48.2% respectively). For income, 34.6% of households reported an annual income exceeding $150,000 (all amounts in US$), with the next highest proportion of respondents (21%) reporting they earned $70,000–$109,000 and $110,000–$149,000 per year, respectively. Median household income in

Table 1. Demographics and Household Characteristics of Citizen Scientists

Variable	f	%
Age Range		
18–39	23	27.4
40–59	35	41.7
60–79	22	26.1
>80	4	4.8
Race		
White	82	97.6
Black or African American	2	2.4
American Indian or Alaska Native	1	1.2
Asian	5	6
Ethnicity		
Not Hispanic or Latino	75	89.3
Hispanic or Latino	8	9.5
Missing	1	1.2
Education Level		
High school graduate or GED certificate	3	3.6
Some college, technical or vocational training	5	6
Associate degree	4	4.8
Bachelor degree	20	23.8
Graduate or professional degree	52	61.9
Current Employment Status		
Employed (full- or part-time)	63	75
Unemployed	3	3.6
Retired	16	19
Student	1	1.2
Approximate Annual Household Income (US$)		
<$15,000–$29,000	3	3.7
$30,000–$69,999	16	19.8
$70,000–$109,999	17	21
$110,000–$149,999	17	21
>$150,000	28	34.6
Received Food Assistance in Last 12 Months		
No	82	97.6
Yes	2	2.4
Number of Adults Living in the Household		
1	8	9.5
2	67	79.8
3 or more	9	10.7
Children Living in the Household		
No	41	48.8
Yes	43	51.2
Number of Children Living in the Household		
1	16	19
2	22	26.2
3	3	3.6
4	1	1.2
Approximate Weekly Spending on Food in a Normal Week (US$)		
<$50–$100	10	11.9
$101–$200	35	41.7
$201–$300	30	35.7
>$300	9	10.7
Year Joined City Curbside Compost Program		
2021	35	41.7
2022	12	14.3
2023	30	35.7
2024	7	8.3
Received Beaten Path Compost		
No	70	83.3
Yes	13	15.5
Missing	1	1.2

Alachua County, $57,566, is lower than the income reported by study participants (U.S. Census Bureau, 2022). Most respondents (97.6%) reported they had not received food assistance (e.g., SNAP) in the past year. In Alachua County, Florida, 8.8% of the population is SNAP-eligible (Florida Department of Health, 2022). There was moderate variability in weekly spending on food, with the bulk of respondents indicating they spent $101–$200 (41.7%) on food in a normal week. The largest percentage of the respondent cohort joined the city's program in 2021 (41.7%), when it started, with the next highest number (35.7%) joining in 2023. Finally, most respondents had not received Beaten Path's finished compost product generated from their food waste (83.3%).

Table 2 presents respondents' attitudes and beliefs about food waste reduction, as well as their perceptions of normative influences and their perceived self-efficacy/control in reducing their household waste. Attitudes about food waste reduction as a practice were extremely positive, with the highest mean scores for the practice being "overall good" (M = 4.99), "beneficial" (M = 4.96), and "good for communities" (M = 4.94). The overall attitude scale mean score of 4.88 reiterates the overall positive food waste attitudes, respondents believing that food waste reduction has positive social and environmental impacts. Respondents believe that reducing food waste will "reduce landfill use" (M = 4.75)

Table 2. Participant Food Waste Reduction Attitudes, Beliefs, Norms, and Perceived Control (*N* = 84)

Variable	*M*	SD
Reducing Food Waste Attitudes		
Overall bad – Overall good	4.99	.11
Harmful – Beneficial	4.96	.19
Bad for communities – Good for communities	4.94	.28
Unimportant – Important	4.91	.28
Useless – Useful	4.90	.34
Not a priority – A high priority	4.55	.59
Attitude scale	4.88	.20
Reducing Household Food Waste Beliefs		
Reduce landfill use	4.75	.83
Make a meaningful difference environmentally	4.52	.81
Decrease greenhouse gas emissions	4.44	.97
Conserve energy	4.35	.77
Conserve water	4.26	.88
Help mitigate climate change	4.19	.94
Reduce food insecurity	3.70	1.03
Beliefs scale	4.32	.70
Household Food Waste Norms		
Most people important to me support my efforts to reduce the amount of food I discard	4.31	.91
The media I consume frequently highlights the importance of reducing FW	3.40	1.31
Most people important to me believe I should reduce the amount of food I discard	3.08	1.25
Norms scale	3.60	.83
Household Food Waste Perceived Control		
Whether I reduce my FW is completely up to me	4.11	1.09
I am capable of discarding less food than I currently do	3.89	1.10
Perceived control scale	4.00	.88

and make a "meaningful difference environmentally" (*M* = 4.52). The generated beliefs scale affirms these moderately strong views. Social norm scores suggest a moderately supportive social environment, with the highest score for "most people important to me support my efforts to reduce the amount of food I discard" (*M* = 4.31). The norms scale score of 3.6 highlights potential uncertainty from respondents about how supportive normative influences were for reducing food waste. Perceived control (i.e., personal efficacy) scores in carrying out food waste reduction were also moderately high, with a scale mean score of 4.0.

The citizen scientists reported the total daily weight of food discarded over the two-week logging period, and the frequency of participants discarding food for specific reasons and discarding food packaging types. Table 3 presents the average daily weight of food composted over two weeks, which participants weighed in a provided two-gallon compost at the end of each day. For both weeks, Sunday (2.5 lbs. and 2.6 lbs., respectively) generated the highest average weight. Weekend averages were overall higher than weekdays, indicating more waste producing activity on those days. Overall, the total weight of composted food remained consistent across both weeks (14.17 lbs. for Week 1, 14.34 lbs. for Week 2).

Table 4 displays the percentage of citizen scientists who discarded food for specific reasons at any point over the two-week data collection period, as well as the average number of days (of 14) that food was discarded for each reason by each citizen scientist over the collection period. For each day, citizen scientists were prompted to indicate whether they had discarded food for any of these reasons with a "check all that apply" question format. All of them discarded "inedible parts," the

average number of days being almost 12 of 14 (M = 11.94 days). Less frequently cited discard reasons included when food was "old" (i.e., past recommended storage time in fridge or pantry; 88.1% of participants; M = 3.4 days), there was "too little food to save" (72.6% of participants; M = 2.87 days), and food had "blemishes/ damage" (70.2% of participants; M = 2.5 days). Responding to the "other" discard category (41.7% of participants; M = 1.45 days), participants were able to write a specific reason for discarding food not described by the preceding options. For example, several respondents indicated that the process of feeding their babies or toddlers generated waste. Finally, discarding food due to public health advisories or food contamination rumors were the least cited reasons by participants.

Table 3. Average Weight of Food Composted, in Pounds (N = 84)

	Week 1		Week 2	
Day	***M***	**SD**	***M***	**SD**
Monday	2.35	2.11	2.25	1.29
Tuesday	2.15	1.57	1.94	1.01
Wednesday	1.27	1.29	1.97	1.21
Thursday	1.97	1.22	2.08	1.47
Friday	1.92	1.47	1.88	1.29
Saturday	2.19	1.73	2.38	1.88
Sunday	2.50	2.20	2.60	2.07
Weekday Average	2.08	1.18	2.03	0.96
Weekend Day Average	2.36	1.78	2.51	1.76
Total for Week	**14.17**	**8.40**	**14.34**	**7.26**

Note: (1 lb. = 0.45 kg)

Table 4. Food Discarded by Reason (N = 84)

Discard Reason	*f*	%	*M*	SD
Inedible parts	84	100.0%	11.94	2.65
Old	74	88.1%	3.4	2.67
Too little to save	61	72.6%	2.87	3.08
Blemishes/damage	59	70.2%	2.5	2.91
Smelled and/or tasted "off"	46	54.8%	1.32	1.99
Past packaging dates	36	42.9%	0.92	1.47
Other	35	41.7%	1.45	2.94
Stored improperly	25	29.8%	0.56	1.17
Ate out or planned to eat out	24	28.6%	0.69	1.8
Too much and too little space to save	18	21.4%	0.43	1.19
Cooked improperly	17	20.2%	0.27	0.65
Part of rumored contamination outbreak	1	1.2%	0.01	0.1
Subject to recall or public health warning	0	0.0%	0	0

Table 5 presents the percentage of respondents who reported discarding specific food packaging types at least once over the collection period. The most frequently discarded types of packaging were plastic containers (100%), plastic film/wraps (97.6%) and bags (95.2%), and paper and cardboard boxes (97.6%).

Participant Feedback on City Curbside Compost Program

The curbside compost program started in 2021, and 42% of study participants enrolled in the program that year, with 14% joining in 2022, 36% joining in 2023, and 8% joining in 2024. Table 6 summarizes their involvement with the pilot program and their perceptions of its impacts. In terms of perceived impacts, respondents reported high rates of agreement ("somewhat agree" and "strongly agree") that their participation in the compost program increased their awareness of food waste (85.8%), reduced their household food waste (71.5%), and increased their appreciation for circular food systems and/or the idea of "closing the loop" (79.8%).

Reflecting the strong "increased awareness" agreement scores in Table 6, responses to the open-ended questions highlighted that increased awareness of food waste translated into reduced food waste. As one respondent noted:

> My family as a whole is more mindful about the food we eat, how much, and in particular our portion sizes starting out so that we reduce the amount we used to throw away.

Another respondent strongly affirmed this sentiment, demonstrating that increased awareness may in fact lead to sustained behavior change for this household:

> We've significantly reduced the amount of garbage we produce, as a large portion of our household waste now goes into the compost bin. This program has heightened our awareness of the amount of food waste we generate daily. We are also considering installing our own compost bin in the backyard to further contribute to environmental sustainability.

Table 5. Packaging Types Discarded (*N* = 84)

Packaging Type	*f*	%	*M*	SD
Plastic containers	84	100.0%	6.69	3.25
Plastic film and wraps	82	97.6%	6.92	3.88
Paper and cardboard boxes	82	97.6%	6.57	3.2
Plastic bags	80	95.2%	6.69	4.04
Plastic bottles	77	91.7%	4.36	3.32
Aluminum cans	71	84.5%	5.08	4.28
Paper bags	70	83.3%	2.2	1.86
Metal aluminum foil and trays	69	82.1%	2.54	2.14
Tin cans	65	77.4%	2.58	3.29
Paper and cardboard composite material	65	77.4%	2.57	2.63
Paper and cardboard wraps	63	75.0%	2.73	3.05
Glass bottles	57	67.9%	1.94	2.1
Glass jars	55	65.5%	1.39	1.5
Plastic foam	54	64.3%	1.52	1.77
Plastic trays	52	61.9%	1.64	2.42
To-go containers	49	58.3%	1.37	1.71
Disposable cups	40	47.6%	1.55	2.5
Disposable plates and bowls	30	35.7%	0.82	1.55
Straws	22	26.2%	0.63	1.39
Utensils	22	26.2%	0.5	1.13

Certain respondents indicated that they were grateful that the pilot composting program provided them with increased capacity and ability to compost, which they struggled to do consistently and/or successfully despite their interest. As one participant noted:

> I have been composting for a while. But my small compost bin was not able to keep up with the amount of food we were putting in it, so I had to throw out the rest. The city compost allows me compost what I can and then send the rest to the city to be composted, rather than the garbage. Also, during colder months I almost exclusively use the city's compost because mine does not break down as fast when not exposed to heat.

Another respondent agreed that their personal composting efforts were complicated by technical issues and lack of confidence, making the Gainesville composting service a much-appreciated asset:

> I am so grateful to have this program as a resource. I was struggling to properly maintain the correct ratio of green to brown compost while doing it on my own, and I was worried about handling it improperly and accidentally creating a biohazard. Through the program, I'm able to be more cognizant of my food waste and achieve my sustainability goals without it being all on me.

Table 6. Gainesville Curbside Compost Pilot Program Participation Impacts

Variable	Strongly disagree (%)	Somewhat disagree (%)	Neither agree nor disagree (%)	Somewhat agree (%)	Strongly agree (%)
Increased awareness of food waste	8.3	—	6	17.9	67.9
Reduced household food waste	6	7.1	15.5	42.9	28.6
Increased appreciation for circular food systems	4.8	2.4	13.1	16.7	63.1

Participants affirmed that "composted waste has ecological value," indicating the practical value that generating compost had for the health of their home gardens and the capacity to attract beneficial pollinators to their yards. One participant noted, "the free compost went into our yard/plants. [The] full circle feels good." Another participant stated, "I started my own backyard compost and started a home vegetable garden and butterfly garden."

Finally, respondents noted that their participation in the community compost program helped to mitigate a frequently mentioned concern about home composting systems attracting rodents. One respondent expressed their appreciation that the program addressed this issue:

> We had problems with rodents getting into our compost bin so the curbside program has allowed us to compost without also having to deal with rats. We're very grateful to have the option.

Another participant echoed this perspective, sharing their own experience with increased rodent and other pest challenges:

> Our vegetable and fruit compost started attracting rodents. We also happen to live near one of the local Publix grocery stores. When we realized it was attracting pests, we stopped composting in our back yard. That was about the same time the curbside pickup started. It solved the issue of pests coming into our yard.

Overall, these quotations reflect appreciation for the practical value that the pilot community composting program provided.

In terms of program logistics, in 2021 and 2024 the curbside compost pilot program participants were asked how frequently they set out their compost buckets for collection. In 2021, 79% of participants set them out every week, while 18% did so most weeks. Very few respondents indicated that they rarely or never set out their buckets. In 2024, the number of participants who put out buckets for collection every week dropped to 61%, although the rate of participants bringing out buckets most weeks increased to 35%. Participants were asked about the frequency of compost buckets not being collected by the contracted compost company after participants had set them out on the curb. Most (84.5%) of participants reported never having their bucket missed. 11.9% experienced a missed pick-up once, 2.4% reported a missed pick-up two or three times, and 7.1% reported there were missed pick-ups multiple times.

Participants were asked how easy or difficult it was to separate food waste from garbage. Most respondents (81%) found it very easy to separate food waste from garbage, and 16.5% found it easy. Only 2.5% of respondents reported it was neither easy nor difficult, and no respondents found it either difficult or very difficult to separate the waste types. While they indicated that it was not difficult, they did have express uncertainty in the open-ended responses about "items that are not okay to put in [the] bucket," and "what paper waste can go into the bucket."

In 2021 and 2024, participants were asked about whether they experienced issues with insects and compost. In 2021, about half of respondents (50%) reported no issues with insects in their collection containers, 28% experienced problems a little, and 16.5% had a moderate amount of issues with insects. In 2024, responses to the same question showed those experiencing no issues increased to 80%, while those experiencing problems a little decreased to 17%. In the open-ended responses, participants described their issues with pests and made suggestions about bucket cleaning to reduce bugs. One respondent advised, "the small collection bucket [should] be emptied at least once a day … this reduced fly infestation." A second respondent provided a more expansive recommendation:

> We had a lot of insects with the small pail in the kitchen. We eventually moved toward just using the bucket and that has prevented insects. I think many may be discouraged if they're using the small pail in combination and not immediately throwing it in the yellow bucket. Perhaps the [program] literature can encourage folks not to leave the small pail out for too long or provide a pail that seals better to prevent insect intrusion.

Participants were asked about when their food waste collection day occurred, in relation to their standard garbage collection day. Approximately half (49%) confirmed that their food waste collection day was the same as their garbage collection day, approximately half (48%) reported that their food waste collection was the day before garbage collection, and only 3% reported food waste collection was the day after garbage collection. Participants were asked what day of the week that they would prefer to have their food waste collected. A significant majority (81%) preferred collection to take place the same day as their garbage collection day; 15% favored food waste collection the day before garbage collection, 3% preferred collection on a Monday or Friday, and only one respondent indicated they preferred food waste collection the day after garbage collection. In the open responses, they expressed their interest in changing and/or adding a compost collection day. As one respondent noted, "our yellow bucket day is two days before garbage day. It would be easier to remember if it were the same day." Another respondent indicated they would prefer an additional pickup day during the week:

> Container collection twice a week. It would help avoid bugs, make [the] container lighter (sometimes mine gets too heavy to carry to the curb), and it would eliminate [the] temptation to discard good scraps in [the] regular trash if I ever forgot to discard something that was sitting in the back of the fridge.

The City of Gainesville hosted an educational event for program participants, where participants learned about how waste is composted and were able to take a bucket of compost home with them. The majority (60%) acknowledged receiving an email about the event but did not attend, and 21% reported being completely unaware of the event. Only 12% indicated they attended the event. Based on the open-ended responses, this event would have answered many questions that participants had about the program. For example, the survey responses included various topics about the program, such as "what the compost is used for after it's collected," and "how the waste is composted." In the open-ended responses, participants expressed an interest in receiving compost from the program; a representative pertinent question was "how [do I] obtain compost for [my] garden, if this will eventually be an option with the program?" A respondent echoed this with an inquiry as to whether "there's a way to purchase the compost that's made."

Discussion

This study contributes new understanding of attitudes, beliefs, social norms, and self-efficacy that community compost program participants have about household food waste and the impact that the community compost program has in their lives. In our study, individuals had positive attitudes toward reducing food waste and believe that reducing food waste will have a positive impact on their communities. However, the lower scores for the responses in the social norms and their perceived agency over reducing food waste highlight the importance of the broader context in which household food waste occurs and individuals' perceived ability to reduce their food waste. Notably, our respondents indicated that they do not think that the media emphasize the importance of reducing household food waste, and they had lower scores for their perceptions of their capability to reduce their household food waste.

These findings have theoretical implications for the adoption of food waste reduction behaviors. As Ajzen's (1985) TPB posits, attitudes, subjective norms, and perceived behavioral control are directly associated with behavioral intention, which has been demonstrated to be the strongest predictor of the actual adoption or maintenance of a target behavior (Ajzen, 1991; Fishbein & Ajzen, 1975). Because TPB has been effectively integrated in previous consumer food waste studies to frame decision making around household food waste reduction (Graham-Rowe et al., 2015; La Barbera et al., 2022), we contend that our TPB-informed results also have implications for household food waste reduction efforts among comparable communities. The low self-efficacy and perceived control scores provide a key example of how efforts to reduce food waste reduction efforts can be hampered and where

policy and programmatic initiatives should focus their efforts.

The open-ended responses provide additional detail on participant positive attitudes and beliefs about how reducing food waste impacts the community. Many of them had struggled with their own efforts to compost, so this program was a valued way for them to keep their food waste out of the landfill and recycled into their community, making this program likely to support feelings of self-efficacy and more positive social norms related to reducing food waste. Responses to open-ended questions regarding their experience with the pilot compost program demonstrated an appreciation of the program's role in repurposing their household's waste into a circular system, rather than into a conventional waste stream. Several respondents indicated that while they had previously attempted to compost, they had struggled to do so effectively.

An important finding of this study was that the citizen scientist households reported more than double the amount of food that discarded per week (with a mean of over 14 pounds for each week) as compared with the EPA estimate of 6.5 pounds per week. This study provides data on the reasons why people waste food, and on the quantity of waste that individuals in a community compost program can divert from landfills. We found that the overwhelming reason that people discarded food was that they were discarding parts of food that they perceived to be inedible. With the goal of reducing food waste, there is an opportunity for future research and education involving awareness/knowledge of food parts that are edible but commonly discarded, such as broccoli stalks, and of ways to reuse food scraps via stocks, pickling, freezing, and recipes designed to use food scraps. As 42% of respondents reported discarding compostable food for "other" reasons, further exploration of these additional reasons may be warranted. Several respondents reported discards that were due to babies or very young children not finishing their food or throwing it on the floor. This dynamic may not be surprising since most respondents (51.2%) reported having children living with them at home. The recurrence of this cited reason may reflect patterns from prior and ongoing research concerning the significant influence children have on household food waste production, despite the best intentions of adult household members (Kansal et al., 2022; von Massow et al., 2019). Other reasons for discarding food included impending travel, returning from travel, and spoilage from a malfunctioning fridge. With respect to household members' agency and personal control in adopting waste-reducing behaviors, these discard reasons appear less subject to fickleness about food quality, taste, and preference; they may be less actionable than other discard reasons as behavioral decisions to reduce food waste. For researchers interested in further examining this topic. and for policymakers and stakeholders interested as well in reducing household waste in their communities, the practical implication of this study may be to increase focusing on sources of food waste that are under the control of individuals.

Finally, this study provides an initial overview of the types of food-related packaging that are thrown away, understanding that can be used to develop strategies to reduce the waste by encouraging the use of compostable food packaging in communities. The finding that four of the five most discarded items were made with plastic highlights opportunities for cities to adopt policies to require or incentivize the use of compostable packaging products.

Limitations

This project sought to understand citizen scientists' attitudes, perceptions, and beliefs about food waste, as well as the types and quantities of their household food waste and its causes. A serious concern with citizen science data is its quality: if it is of low or inconsistent quality, it can be of limited use (Kosmala et al., 2016). To mitigate this potential issue, we enlisted citizen scientists who were relatively knowledgeable about composting practices, who would have a better chance of understanding what was being asked of them and would have a greater likelihood of completing data collection as directed for the duration of the study, due to already separating their compostable food waste. However, enlisting a group that would yield higher

quality data and with more fidelity meant that our population is not representative of the public, and, hence, these results are not strongly generalizable. As was the case for our study population, it is common for citizen scientists not to be representative, as there is a narrow range of individuals who self-select into participating in citizen science projects who tend to be more educated and affluent, with high levels of interest in science and positive attitudes about the environment prior to enrolling (Chase & Levine, 2018; Domhnaill et al., 2020; Pateman et al., 2021).

Recommendations for Practice

Policymakers, educators, and community stakeholders interested in developing community household composting programs should consider a suite of practical and logistical challenges, many of which were identified by our pilot cohort. First, there must be personnel who can pick up food waste and drop off empty buckets. Program operators may be municipal staff or a contracted third party, as is the case in our study. Sites for waste transfer and processing as well as trucks and waste collection bins are required to facilitate the smooth operation of the composting program. To develop a program, a municipality should assess community needs, scout potential target neighborhoods, identify potential partners, and negotiate a contract or memorandum of understanding with a partner providing the waste pick-up and drop-off service. As the City of Gainesville has done, interested municipalities or organizations should consider implementing a pilot program initially limited to select neighborhoods and households**.** If the pilot program demonstrates promise, program staff can expand the program to additional homes in other neighborhoods.

Educational outreach is also critical. Both in the needs assessment phase of program development, and after a pilot program is launched, stakeholders should conduct regular community workshops and information sessions to educate participants about the benefits of composting, the importance of reducing household food waste, and ways to appropriately discard food waste. As we found from our cohort of participants, logistical constraints can erode participant confidence and willingness to continue to participate in the program. Our data demonstrated that odor, pests, theft, and lack of knowledge could be deterrents for participants. Receiving feedback from participants can help to identify areas for improvement and adjustments to the program, and can also capture information on how to positively motivate participants. Fostering a collaborative environment where participants can share such positive experiences and perspectives with program staff and one another may stimulate program growth.

Conclusion

Community-based compost programs divert food waste from landfills and use it to create compost that can be used by program participants, school and community gardens, municipal landscaping, and commercial farming. Participants in the community compost program in our study had little difficulty participating in the program and identified numerous benefits beyond simply diverting their food waste from landfills. Our finding that households produced more weekly food waste than the EPA official estimates may necessitate additional household-level studies to gain more accurate estimates of the levels of household food waste that could be diverted from landfills and become a part of a circular community food system. While more research is warranted, our study demonstrates that community compost programs are a promising strategy to improve household-level awareness, knowledge, and confidence in reducing food waste, and to bolster a circular food system in a target area. At a broader, global scale, the United Nations Sustainable Development Goal 12.3 target to halve global food waste at the retail and consumer levels necessitates that a wide array of innovative, community-driven models should be proposed, piloted, and studied for their capacity to scale up for regional, national, and potentially global application and impact. While our study highlighted a specific community composting program in a specific target area, our review of literature identified several comparable programs, with understandable variation in size, scope, and structure, across North America and several countries (Benyam et al., 2018; Breitenmoser et al., 2024; Bruni et al., 2020; Christie & Waller, 2019).

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