Understanding electric composting machines as a potential household food waste management strategy

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Abstract:
Household food waste is a significant problem in the US, with billions of dollars of food waste being generated by households each year. In addition to financial loss, food that is disposed of in landfills and through incineration also contributes to greenhouse gas emissions. Composting has long been one method of dealing with household food waste, but traditional composting methods may not be feasible for many households, including those living in the city, in apartments and those with physical limitations. Newly created electric household composters are being advertised as a potential solution to these barriers, but little research has been done into the effectiveness of these machines. This study tested two different brands of electric household composters to determine their usability and effectiveness at reducing food waste and resulting greenhouse gas emissions. Our study found that while electric household composters did reduce the mass of food waste there were still limitations in their feasibility as a large-scale solution to the problem of food waste.

Introduction

Food waste is a significant problem in the United States and around the world. Every year approximately 30% of all edible food, weighing an estimated 67 million tons, is wasted at the consumer and retail level[1]. In the US, over 24% of all municipal solid waste entering landfills comes from food waste[2]. Once in landfills, food waste breaks down and contributes greenhouse gas emissions[3]. For households and individuals, the most effective method of reducing food waste is prevention, but complete prevention is not possible. Some food waste results from the preparation of food for cooking, such as peels of fruits and vegetables, or because foods spoil before being eaten, such as leftover cooked food[1]. Rather than throwing these items in the trash, composting provides a more environmentally friendly method of managing food waste.

Composting is the use of heat, aerobic conditions, and biological decomposition to reduce the volume of organic waste and to create a product that stabilizes carbon. Compost provides nutrients, specifically carbon, to plants[4]. Traditional methods of household composting allow households to dispose of food waste and utilize it for household gardens, or landscaping. These methods have generally included outdoor compost piles and turning composters, as well as indoor vermicomposting. Upkeep of these composting methods can be relatively simple and involves occasionally turning over the compost and rotating between piles over time. Individuals who intend to use the compost for gardening or landscaping may want to invest additional time and energy to ensure that the compost has the desirable nutrient balance. However, if the goal of composting is simply to reduce the amount of food and yard waste entering the municipal garbage system, this is not necessary.

Unfortunately, these methods of composting have significant barriers for many households. Renters are significantly less likely to engage in composting as many apartments do not have access to outdoor space for composting[5]. These methods can also be physically demanding and may be challenging for some senior citizens and individuals with disabilities. Finally, some people find compost piles to be gross and may not be willing to compost because of concerns about pests or general "ickiness."[5]. A study in New York City, for example, found that 35% of city residents who had access to composting through a pilot program chose not to compost out of concerns about rodents and other pests[6]. In some areas, compost piles may even be restricted by HOA rules or municipal ordinances -especially when there are concerns about certain animal pests such as rodents[6].

One possible solution to some of these composting barriers are newly designed household electric composters. These are small, countertop machines that break down food using heat and a rotating mechanism. There

are several different brands on the market, and they claim to produce high quality compost in a few hours while also reducing food waste by 60% or more and limiting greenhouse gas emissions[7-9]. They also advertise as reducing some of the ickiness factors involved in composting[7-9]. If these claims are true, these electric composters could be a solution to managing household food waste for households who are unable to use outdoor methods.

Yet there is limited research so far on the effectiveness of electric composting machines for household food waste management, as well as potential usability factors such as odor, noise, and electricity usage. Thus, our research objective was to examine how electric composting machines perform as a potential tool to manage household food waste. Additionally, we examined how electric composting machines compared to several existing common composting methods.

Methods

Comparison of Composting Methods

We used literature review to compile information on several common existing ways to manage household food waste, specifically: outdoor compost piles and tumbling composters and vermicomposting. We assessed: the physical space requirements needed for the composting method, the volume of food waste the composting method had the capacity to handle, the time required for the food waste to break down into compost, the startup supplies and materials needed, the cost of those supplies, and the time required to set-up the method. In addition, we assessed energy usage with a watage meter, energy source and energy costs, noise generated with a decibel meter, odors generated, and any pest concerns. We obtained information about the existing composting methods from agricultural extension websites, government agency reports and academic databases, including Web of Science and Google Scholar.

Electric Composting Machine Testing

In order to study the effectiveness of electric household composters, we purchased two brands of composting machines, the Lomi Classic model (Machine A) and the Pursonic Food Waste Processor (Machine B). As cost was one of our research interests, we intentionally purchased these two machines from the high and low end of the price spectrum respectively. We collected food waste, including fruit and vegetables peels, eggshells, coffee grounds and cooked grains. We did not include food waste items that were listed by the companies as being incompatible with their machines, including: hard bones, cooking oils, and fruit pits. We also excluded several items that were listed as compostable by the companies, including: compostable household products and meat by products. These items were excluded for reasons of consistency and personal preferences of the testers

to not work with meat products. A full list of items included and excluded is available in Appendix A.

We set up the machines and following the instructions provided by the manufacturer, we ran replicate samples using each machine. In total, we ran fifteen cycles using three different cycles on these two machines. For Machine A, we tested two different cycle types. For each cycle type tested for Machine A, we ran 5 replicates each. For Machine B, we ran 5 replicates of the default cycle. For each replicate tested, we measured the volume, mass, and composition of the food waste before and after the machine finished running. We also measured the total energy used by the machine per cycle using a wattage meter. To assess usability, we measured noise production using a decibel meter and heat production using an electric thermometer at two, 10 and 20 feet from the machine. We also observed the machine and surrounding indoor environment during the cycles to assess for odor, ease of clean-up and other ickiness factors.

Results

Comparison of Composting Methods

We reviewed three existing composting methods, including outdoor compost piles and tumbling composters as well as indoor vermicomposting (Table 1). Outdoor compost piles and turning composters had the potential to hold the largest volumes of food and yard waste and did not require any additional energy outputs since the heat required for composting comes from the sun. Vermicomposting bins hold a smaller volume of food waste (<20L) but can be stored indoors and do not need external energy inputs once they are set up. All of these methods can be set up in relatively little time (1-3 hours) and at low cost although options for more expensive and labor-intensive bins and turners are available. However, these methods require considerable time for food waste to break down into compost. This can take 2-6 months in turning composters and 3-6 months with outdoor compost piles and vermicomposting. They also require ongoing upkeep, including turning over compost bins and tumblers, maintaining conditions in bins for vermicomposting and occasional switching between bins as food waste breaks down. All three methods also have the potential for considerable pest related issues as well as odor and other ickiness factors. Vermicomposting, since it requires the use of worms in an indoor environment, may strike some people as particularly challenging.

Electric Composting Machine Testing

For both machines, there was a significant decrease in the mass of food waste after composting—ranging from a 54 – 76% reduction. From our tests of machine B, we found the average mass of food waste decreased by 66% from the start to end of the cycle. The average energy use per cycle with this machine was 1.187 kilowatt hours (KWH). From our tests of machine A,

we found the average food waste mass decreased by 64% overall. The different kinds of cycles that can be programmed with this machine generated slightly different findings, with the Eco-cycle having an averaged decreased mass of 76% and the Grow-cycle having an average of 54% mass decrease per cycle tested.

Energy use per composting cycle was relatively low between 0.881 – 1.187 KWH, slightly less energy than the average dishwasher uses per load[10]. Overall machine A energy use was an average of 0.962 KWH per cycle. Again, we observed differences by the specific cycle programmed. The Eco-cycle averaged 1.042 KWH per cycle, while the Grow-cycle averaged 0.881 KWH.

Noise production at 2 feet was also relatively low for both machines, ranging from 35 – 50 dB – similar to the sound of a refrigerator running. On average, machine A had slightly lower noise production than machine B, however, the variation was not appreciatively different.

Excess heat production at 2 feet was negligible for machine A, and ~2 degrees F for machine B. However, the room where the machine was tested did not have consistent temperature generally, with larger variation depending on distance from windows. Thus we concluded that precise quantitative measurements about the heat generated from the machine specifically could not be determined, and we accordingly did not include these in the results tables (Table 2).

There were some significant differences observed between the two machines tested in terms of durability and wear-and-tear. Machine B stopped performing well after the 4^{th} cycle run and failed completely after the 5^{th} cycle run. This machine also showed considerable wear and began losing some of its non-stick coating. Machine A did not have any observed issues with wear or performance during the testing period.

Discussion

Our results show that electric composters could be a potential solution to addressing some of the barriers to household composting. Compared to three common composting methods examined, we found electric composters use less space to operate, less time to process food waste, and less time to set up. However, these machines have some significant limitations that would need to be addressed before they could be considered a viable large-scale solution to addressing household food waste. Currently, the machines have a high purchase price which may put them out of reach for many households. In addition, they require electricity which can add an additional cost burden as well as contributing to further greenhouse gas emissions if a household does not have renewable forms of electricity. Finally, there seems

to be significant variation in the performance and longevity of different models. The lower cost model we tested (machine B) broke after only five uses and we noticed other issues with it during testing – including odors that could prevent many individuals from wanting to run it indoors. As a result, for most households who are able, an outdoor compost pile or turning composting bin remains a less expensive and more environmentally friendly method of reducing food waste. Other common methods of composting have lower start-up costs and may generate lower greenhouse gas emissions because they do not require electricity.

Our results are in line with other investigations of electric composting machines. While there are limited studies on the two specific models we tested, New Yorker author, Helen Rosner, has done some similar, informal studies with electric composting machines, including the same model of Lomi as we used in our research (Machine A). Her research found that while these machines dramatically reduced the volume of food waste, whether they ultimately reduced the negative environmental impacts of food waste was less clear and depended on the household's energy grid and what was done with the food waste once it has been processed through the machines[14]. Our findings are also aligned with recent research on consumer preferences for electric compost machines, which found that people want a "user friendly" method of composting[15]. That study also found that cost was not a high priority consideration of those surveyed which potentially indicates that the high price point may not be a barrier for everyone.

Further research looking at a wider range of machines and testing over a longer duration could help us to better understand the strengths and weaknesses of utilizing these machines. There are also many other models of electric composting machines on the market. Testing our study on additional models may find different results.
Additionally, critical questions remain about whether electric compost machines produce usable compost and what potential benefits or harms the output could have when applied to potted plants or outdoor gardens. For example, other models of indoor food scrap processing machines refer to their output as 'dehydrated food waste' and discuss the process as volume reduction, not compost[16]. This distinction refers to the potential distinction that electric machines may be outputting mixtures that are significantly different in nutrients than traditional compost. Several studies looking at the nutrient ratios from compost produced by eclectic composting is not similar to that of compost produced through outdoor compost bins, tumblers or vermicomposting [18-20]. This has recently been confirmed by several of the machine producers, including Lomi founder Jeremy Lang[17]. While our study did not assess the nutrient value of the product produced by these machines, it does agree with these studies that currently, these machines are unlikely to be a better solution for individuals who have the ability to

deal with food waste through more traditional methods.

Ultimately, our findings show that electric composters have many positive attributes when compared to three other common composting methods. The relatively small size of the machines and the ability to run them on a daily or weekly basis allows households without space for an outdoor composting method to reduce the amount of food waste they throw away. In addition, these machines may be more accessible for some senior citizens and individuals with disabilities because of the small size and relative ease of operation. However, the machine's ability to reduce greenhouse gas emissions caused by food waste is more limited and likely offset by the need for electricity to run the machine. More research on electric compost machines is needed to better understand their full life cycle impacts and comparison to other potential methods of managing wasted food in households.

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Tables

Table 1: Comparison of three existing composting methods

	Composting Methods		
	Compost Pile (Outdoor)	**Tumbling Composter (Outdoor)**	**Vermi-composting (Indoor)**
Capacity	> 50L[10]	110 – 375 L[10]	<20 L[11]
Space Requirements	>1 sq. meter	1-2 sq. meters	1-3 sq. feet
Time Required for food breakdown	3-6 months[10]	2-6 months[10]	3-6 months[11]
Startup Supplies Required	Minimal	premade kit or self- designed and built turning bin	Dark colored bin with tight fitting lid; larger bin to catch any drainage ~1 lb of earthworms
Cost of startup supplies	Minimal or free	~$80-$500	$0 - $150
Time required for set-up	1+ hours	1-3 hours	1-2 hours
Energy Source	Sun	Sun	No external energy inputs
Energy Cost	Free	Free	Free
Noise	None	None	None

Smell	Mild – moderate (near the pile)[10]	Mild (near the bin)[10]	Mild - Moderate
Pest concerns	Possible issues with rodents and other wildlife [10,12]	None	Fruit flies and other small insects

Table 2 caption: Comparison of three common composting methods, using data compiled from reviewing literature. We assessed the time, cost, and resources needed to set up the composter, the space requirements and capacity, the time required for food breakdown, energy sources and costs, and potential noise, smell, or pests resulting from the method.

Table 2. Results from testing two models of electric composting machines

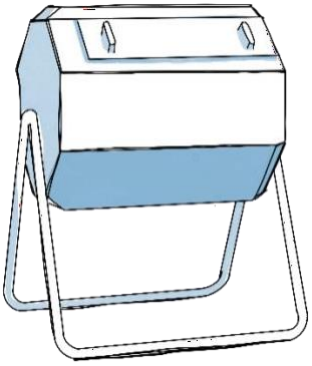
	Electric Composting Machines Tested	
	Lomi Classic (Machine A)	**Pursonic Food Waste Composter (Machine B)**
Capacity	3 L[10]	3 L[7]
Space Requirements	~1.5 sq. feet[10]	~1.25 sq. feet
Time Required for food breakdown	4 – 16 hours depending on the type of cycle run	6-7 hours per cycle
Startup Supplies required	Electric composter; activated charcoal for the filter; activator tablets (optional)	Electric composter
Cost of startup supplies	$595	$350[7,8]
Time required for set-up	15 Minutes	15 Minutes
Energy Source	Electricity	Electricity
Energy Cost	$0.20/cycle[13]	$0.27/cycle[13]
Noise	~ 35 dB at 2 feet from machine	~50 db at 2 feet from machine
Smell	No noticeable smell	Strong odor when operating
Pest concerns	None observed	None observed

Figure 2 caption: Results from our study testing two models of electric composting machines to process household food waste, using lab observations. We assessed the time, cost, and resources needed to set up

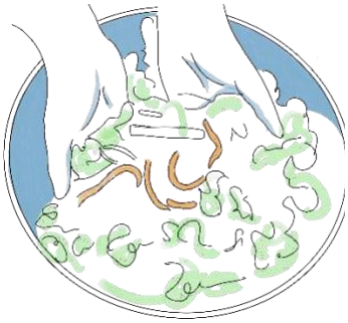
the composter, the space requirements and capacity, the time required for food breakdown, energy sources and costs, and potential noise, smell, or pests resulting from the method.

Figures

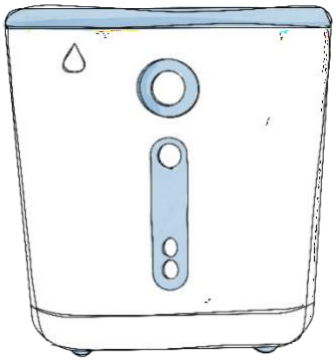
Figure 1: Composting methods examined in study



Outdoor Composting
Outdoor composting can be done with a variety of containers and methods. We examined specifically outdoor compost piles on the ground and tumbling bins, like the one pictured at left.



Vermicomposting
Vermicomposting uses worms to produce compost. This method is often done indoors in bins.



Electric Composters
Electric composters are tabletop machines used indoors that use electricity to break down food waste.

Appendices

Appendix A. Food scraps used in study

Allowed	Not allowed
Fruits (including skins and cores)	Bones
Vegetables	Shells
Rice	Oils and fats
Pizza	Liquids or soups (drained is fine)
Breads and Bread products	Hard pits or large seeds
Cheese	Candy or gum
Eggshells	Meat and Fish*
Cooked beans	Compostable paper products*
Coffee grounds	
Teabags** and loose tea	

* Machine claims to be able to compost, but we did not include.
** Teabags are ok if they are labeled compostable and are not made of plastic. Remove any staples.