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Household Kitchen Waste Management in Ernakulam District: A Focus on Composting Techniques and Challenges

Treesa Sindhu P. Thomas
Research Scholar
Department of Home Science, St. Teresa's College, Ernakulam, Kerala, India
Dr. Leena Leon
Associate Professor and Academic Coordinator
Rajagiri College of Social Sciences, Kalamasseri, Kerala, India

Abstract
The study explores the current household kitchen waste management scenario in Ernakulam district, with a particular emphasis on composting techniques as a viable solution. Composting is highlighted as a basic, efficient, and feasible method for managing biodegradable waste, especially in emerging nations like India. Various composting methods, ranging from traditional pit/store techniques to modern in-vessel systems, are discussed, with a focus on their benefits and challenges. Additionally, the need for an improved organic waste composter is addressed, considering factors such as ease of use, cost-effectiveness, and space consumption. The article also presents findings regarding challenges in managing household waste, based on responses from both urban and rural areas, emphasizing the importance of targeted interventions and awareness campaigns to enhance kitchen waste management practices.
Key words: 1. Households, 2. Kitchen waste, 3. composting, 4. sustainability

Introduction

Household kitchen waste management is a critical aspect of environmental sustainability, particularly in densely populated regions such as the Ernakulam district of Kerala. With the increasing volume of biodegradable waste generated daily, the adoption of efficient waste management techniques is imperative. Composting emerges as a practical solution due to its ability to convert organic waste into valuable fertilizer, thereby reducing the burden on landfills and promoting soil health. However, challenges such as lack of awareness, insufficient facilities for waste collection, and segregation issues hinder effective waste management efforts. The present study aims to explore the potential of composting as a sustainable waste management solution while addressing the challenges encountered in household waste management.

Various composting techniques are available for household-level waste

management, ranging from traditional methods to advanced in-vessel systems. Traditional composting involves simple pit or store setups, which have been practiced for centuries in rural and semi-urban areas. While these methods are cost-effective, they may lack control over environmental conditions and can be labor-intensive. In contrast, in-vessel composting systems offer greater control over factors such as temperature, moisture, and airflow, leading to faster and more efficient composting. Among the in-vessel systems, bin composting stands out for its simplicity, lightweight design, and space-saving attributes. However, challenges such as manual handling of compost, odor issues, and concerns about cost and space consumption persist, highlighting the need for innovation in composting technology.

An analysis of challenges in household waste management, based on responses from both urban and rural areas in Ernakulam District, reveals common issues such as lack of facilities for waste collection, segregation difficulties, scarcity of land for disposal, and dumping of electronic waste. Additionally, the lack of awareness about proper waste management practices is a significant challenge, particularly in rural areas. Addressing these challenges requires targeted interventions, including educational programs and awareness campaigns, aimed at promoting sustainable waste management practices and fostering community participation.

Efficient household kitchen waste management is essential for environmental sustainability and public health. Composting emerges as a viable solution for managing biodegradable waste, offering benefits such as waste reduction, soil enrichment, and resource conservation. However, challenges such as lack of awareness, inadequate infrastructure, and technical constraints need to be addressed to enhance the effectiveness of waste management initiatives. By promoting innovative composting technologies and raising awareness about proper waste management practices, we can work towards creating cleaner, healthier, and more sustainable communities in Ernakulam District of Kerala and beyond.

Methodology

The study was conducted among 526 homemakers of both urban and rural areas of Ernakulam District, Kerala. The survey method was adopted and the data was collected with the help of a structured interview schedule. The data was consolidated and analyzed using percentage and statistical analysis.

Results and Discussion

The demographic characteristics of the respondents were collected to record the relevant information about the respondent's personal and family details.

Table No: 01 General details of the homemakers

Personal details of the homemakers		Frequency (N=526)	Responses in percentage (%)
Age (Years)	21-30	147	27.9
	31-40	185	35.2
	41-50	127	24.1
	51 – 60	48	9.1
	Above 60	19	3.6
Marital status	Married	473	89.9
	Unmarried	53	10.1
Type of family	Nuclear	394	74.9
	Joint	132	25.1

The structure of respondents based on their age group is set between 21 years to 30 years, 31 years to 40 years, 41 years to 50 years, 51 years to 60 years, and above 60 years constituted 27.9%, 35.2%, 24.1, 9.1, 3.6% respectively. The majority of the respondents belonged to the age group of 31-40 years with 35.2%. Considering the marital status the respondents were either married (89.9%) or unmarried (10.1%) category. The nuclear family refers to the core members of a family, usually parents and children and 74.9% of studied samples represented the nuclear family system and 25.1% of the homemakers belonged to the joint family. Moreover, this study and the report of NFHS 4 Kerala both highlighted the prevalence of nuclear families, where the present study reported a majority (74.9%) and NFHS 4 Kerala reported (2019) as 57.9% of representation is from nuclear families

Socio-economic profile of the homemakers

The socio-economic details of the urban and rural homemakers collected include educational qualification, employment status, and type, and total monthly income of the family.

Table No: 02 Socio-economic profile of the homemakers

Socio-economic variables		Frequency (N=526)	Responses in Percentage (%)
Educational Qualification	Illiterate	0	0.0
	Primary	83	15.8
	Secondary	16	3.0
	HSC	25	4.8
	Graduation	141	26.8

	Post Graduate	209	39.7
	Professional Graduation	52	9.9
Employment status	Employed	253	49.1
	Unemployed	273	51.9
Total monthly income of the family	Below Rs.10000/-	27	5.1
	Rs.10001 to Rs.30000/-	193	36.7
	Rs.30001 to Rs.50000/-	134	25.5
	Rs.50000 to Rs.100000	125	23.8
	More than Rs.100000	47	8.9

Based on the data obtained, all the homemakers were literate. The literacy stages constituted of primary education, secondary, higher secondary, graduation, post-graduation, and professional graduation were 15.8%, 3.0%, 4.8%, 26.8%, 39.7%, and 9.9% respectively. 39.7% of the respondents were post-graduation holders and they constituted the highest in the participation. Most of the respondents were unemployed with 51.9% of participation. In this study, 36.7% of the participants constitute the income group of Rs.10001- Rs.30000. 25.5% belonged to the group of Rs.30001- Rs.50000 followed by 23.8% respondents in the Rs.50001- Rs.100000 total monthly income group and just 8.9% fall under the above 1 lakh category.

Household solid waste characterization study

Table No: 03 Generation of household solid waste by rural and urban households

Type of waste generat-ed	**The area of the household is located**	**Frequency of generation of household solid waste in (%)**			x^2	**p-value**
		Daily	**Some times**	**Never**		
Kitchen waste	Urban (N=421)	387 (91.9)	18 (4.3)	16 (3.8)	15.71	0.000***
	Rural (N=105)	105 (100)		-		

(***) level of significance at the 0.001 level.

The chi-square test revealed a statistically significant association between waste generation and area, indicating a significant difference in kitchen waste generation between urban and rural areas ($\chi 2 = 15.71$, $p < 0.001$). In urban areas, 91.9% of households generated kitchen waste daily, followed by 4.3% and 3.8% reported sometimes and never generated kitchen waste respectively. In rural areas, 100% of households generate kitchen waste daily.

Table No: 04 Quantification of household solid waste generated

Type of waste	Area of house	Quantity of household waste generated Responses in percentage (%)				x^2	p value
		<1kg	1-2 kg	>2kg	No Waste		
Kitchen waste	Urban (N=421)	165 (39.2)	169 (40.1)	87 (20.7)	-	43.855	0.000***
	Rural (N=105)	46 (43.8)	59 (56.2)	-	-		

(***) level of significance at 0.001 and (**) level of significance at0.05.

In urban areas, 39.2% of households generated less than 1kg of kitchen waste, 40.1% generated 1-2 kg, and 20.7% generated more than 2 kg. In rural areas, 43.8% of households generated less than 1kg, 56.2% generated 1-2 kg, and none generated more than 2 kg. The chi-square test showed that there was a significant difference in the quantity of kitchen waste generation between urban and rural areas ($\chi 2=43.855$, $p < 0.05$). The study responses demonstrated how food and kitchen waste (the organic part) consistently made up more than two-thirds of the waste composition in both urban and rural areas. The fact that there is a high level of consumption can be ascribed to the high proportion of organic content in the household solid waste produced from households. As a potential way to reduce the amount of garbage that needs to be transported to the landfill and to turn the organic portion of waste into compost, a high level of organic fraction can be used for composting.

Recycling and reusing of waste generated

This study explored the recycling and waste reutilization habits among urban and rural homemakers to understand the patterns and disparities. Table No. 05 breaks down responses, showing the percentages of households engaged in recycling practices.

Table No: 05 Habit of Recycling and reusing of waste generated

The area of the household located	Habit of recycling and reuse of waste generated			x^2	p-value
	Responses in percentage (%)				
	Yes	No	Total		

Urban	340 (80.8)	81 (19.2)	421 (100)	.031	.861
Rural	84 (80.0)	21 (20.0)	105 (100)		
Total	424 (80.6)	102 (19.4)	526 (100)		

The P-value in the above table is considered non-significant

From the data obtained it was observed that the majority of respondents in both urban and rural areas recycled or reused the waste generated. In urban areas, 80.8% of respondents indicated that they recycled or reused the waste, almost the same results were also observed in rural areas, regarding recyclable and reusable waste management.

Methods of handling recyclable kitchen waste

Table No: 06 Methods of handling recyclable kitchen waste

The area of the household located	**Methods of handling recyclable kitchen waste Responses in percentage (%)**				x^2	**p-value**
	Own use	**give free of cost to others**	**Selling to scrap buyers**	**Total**		
Urban	241 (57.2)	180 (42.8)	-	421 (100)	44.940	.000***
Rural	75 (71.4)	21 (20.0)	9 (8.6)	105 (100)		

(***) level of significance at 0.001.

For kitchen waste in urban areas, 57.2% adopted it for personal use, while 42.8% shared it free of cost. In the rural setting, 71.4% employed it personally, 20.0% bestowed it without charge, and 8.6% opted for sales. The chi-square test outcomes underscored notable disparities in the approaches to handling recyclable waste between urban and rural areas for each waste type. In both urban and rural areas, kitchen waste was more commonly recycled or reused than not.

Reasons for engaging in composting or recycling activity

Different variables were analyzed to identify the reasons behind the practice of engaging in recycling or composting activities by the homemakers. They are explained in the table below

Table No:08 Reasons for engaging in composting or recycling Activity

Particulars	Area of the household locale	Responses in percentage (%)			x^2	p-value
		No	Yes	Total		
Enhances the fertility of the soil	Urban	205 (48.7)	216 (51.3)	421 (100)	48.892	0.000***
	Rural	89 (84.8)	16 (15.2)	105 (100)		
For the sale of fertilizer	Urban	213 (50.6)	208 (49.4)	421 (100)	16.939	0.000***
	Rural	30 (28.6)	75 (71.4)	105 (100)		
To keep surroundings clean	Urban	377 (89.5)	44 (10.5)	421 (100)	20.575	0.000***
	Rural	105 (100)	-	105 (100)		
Waste collection is not reliable	Urban	374 (88.8)	47 (11.2)	421 (100)	22.054	0.000***
	Rural	105 (100)	-	105 (100)		

(***) level of significance at 0.001.

The data presented in the above table represents the reasons why people engaged in composting and recycling activities. The main reasons for engaging in composting and recycling in urban and rural areas were also similar. These reasons included enhancing the fertility of the soil, selling the resulting fertilizer, and keeping the surroundings clean. However, there were some notable differences between urban and rural areas. In urban areas, the main reason for engaging in composting and recycling was enhancing the fertility of the soil, with 51.3% of respondents citing this as a reason. In rural areas, the main reason for engaging in these activities was for the sale of fertilizer, with 71.4% of respondents citing this as a reason.

The major reasons pointed out by homemakers for not engaging in composting and recycling of waste in urban and rural areas were similar. These reasons included lack of knowledge, inconvenience, and others like they were not worried at all. However, there were some notable differences between urban and rural areas regarding not composting or recycling waste. In urban areas, the main reason for not engaging in composting and recycling was lack of knowledge, (92.6%), and in rural areas, the main reason for not engaging in composting or recycling was lack of space, (100%).

Design development of a user-friendly device for household biodegradable solid waste management

The development of a new model composting device stemmed from the identified inadequacies during the survey on the awareness and practices of homemakers in household solid waste management. The research results highlighted a prevailing lack of awareness and poor practices among respondents, particularly in Ernakulam district. A significant portion of homemakers surveyed exhibited limited knowledge, with many unaware that composting could be effectively conducted in their constrained spaces, such as balconies or terraces. Recognizing the need to address this gap in awareness and to improve kitchen waste management practices, the researcher undertook the initiative to develop a composting device and is specifically designed to accommodate the spatial constraints of households, allowing placement in balconies, terraces, or near houses. The aim is to empower homemakers with a convenient and efficient solution for managing kitchen waste, fostering improved waste disposal practices within the confines of their living spaces.

Basic issues regarding waste management identified

One of the significant challenges is the difficulty in adding waste and removing compost from the compost bin. Manual treatment of compost can be time-consuming, and leach spillage can cause contamination. Further, pests and unpleasant odors can be problematic. Additionally, concerns such as the spending attitude towards composting, the cost of vessel technique gadgets, and space consumption have also been raised. Hence, there is a need for an improved organic waste composting device which addresses the aforementioned issues.

Design and development of the household waste management device

The study recognized the need for an eco-friendly practicable easy-to-use device. To give a creative framework for source conversion of household biodegradable solid waste management a compact device that can be used as an individual unit is more feasible. To accomplish an on- location composting of solid organic waste, the investigator decided to proceed with a canister composting framework which was space-saving and ergonomically feasible. The waste composting device developed had many merits over other accessible models. The signature features of the newly developed device are –user-friendly, less space is needed like a balcony or corner space of the porch, creates brisk manure, easy to turn the waste and the compost, no direct contact with fertilizer and leachate, tough, durable, strong, and easy to operate.

Design information

A fertilizer container can be made of any tough and inflexible material to help the composting procedure. The main component of the newly developed waste compost device was a metal wire bucket like structure, which is made from

metal wastes and recyclable metals. The metal wire mesh structure with a lid and stirrer fixed then inserted into any other plastic bucket and then used as a kitchen waste collector. The food waste is thus collected daily. The space between the metal wire structure and plastic bucket is filled with eggshells, newspapers, and dry leaves, which aid in composting process and reducing odor. Jaggery water, sour curd or any compost accelerator available in the market can also be added on alternate days in order to enhance the composting process. The device get full within 3 weeks and the stirring can be continued on alternate days in the initial week, followed by weekly once basis. And the compost may get ready within 45-50 days. The bottom part of the plastic bucket collects the leachate and compost. When the compost is ready, we can lift the wire mesh basket pulling from the top using the wire basket handle. Since this designed wire mesh waste collecting container can be kept inside any plastic bucket and another advantage is that less space is needed to place it. The device is designed in such a way that the compost and leachate never comes indirect contact. It is also unbreakable, long-lasting, durable, and very economical.

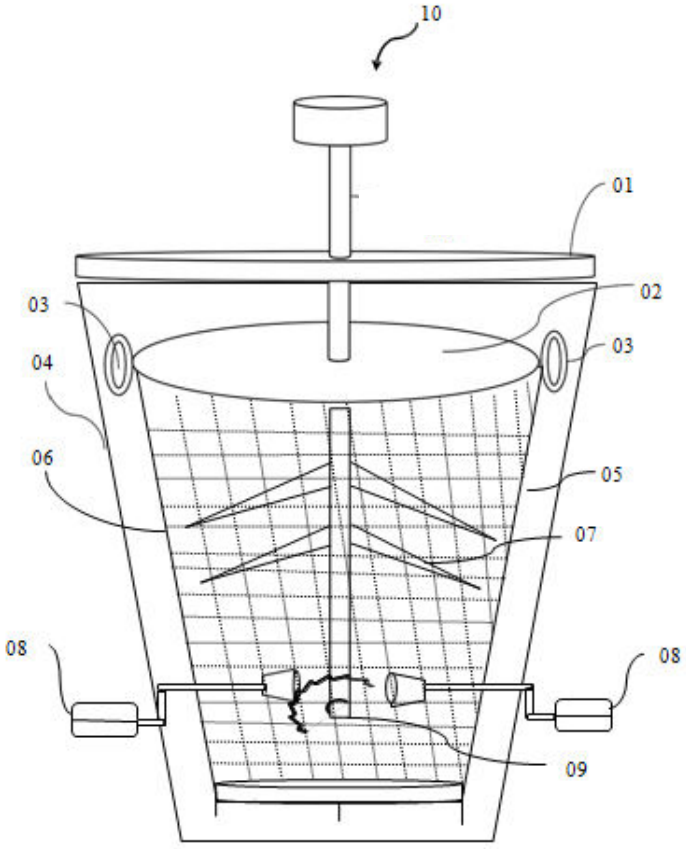

Fig: 01 Structural details of the household waste management device

KEY

Lid (01)	**Opening** (02	**Handle** (03)
Outer part (04)	**Outer bucket** (05)	
Inner metal bucket (06)	**Plurality of blades** (07)	
Pedal pair (08)	**Bevel gear** (09)	**Stirrer** (10)

Figure 01 given above depicts the diagram of the household solid waste management device. Considering the construction details, it had two sharp blades, one at the bottom attached to the bevel gear and one at the middle part of the bucket attached to the stirrer rod. The pedal attached to the bevel gear rotates the rod and assists in giving physical exertion to the operator. The composting device had an opening at the bottom side of the bucket for the collection of manure generated.

Bevel gears: Bevel gears are used to connect shafts, where the axes lie at an angle to each other and the shafts are at right angles. The tooth profile is the same as used for spur gears except that the tooth gets progressively smaller as it approaches the apex of the projected cone. Because of their cone shape, bevel gears produce axial thrust force a type of force that acts parallel to the axis of rotation. A spiral bevel gear exerts more thrust force on bearings.

The device is incorporated with two-sided bevel gears to enhance revolving speed by two side pedal pressure and single vertical bevel gear with a rod connected to both sides of the pedal.

Pedal: Pedals each of a pair of foot-operated levers used for powering the bevel gear to rotate the stirring rod that fastens the shredding and minimizing of the kitchen waste. A pair of cycle pedals is used to operate/ rotate the stirrer rod.

Blades: A round blade is attached to the bottom of the bevel gear and three shredding knives are attached to the stirring rod. These help to cut food waste into thin slices that minimize the volume of waste in the base basket. Sharp blades are attached by welding to the stirrer rod in a diagonal position. This feature given for the effective use of the interior space of the container and also helped better shredding of solid waste. A round blade below the bevel gear further doing the shredding of the kitchen waste before its settling at the bottom of the wire-mesh basket.

Pedaling exercises are good for weight loss because they are an efficient and effective way to burn calories. pedaling is a cardiovascular aerobic activity that has added benefits such as strengthening the heart, lungs and muscles. Sedentary cycling exercises also results in the same benefits as walking with an added bonus that it puts less pressure on the joints than other weight-bearing activities such as walking.

Working Principle of the developed device

The device operates through a systematic process. Organic waste is stored in the inner wire mesh container which is kept in the base basket allowing aeration and drainage. The daily kitchen waste can be deposited through the top opening, and a centrally affixed stirrer, operated by a pedal pair, stirs the waste at intervals, ensuring even oxygen distribution for the growth of microorganisms.

The inner container had two sharp blades-one at the bottom attached to a bevel gear and one in the middle attached to the stirrer rod. The bevel gears connect shafts at right angles, facilitating rotation. Pedals power the bevel gear, providing physical exertion to the operator and enhancing revolving speed. The device also includes an opening at the bottom of the bucket to collect the final compost product. The bevel gears produce axial thrust force, optimizing the stirring process. Pedaling, facilitated by a pair of cycle pedals, operates the stirrer rod and shredding knives, cutting kitchen waste into thin slices and minimizing volume. This composting process not only efficiently breaks down organic waste into compost but also promotes physical exercise, contributing to weight loss and cardiovascular health. The incorporation of blades, bevel gears, and pedals creates a sustainable solution, turning kitchen waste into homemade manure for plant nourishment.

Technical advancement

- Various embodiments of the present device provide the device provides a simple, effective, and efficient solution for solid waste management and converts it into useful compost, reducing the amount of waste that ends up in landfills and reducing greenhouse gas emissions associated with waste management.
- The device is operated using a pedal pair, making it easy to use with minimal physical exertion. This reduces the strain on the user's muscles and joints, making it more user-friendly and safer to use.
- The metal wire mesh structure of the inner bucket allows better aeration and drainage of excess moisture from the organic waste, which helps regulate the moisture level inside.
- The lid also helps regulate moisture and prevents unpleasant odors and pests from escaping the inner bucket.
- The outer bucket encloses the inner bucket and has a handle for easy removal of the finished compost.
- The device is suitable for both rural and urban households especially where space constraints in managing kitchen waste.

Conclusion

The study focused on understanding the composition of solid waste and the methods of waste disposal, aiming to enhance sustainability in managing household solid waste and to identify composting opportunities. The findings indicate that urban areas generate more household solid waste compared to rural areas, potentially due to differences in lifestyle and consumption patterns. The study highlights kitchen waste as the most significant type of waste generated daily, with urban areas producing a higher amount. Future waste management strategies should prioritize reducing kitchen waste generation, especially in urban households, while promoting waste material reuse and recycling. Waste storage and primary disposal are the dominant means of managing waste in any place. The investigator also found the same caused significant challenges in the opted study areas. Therefore, the nature and components of waste generated by households in the waste reduction, reuse, recycling, and composting processes would be more suitable for managing the challenge. The study also found a spatial disparity between urban and rural areas in waste disposal methods.

The findings underscore the necessity for targeted interventions and awareness campaigns on household solid waste management in rural as well as urban areas to enhance participation and knowledge acquisition. Implementing educational programs in both urban and rural regions can foster better waste management practices and promote environmental sustainability. The device developed provided a simple and efficient solution for waste management at the household level which can be popularized. There is a need for further scientific studies about compact waste management practices and their impact on the environment and sustainable development.

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