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# From Leaf to Leftover: Sustainable Gastronomy and Culinary Waste Reduction in Kerala Kitchens

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**Abstract**

*Background*: Waste created due to lack of planning and proper storing prompts to analyse and evaluate the food waste in Kerala households. Taking consideration of future generation, the need for sustainable cooking critically assess and focus on ancient preservation techniques and traditional culinary practices. This paper provides a general idea on Kerala culinary practises and importance of traditional Kerala food preserving techniques. *Objective*: This study aims to analyse Kerala household's food waste pattern and effectiveness of traditional and modern food preservation and cooking methods. *Methodology*: This research utilizes both primary and secondary data collection. Primary data collection was done through questionnaire and secondary data collection was done through referring various articles and research papers. *Results*: Portion control and behavioural aspect in Kerala households along with combination of modern and ancient food preservation techniques can bring down the household food waste to considerable level. *Conclusion:* Combining both traditional and modern techniques can help in reducing the food waste to considerable level.

**Keywords:** Economic Influences, Efficient Strategies, Environmental Concerns, Food Waste, Kerala Cuisine

## INTRODUCTION

Sustainability especially in the current culinary world has been facing a lot of pressure as the natural resources are utilised in an unplanned manner. As an add-on to this, a large quantity of food waste which are also being generated at each household's possess a major hazard which can gradually affect the future generation. Arresting this issue has been prioritized around the world in the recent times. This issue has been considered in priority as the resources are getting depleted which in turn has resulted in high price of ingredients which are used in day to day life. To encounter this problem, the most common and logical idea that can be adapted is planning and executing a detailed structure and frame work in the culinary aspect. By adhering to these steps, it is possible to control and manage the resources and food waste generated. This uplift the idea of promoting an eco-friendly and sustainable food diet in every households. Enforcing this can ensure that there is a control over the resources available to the public and utilisation of the resources are in an efficient manner.

Digging deep into the traditional roots can help in understanding the culture and techniques linked to the food practices which have been carried through various generations to present. This can include various methods of traditional cooking that ensure and focus on using each and every possible part of ingredients used and preparing dishes adhering to retaining the nutritional goodness of each ingredients being used. Also various preservation methods can ensure that ingredients are available throughout the year even if it is off season for certain ingredients known to the local community.

Apprehending the idea of ancient cooking and preservation technique and comparing it with the modern aspect can help in giving a broader outlook into managing and efficient planning of food waste. This can be of a great use to promote eco-friendly cooking and minimal wastage recipes. This highlights the fact that even though the world has advanced ahead, there are certain things that can be adapted from the past generations to ensure an efficient and economical way of using the ingredients. Understanding and analysing ancient methods of cooking can help out in adapting new techniques to the modern gastronomy and thus promote a sustainable food culture.

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To advance these objectives, with a focus on the previously mentioned facets, Kerala possesses a rich and varied heritage along with culinary traditions that endorse and implement a sustainable and valuable gastronomic approach. Kerala is known for its rich culinary heritage and a range of traditional cooking methods, many of which promote environmentally friendly behaviour. To help support this factor, varieties of natural preservation methods has been passed down through generations ensuring seasonal and locally sourced ingredients are accessible throughout the year.

## OBJECTIVES

Among the household kitchens in Kerala:

- To determine types, origin and seasonal patterns of food waste generated in Kerala kitchen households.
- To evaluate attitude, awareness and behaviours around food preservation and waste reduction techniques (Modern & Traditional).
- To investigate challenges, motivations and behavioural factors impacting food waste management at the household level.

## METHODOLOGY

### Research Design

To collect the data for the research, combination of both primary and secondary data was applied. This has helped in providing a depth into the objectives of the research.

### Locale

For the sample collection, the questionnaire were aimed to circulate to residents of Kerala.

### Sampling

*Sample :* Kerala Households.

*Sample Size:* 172 individuals from Kerala responding to the questionnaire.

The sampling used for this study was mainly collected through google forms. The questions formulated considered factors like district and age group of each participant.

### Tools and Techniques

For the primary data collection, questionnaire was developed with questions focusing towards the main objectives. Questionnaire was the main tool used for quantitative data. Questions were structured to accumulate data on various factors. Survey provided overall notion on preservation techniques and cooking methods followed in households of Kerala. An insight to how food waste is managed was also measured through the mention technique.

For the secondary data collection, various research papers and articles were referred. The referred papers mainly aimed on sustainability and waste management. Furthermore, influence and adaptation of Kerala cuisine was put forward through this method. This data references provide a much clearer data on different ways of waste management. The adapted diagram being used in this paper, was developed by adapting to a structure put forward in a research paper.

## REVIEW OF LITERATURE

### Importance of Sustainable Cooking

The world has started to move towards focusing on sustainable cooking techniques. The sole reason for the above being depleting resources which the human have depended on for life. There are various research that has started to focus on key areas. The main objective of it is to promote sustainable cooking. Various studies have provided the base and confidence to promote efficient cooking. There are various traditional techniques of food preservation that also promotes sustainability. Binding the techniques with eco-friendly cooking methods can boost up the sustainability value to its best. This can be a boon in maintaining a safe level of resources for the coming generation.

### Understanding Sustainable Gastronomy

Up to one-third of the food that is purposefully produced for human use is never eaten, leading to waste that has

serious negative effects on the environment, society, and economy (Garcia-Garcia et al., 2017). This emphasizes the reality that a much important focus has to be done in keeping control over food waste. According to (Brundtland, 1987), sustainable development involves meeting present needs without hindering future generations' ability to meet theirs. This emphasizes the fact that, there is a huge demand in understanding the value of gastronomy. Gastronomy is study and practice of food preparation, cooking, and consumption with an emphasis on flavour, ingredients, culinary techniques, and food-related cultural customs. Gaining knowledge on the above helps in the better understanding of resource and waste management. Portion control and food waste management can also be kept in par focusing more on sustainable gastronomy.

Local populations will immediately profit from the creation of new foods from leftovers and by-products produced in the world's poorest locations (Torres-León et al., 2018). This shows that, there is huge potential to evaluate and formulate plans to control food waste and promote planning menu. Emphasising on the above facts can help in a better sustainable culinary practice which provides a strong base for sustainable gastronomy.

## Culinary Food Waste

Considering the sustainability in gastronomy, food waste is the most important factor that holds the value. This food waste can be anything from peels, trimmings to surplus food after service. Culinary food waste can be found in pre-production, production and post production of food preparation. Poor demand forecasting and meal planning can result in overproduction of food, which generates a significant amount of waste (McArthur-Floyd et al., 2024). This clearly shows that there should be clear and well defined structure to support sustainability.

## Traditional and Modern Preservation Techniques

There are number of modern and traditional preservation techniques helps in reducing wastage. From pickling vegetables, sun drying to modern technologies like vacuum packing and others helps in controlling wastage.

Modern techniques like, High-pressure food preservation is a process that alters only the non-covalent connections of food particles, and changing their form and preserving nutrients while avoiding soiling. Ancient techniques like drying and salting are still carried forward to ensure the quality and availability of food for a longer period of time. Salting being one of the oldest techniques, (Ahmad et al., 2021) explain that many food products contain salt to prevent the growth of unwanted microbes. Since salt extracts moisture from tissues, inhibition is thought to be caused by a decrease in water activity. Similarly, in the process of drying, water is removed naturally resulting prolonged shelf life.

Although contemporary technologies such as dehydration and refrigeration have been developed, their roots can be drawn from earlier preservation techniques. These orthodox methods forms the groundwork and still serve as an inspiration for contemporary advancements in food preservation.

## Traditional Culinary Practices in Kerala

The state of Kerala is situated along the Malabar Coast in southern part of India. Kerala exhibits a lengthy coastline added with tropical scenery, have Arabian Sea and Western Ghats mountains on west and east respectively. Keralan food finds the perfect balance between spices, seafood, and seasonal vegetables. The state of Kerala is popularly known for its backwaters, coconut trees, and spice farms.

As sited by (Shaji, 2024), Traditional eating practices in Kerala were wholesome and well-planned. Foods like banana flowers, avial, thoran, puttu, and appam were beneficial to one's health. Avial a famous dish in the cuisine, blends and balances different vegetables with seasoned coconut. This provides a highly nutrient valued diet yet simple and harmonious flavour palette. Another jewel in the Kerala cuisine is Kerala sadhya. Sadhya is thought to be a nutritious and readily digestible meal. The sequence of having sadhya is from left of banana leaf to right. In this, each dish add a distinctive flavour and taste to rice (Mololath, 2022).

Kerala's culinary legacy is a distinctive fusion of various influences brought to the region by Arabs, Chinese, Portuguese, Dutch, and British settlers (Davis, 2024). This highlights the fact that Kerala has got wide mix of various cuisine influence. Kerala's topography, climate, and trading connections with other nations all have a significant impact on the state's cuisine (Shaji, 2024).

Arabic region has influenced the Kerala culinary practises especially for Mappila cuisine. While the other cultures in the area mainly rely on coconut oil, ghee is a common ingredient in Mappila cuisine. It is also known that the Arab Bedouins consume ghee produced from their own livestock (Tanya, 2016). It is thought that the Portuguese brought foods like meat samosas and appam (Kerala Tourism, n.d.). There are various other references that can be pinned to support the fact for the above line.

## RESULTS AND DISCUSSION

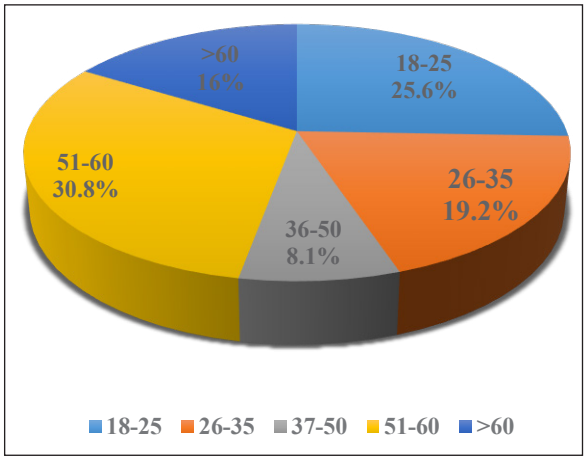



**Fig. 1: Age Group Composition**

The study included total of 172 respondents accounting to various age groups, geographical areas and residential settings. The maximum number of respondents were observed between the age group of 51-60 30.8% followed by 18–25 years 25.6% and 26–35 years 19.2%. The least response were received from the age group of 36-50 category 8.1%. Younger and middle-aged persons are well represented in this distribution, providing views from a range of generational viewpoints.

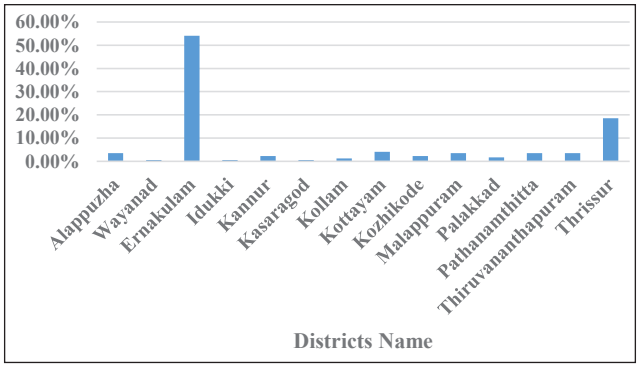



**Fig. 2: Contributors by District %**

Ernakulum district accounted for the majority of responders 54.1%, with Thrissur coming in second 18.6%. Smaller contributions were received from other districts, including Kottayam 4.1%, Alappuzha, Malappuram, Pathanamthitta, and Thiruvananthapuram each 3.5%.

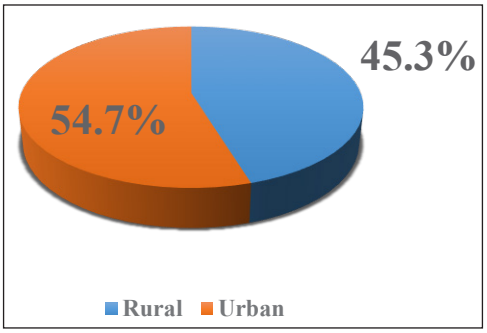



**Fig. 3: Rural v/s Urban %**

A good balanced representation of living settings was provided by the sample's 54.7% urban dwellers and 45.3% rural residents.

### Objective 1 - Pattern of Food Waste Produced in Kitchens in Kerala

**Table 1: Variable and Frequency Table on Pattern of Food Waste Generated in Kerala Kitchens**

| *Variable* | | *Frequency* | *Percentage (%)* |
|---|---|---|---|
| Type of food waste | Raw vegetables and fruits | 30 | 17.4% |
| | Leftover cooked food | 31 | 18.0% |
| | Packaged/ expired items | 12 | 7.0% |
| | Peels, stems and scraps | 88 | 51.2% |
| | None/ very minimal | 11 | 6.4% |

| *Variable* | | *Frequency* | *Percentage (%)* |
|---|---|---|---|
| Amount of food wasted | < 5% | 103 | 59.9% |
| | 10-20 % | 52 | 30.2% |
| | > 20% | 7 | 4.1% |
| | Not sure | 10 | 5.8% |
| Seasonal distribution | Summer | 92 | 53.5% |
| | Monsoon | 62 | 36.0% |
| | Winter | 18 | 10.5% |
| Ingredient/ dish with most wastage | Fruits | 25 | 14.5% |
| | Leafy vegetables | 21 | 12.2% |
| | Milk/ dairy | 11 | 6.4% |
| | Leftover rice/ curries | 80 | 46.5% |
| | Not applicable/ don't know | 35 | 20.3% |
| Frequency of disposal | Daily | 45 | 26.2% |
| | Weekly | 33 | 19.2% |
| | Monthly | 16 | 9.3% |
| | Rarely | 69 | 40.1% |

The kind of food waste that was most commonly reported was by the peels, stems and scarps with 51.2% which directly points out that most of the ingredient waste were inedible or unavoidable parts of ingredients. However the waste that can be prevented remains as a big concern, with raw fruits and veggies 17.4% and leftover cooked food 18.0% were recorded. 7.0% of the garbage was from packaged or expired goods, whereas 6.4% was from little to no waste. Most people 59.9% thought that less than 5% of the food that was prepared was wasted, whereas 30.2% said that between 10% and 20% was squandered. Just 4.1% acknowledged wasting more than 20%, and 5.8% weren't sure.

Summer season 53.5% projected the highest food waste compared to monsoon 36.0% followed by winter 10.50% suggesting the high temperature being the reason for it. Leftover curries ranked the highest 46.5% in frequently wasted food items fruits 14.5%, leafy vegetables 12.2%, and milk/dairy products 6.4% following it.

40.1% responded they disposed the food waste rarely while 26.2% did it on daily basis whereas 19.2% did weekly and 9.3% monthly.

## Objective 2 - Behaviours, Attitudes, and Knowledge Around Food Preservation and Waste Minimization Methods

**Table 2: Variable and Frequency Table on Attitude, Awareness and Behaviours Around Food Preservation and Waste Reduction Techniques**

| *Variable* | | *Frequency* | *Percentage (%)* |
|---|---|---|---|
| Appliances/techniques used | Pressure cooker | 122 | 70.9% |
| | Induction stove | 16 | 9.3% |
| | Microwave oven | 12 | 7.0% |
| | Vacuum sealer/ air fryer | 7 | 4.1% |
| | Traditional methods | 15 | 8.7% |
| Indigenous methods used | Frequently | 18 | 10.5% |
| | Occasionally | 73 | 42.4% |
| | Rarely | 48 | 27.9% |
| | Never | 24 | 14.0% |
| | Not familiar with them | 9 | 5.2% |

| Variable | | Frequency | Percentage (%) |
|---|---|---|---|
| Better practice to reduces food waste | Traditional methods | 17 | 9.9% |
| | Modern techniques | 15 | 8.7% |
| | Combination of both | 121 | 70.3% |
| | Neither | 4 | 2.3% |
| | Not sure | 13 | 7.6% |
| Storage of items | Airtight containers | 8 | 4.7 % |
| | Airtight containers + Zip-Lock pouches | 1 | 0.6 % |
| | No specific method | 10 | 5.8 % |
| | Refrigeration | 105 | 61.0 % |
| | Refrigeration + Airtight containers | 18 | 10.5 % |
| | Refrigeration + Airtight containers + Zip-Lock pouches | 6 | 3.5 % |
| | Refrigeration + Zip-Lock pouches | 3 | 1.7 % |
| | Sun drying or salting | 11 | 6.4 % |
| | Sun drying or salting + Refrigeration | 5 | 2.9 % |
| | Sun drying or salting + Refrigeration + Airtight containers | 1 | 0.6 % |
| | Sun drying or salting + Refrigeration + Airtight containers + Zip-Lock pouches | 2 | 1.2 % |
| | Zip-Lock pouches | 2 | 1.2 % |
| Preservation method used | Drying in shade/sun | 28 | 16.3 % |
| | Drying in shade/sun + Smoking | 2 | 1.2 % |
| | Fermentation | 8 | 4.7 % |
| | Fermentation + Drying in shade/sun | 2 | 1.2 % |
| | Fermentation + None of these | 1 | 0.6 % |
| | None of these | 57 | 33.1 % |
| | Pickling | 43 | 25.0 % |
| | Pickling + Drying in shade/sun | 7 | 4.1 % |
| | Pickling + Fermentation | 9 | 5.2 % |
| | Pickling; Fermentation + Drying in shade/sun | 13 | 7.6 % |
| | Smoking | 2 | 1.2 % |
| Do you find traditional preservation methods more effective than modern refrigeration for long-term storage? | Yes | 15 | 8.7 % |
| | No | 23 | 13.4 % |
| | Sometimes | 46 | 26.7 % |
| | Not sure | 25 | 14.5 % |
| | Depends on type of food | 63 | 36.6 % |
| Do you use parts of ingredients often thrown away? | Yes, always | 34 | 19.8 % |
| | Occasionally | 53 | 30.8 % |
| | Rarely | 44 | 25.6 % |
| | Never | 33 | 19.2 % |
| | Only for specific recipes | 8 | 4.7 % |
| What do you do with leftover food from meal preparation or consumption? | Reuse in another dish | 19 | 11.0 % |
| | Compost | 44 | 25.6 % |
| | Feed animals | 39 | 22.7 % |
| | Throw away | 19 | 11.0 % |
| | Store for next day consumption | 51 | 29.7 % |

| *Variable* | | *Frequency* | *Percentage (%)* |
|---|---|---|---|
| Zero-waste techniques followed | Using peels/stems for chutney/stews | 12 | 7.0 % |
| | Turning leftover curries into new dishes | 39 | 22.7 % |
| | Using bones/shells for stocks/soups | 10 | 5.8 % |
| | Share existing food with others | 54 | 31.4 % |
| | I don't follow any of these | 57 | 33.1 % |
| Do traditional serving practices (Like eating on banana leaves or serving small portions) help reduce waste? | Yes, very much | 32 | 18.6 % |
| | To some extent | 76 | 44.2 % |
| | Not really | 33 | 19.2 % |
| | Only when followed consistently | 11 | 6.4 % |
| | Not familiar with such practices | 20 | 11.6 % |
| Disposal of organic waste | Compost pit or biogas | 91 | 52.9 % |
| | Dumped outside | 13 | 7.6 % |
| | Municipal collection | 46 | 26.7 % |
| | Burned or buried | 14 | 8.1 % |
| | Animal Feed | 8 | 4.7 % |

Just 10.5% of respondents said they frequently employed indigenous methods, compared to 42.4% who used them occasionally, 27.9% who used them seldom, 14.0% who never used them, and 5.2% who were not familiar with them. A huge fraction of people believed that combination of traditional and modern techniques can be the best effective strategy in reducing food wastage. Then came traditional ways only 9.9%, modern methods only 8.7%, people who weren't sure 7.6%, and people who thought any of the approach was appropriate 2.3%.

19.8% of respondents reported regularly utilizing ingredients, 30.8% reported using them occasionally, and 25.6% reported using them infrequently. 4.7% used them exclusively for certain recipes, while 19.2% never used them. 27.3% believe planning meals in advance can reduce the waste while composting 22.7% reusing leftover creatively 20.3% and sharing surplus food 3.5% can help in reducing food waste. Storing for next-day consumption 29.7%, followed by composting 25.6% and feeding animals 22.7% were the common ways suggest by respondents to reuse the leftover food usage. For promoting zero wastage technique, 31.4% suggested sharing food and turning leftover curries to dishes 22.7%. In contrast, 33.1% did not follow any zero-waste practices. Composting or biogas systems were the most popular way to dispose of organic waste 52.9%, followed by municipality pickup 26.7%, burning or burying 8.1%, dumping outdoors 7.6%, and feeding animals 4.7%.

## Objective 3 - Challenges, Motives, and Behavioural Aspects in Food Waste Management

**Table 3: Variable and Frequency Table on Challenges, Motivations and Behavioural Factors on Food Waste Management**

| *Variable* | | *Frequency* | *Percentage* |
|---|---|---|---|
| Causes of food wastage | Cooking excess food | 22 | 12.8 % |
| | Cooking excess food + Lack of planning | 6 | 3.5 % |
| | Cooking excess food + Lack of planning + No clear reason | 1 | 0.6 % |
| | Cooking excess food + No clear reason | 3 | 1.7 % |
| | Improper storage | 16 | 9.3 % |
| | Improper storage + Cooking excess food | 3 | 1.7 % |
| | Improper storage + Cooking excess food + Lack of planning | 3 | 1.7 % |
| | Improper storage + Lack of planning | 2 | 1.2 % |

| Variable | | Frequency | Percentage |
|---|---|---|---|
| | Lack of planning | 44 | 25.6 % |
| | No clear reason | 41 | 23.8 % |
| | Over-purchasing | 15 | 8.7 % |
| | Over-purchasing + Cooking excess food | 3 | 1.7 % |
| | Over-purchasing + Cooking excess food + Lack of planning | 4 | 2.3 % |
| | Over-purchasing + Improper storage | 2 | 1.2 % |
| | Over-purchasing + Improper storage + Cooking excess food | 1 | 0.6 % |
| | Over-purchasing + Improper storage + Cooking excess food + Lack of planning | 3 | 1.7 % |
| | Over-purchasing + Lack of planning | 3 | 1.7 % |
| Challenges faced in reducing food waste | Lack of time | 29 | 16.9 % |
| | Lack of storage options | 21 | 12.2 % |
| | Limited awareness or information | 11 | 6.4 % |
| | Family habits/traditions | 36 | 20.9 % |
| | No major challenges | 75 | 43.6 % |
| Utilization of kitchen scraps or leftovers | Composting | 58 | 33.7 % |
| | Composting + Discard as waste | 2 | 1.2 % |
| | Discard as waste | 32 | 18.6 % |
| | Feed animals | 27 | 15.7 % |
| | Feed animals + Composting | 10 | 5.8 % |
| | Feed animals + Composting + Discard as waste | 3 | 1.7 % |
| | Feed animals + Discard as waste | 3 | 1.7 % |
| | Not applicable | 3 | 1.7 % |
| | Reuse them in cooking (e.g., soups, curries) | 13 | 7.6 % |
| | Reuse them in cooking (e.g., soups, curries); Composting | 2 | 1.2 % |
| | Reuse them in cooking (e.g., soups, curries); Composting + Discard as waste | 2 | 1.2 % |
| Motivation to reduce food waste | Environmental concern | 35 | 20.3 % |
| | Economic savings | 22 | 12.8 % |
| | Cultural values | 13 | 7.6 % |
| | Health & hygiene | 43 | 25.0 % |
| | Personal responsibility or ethics | 59 | 34.3 % |

The main cause for food waste was lack of planning 25.6% followed by no clear reason 23.8%. Cooking excess food 12.8%, improper storage 9.3%, and over-purchasing 8.7% were also reasons contributing towards food waste in Kerala households. Looking into the challenges to reduce the waste, 43.6% reported no major challenges whereas some pointed out family habits and traditions 20.9% to a reason. Lack of time 16.9%, lack of storage options 12.2%, and limited awareness 6.4% were also cited.

For utilisation of kitchen scrapes, 33.7% suggested composting to be a good method whereas discarding 18.6%, feeding to animals 15.7%, and reusing in cooking 7.6% were alternatives which were suggested by the respondents. Supermarkets accounted for 58.1% of purchases, with local farmers or markets 31.4%, cooperative stores 5.2%, internet platforms 4.7%, and direct sourcing from neighbours or producers 0.6% following closely behind.

The motivation to reduce waste, personal accountability and ethics contributed the highest 34.3%, followed by ecological concerns 20.3%, cultural values 7.6%, health and hygiene 25.0%, and financial savings 12.8%.

## FINDINGS

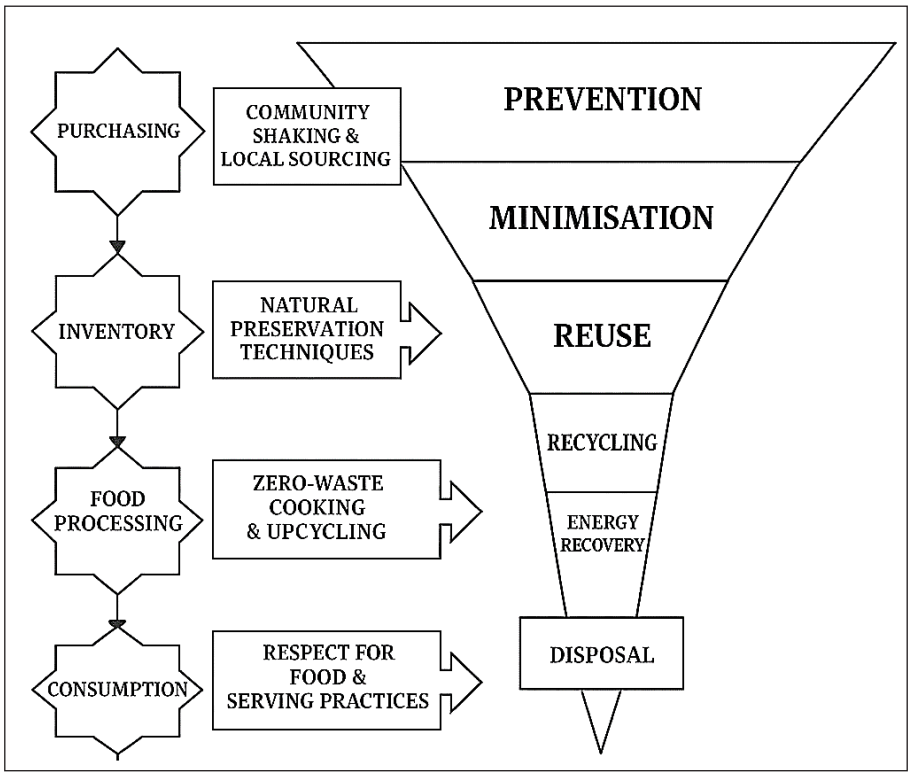
The finding shows that most of the food waste in households of Kerala are unavoidable items like peels and trims. However, a good proportion of raw produce and leftover cooked food indicates the fact that food waste can be kept under control. Portion control, food storage and creative reuse of dishes can uphold the above mentioned statement.

Preservation methods like refrigeration, air tight containers, sun drying and other various traditional techniques can help to arrest food wastage especially in summer season. Even though modern techniques are been used, a massive proportion of the respondents have suggested a blend of traditional and modern techniques to reduce food wastage. This highlights the fact to revive the scope of sustainable cooking and cost effective methods such as pickling and fermentation.

The major cause of food wastage are caused due to behavioural aspect of people especially focusing on lack of planning and family traditions combined with time constrain and limited storage.

In general to conclude, the community shows partial involvement but holds an untapped potential. Combining both modern and technical techniques, along with fostering behavioural change and capitalizing ethical and cultural values, can promise in a better waste reduction in households of Kerala.

## CONCEPTUAL FRAMEWORK: COMBINING SUSTAINABLE FOOD WASTE MANAGEMENT WITH TRADITIONAL KERALAN PRACTICES




In order to lower environmental risks, (Gruia et al., 2022) suggested a polyvalent waste management model specifically designed for the restaurant sector, with an emphasis on integrated processing channels (p. 7, Fig. 3). This model's components are reinterpreted in the current study to incorporate local sustainability practices, preservation techniques, and domestic food waste sources in Kerala households.

The left part demonstrates the various household stages in food processing that are carried out in households of

Kerala. This explains the process from purchasing of ingredients to consumption of final product prepared at households.

The middle part of the diagram highlights the hierarchy of different sustainable waste management techniques that can be embedded to reduce wastage.

The right part integrate the traditional approach to reduce the food wastage from most prioritized to least favoured in contrast to food waste.

## CONCLUSION

In general to conclude, the community shows partial involvement but holds an untapped potential. This study has helped to identify an opportunity to reduce food waste that are produce in the Kerala households on daily basis. Combining both modern and traditional techniques, along with fostering behavioural change and capitalizing ethical and cultural values followed in families, can promise in a better waste reduction in households of Kerala.

The framework proposed in the study, outlines the several steps involved in food preparation along with potential strategies for reducing food waste. By supplementing the proposed framework, considerable reduction in food waste can be achieved.

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