Use of Biomineralizer for Composting Urban Kitchen Waste

By

I. Akshathaa

(20PIR001)

Thesis Submitted to

Avinashilingam Institute for Home Science and

Higher Education for Women

Coimbatore – 641 043.

In partial fulfilment of the requirement for the Degree of

Master of Science in Interior Design and Resource Management

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Signature of Head of the Department

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INTRODUCTION

Reuse the past, Recycle the present, Save the future

India is the land of Kanad, Vishwamitra, C.V Raman, and, most importantly, Dr. A.P.J Abdul Kalam. In 2013, India's population surpassed 1.2 billion, and it now stands at 1.33 billion. India's 2.9 million square kilometre of land area hosts close to 18 percent of the world's population, with a population density of 325 per square kilometre (Census 2011). Modern India has placed a high emphasis on science and technology, realising that it is a critical component of economic development.

As a result of India's young population and ensuing low dependency ratio, healthy savings and investment rates, increasing globalisation in the country, and integration into the international economic system, its long-term growth outlook remains positive.(https://en.wikipedia.org/wiki/Waste_management_in_India#:~:text=India%20generates%2062%20million%20tonnes,are%20dumped%20in%20landfill%20sites.**)**.The country's position as the world's sixth-largest consumer market has not changed despite the integration of the global economy. The Indian consumer durables market is broadly divided into urban and rural markets, and it is attracting marketers from all over the world to enter the country. One can distinguish three distinct classes in this sector: the vast middle class, the relatively large affluent class, and the small economically disadvantaged class. As the market for consumer durables grows, so does the amount of waste generated by the industry.

India generates 62 million tonnes of waste each year. About 43 million tonnes (70%) are collected of which about 12 million tonnes are treated and 31 million tonnes are dumped in landfill sites. With changing consumption patterns and rapid economic growth it is estimated that urban municipal solid waste generation will increase to 165 million tonnes in 2030. (https://en.wikipedia.org/wiki/Waste_management_in_India#:~:text=India% 20generates%2062%20million%20tonnes,are%20dumped%20in%20landfill%20sites.)

According to the “Swachhata Sandesh Newsletter” by the MoHUA, as of January 2020, 147,613 metric tonnes (MT) of solid waste is generated per day, from 84,475 wards (Singh, 2020) . Municipalities with rapid urbanisation are experiencing a burden on their socio-economic and environmental prospects as a result of migration and the

depletion of natural resources (Gerdes and Gunsilius, 2010). According to the Central Pollution Control Board (CPCB) of India, per capita waste generation has increased at an exponential rate (0.26 kg/day to 0.85 kg/day) over the last decade (CPCB India, 2018).

Waste is defined as materials that are unwanted or unusable. It is also defined as any substance that is discarded after its primary use or that is worthless, defective, or otherwise unusable. (https://en.wikipedia.org/wiki/Waste). Waste can be described as anything that is superfluous and has no further use value for its owner, and it is collected in a designated container before being composted in a landfill. Waste, as per Basu and Xavier (2016), refers to substances that have been eliminated or discarded because they are no longer useful or required after a process has been completed. According to the Basel Convention, "wastes are substances or objects that are disposed of, are intended to be disposed of, or are required to be disposed of by the provisions of national law." The term is typically used to refer to substances that are produced as a result of human activity.

Waste can be divided into five categories, each of which is commonly found in and around the home. There are several types of waste: liquid waste, solid waste, organic waste, recyclable waste, and hazardous waste. (https://4waste.com.au/).

A non-hazardous solid waste material is defined as any urban solid waste that is both biodegradable and non-biodegradable but does not contain any corrosive, toxic, ignitic, or reactive elements. Yard trimmings, cardboard, packaging materials, slaughterhouse solid waste, and other similar materials are examples of what can be recycled (Sasikumar and Sanoop 2017).

Household waste generated in residential neighbourhoods, according to Subhash (2010), constitutes the "largest component of urban solid waste." The waste stream is made up of a large number of different elements that are difficult to separate, including food and garden waste as well as paper and plastic cardboard. It also contains leather and old clothes, as well as furniture, newspapers and magazines and vegetables such as peaches and egg shells.

Sasikumar and Sanoop (2017), opine that it is critical for the government to have a thorough understanding of the quantity, composition, and characteristics of the various types of waste generated by urban local bodies in order to effectively manage waste (wastes from households, waste resulting from economic activities, shops, establishments

and institutions. etc.). For the collection, transportation, and treatment of waste, local governments and even the central government spend significant amounts of money for collection, transportation and treatment of waste.

Numerous studies also have found that improper waste disposal results in the release of hazardous gases and leachates as a result of microbial decomposition, environmental conditions, refuse characteristics, and land-fill operations.

Singh, 2020 discloses that in recent years, the exponential population growth, high density of urban areas, diverse culture, changing food habits, and changing lifestyles have resulted in an unresolved problem in terms of Municipal Solid Waste Management (MSWM) in India, which has been exacerbated by the country's rapid urbanisation and urbanization's high density. Therefore, municipalities have been dealing with a variety of other issues related to the collection, treatment, and management of solid waste as a consequence. Solid waste that has not been sorted at the source, social taboos, citizen attitudes, poor assessment, inadequate potential strategies, an unorganised informal waste sector, unplanned fiscal policies, and poor implementation of government policies are all factors to consider. There is an urgent need for solid waste management through appropriate treatment and recycling strategies to be implemented in accordance with the composition of Indian municipal solid waste.

The unawareness among the general public about waste management issues and their careless attitude toward their waste creates difficulties for municipal waste management departments. When municipal solid waste is disposed of in landfills, it can cause environmental pollution by releasing harmful greenhouse gases into the atmosphere, which can then contaminate groundwater through the formation of leachates (Ngwabie et al., 2019). Pollution is merely a resource, that isn’t being used properly (Li and Zhao, 2001 and Ko et al., 2015). Another issue that arises during transportation is the noise and micro-dust, which causes discomfort for the elderly and new born (Yusof et al., 2009). https://www.sciencedirect.com/science/article/pii/S2666049020300244.

According to Kumar,(2020)the most serious issues affecting solid waste management are unscientific treatment, improper waste collection, and ethical issues relating to waste disposal. As a result, environmental degradation, water pollution, soil pollution, and air pollution are all possible consequences of this process. https://flores.unu.edu/en/news/news/the-crisis-of-waste-management-in-

iHomeNewsNews. In this condition India is confronted with significant environmental challenges as a result of waste generation and insufficient waste collection, transportation, treatment, and disposal. The current waste management systems in India are unable to cope with the volume of waste generated by an expanding urban population, which has negative consequences for the environment and public health. The difficulties and obstacles are significant, but the opportunities are also limited. Waste segregation at the point of generation, as well as the use of specialised waste processing facilities to separate recyclable materials, plays an important role in this effort. The disposal of residual waste following the extraction of raw materials necessitates the construction of engineered landfill sites which demand space for land filling and/or the establishment of waste-to-energy facilities. The potential for energy generation from landfills, whether through methane extraction or thermal treatment, represents a significant opportunity. However, a significant barrier is the scarcity of qualified engineers and environmental professionals with the necessary experience to deliver improved waste management systems in India.

Despite significant advancements in social, economic, and environmental areas, India's solid waste management (SWM) systems have remained largely unchanged. When it comes to extracting value from waste, the informal sector plays a critical role. Approximately 90 percent of residual waste is currently dumped rather than properly landfilled, according to the World Resources Institute. In order to achieve a more sustainable system of waste management, it is imperative that new management systems and waste management facilities be implemented. Current solid waste management systems are inefficient, and waste has a negative impact on public health, the environment, and the economy as a result.

As of now, India's waste management practice consists in collecting waste from sources through a community collective bin system, after which it is transported to a low-lying landfill system with intermediate treatment of Municipal Solid Waste (MSW). The practise of open dumping contributes to a variety of issues, including pollution and health risks. This has an impact on both surface and groundwater; in fact, groundwater is in a critical state as a result of this. As an outcome, current procedures are not optimal, resulting in the solid waste management crisis.

Waste minimisation and segregation at the household level would be beneficial in the pursuit of effective waste management. As part of the waste hierarchy, this is in

accordance with the motto 'Reduce, Reuse, Recycle, and Recover.' Starting with consumption, the more we consume the more waste we produce. It is a vicious cycle. Because the less waste we generate, the fewer resources we will require to manage it. Aside from reducing waste, categorising it according to type can also aid in the waste management cycle by reducing waste. Effective waste management begins at home.

In order to achieve sustainability in waste management, it is necessary to choose a method that is environmentally friendly. A technique of this nature must be effective, efficient, and less expensive than many other alternatives. Solid waste management is a massive undertaking in developing countries all over the world, owing to factors such as poverty, population explosion, urbanisation, and a lack of adequate government funding, among other things. Efficient, disposal methods such as incinerators, landfills, pyrolysis, and gasification have negative effects on the environment and pose a threat to public health. Composting is an efficient way of recycling waste.When composting is done properly, it is environmentally friendly and has a number of advantages, including the production of biofertilizer, the reduction of air and water pollution, the reduction of operating costs, and the generation of income. Composting for the purpose of bioremediation of contaminated soil has gained significant traction in many developed countries around the world in recent years. In contrast, improperly designed composting can result in methane production, odour emission, and heavy metal build-up in the final product, all of which are harmful. Hence it is important that composting should be done in a scientific manner.

Compost is a mixture of properly decomposed organic matter that can be used as a soil conditioner and as a source of nutrients for crops. Compost can also be used as a fertiliser to increase the yield of crops. Singh and Longkumer (2018), inform that compost manures are decayed refuse such as leaves, twigs, roots, stubble, crop residue and hedge clippings, street, refuse collected in towns and villages, water hyacinth, sawdust, and bagasse. Himadri and Dharamvir (2007), evince that compost manures are decayed refuse such as leaves, twigs, roots, stubble, and crop residue. Cow dung, night soil, urine, and fertilisers are examples of nitrogenous materials that can be used to speed up the decomposition process. These wastes are consumed by a large number of soil microorganisms, which break them down and turn them into well-rotted manure. Compost is the term used to describe the final product.Based on the research conducted by Hari (2010), compost is generally recommended as an additive to soil, or

other matrices such as coir and peat, in order to improve soil quality by supplying humus and nutrients.

Compost, as viewed by Lingaraj (2013), has numerous advantages because it can be high in nutrients. In addition to gardens and landscaping, it is used in horticulture and agriculture. Composting, according Sajnanath and Sushama (2004) and Gupta (2008), inform that composting would relieve farmers of the pressure to reduce the cost ofcultivation as a result of rising fuel, labour, and farm machinery costs, as well as falling prices for agricultural products by enhancing the production of farm products.

Despite the fact that composting is fundamentally a biological decomposition of organic residues, Singh and Longkumer (2018) explain that it can be accelerated by applying physical and chemical treatment to the waste. There are several different types of compost available, each with its own set of advantages and disadvantages depending on the composting method used.

Singh and Longkumer (2018) express that composting is basically a biological decomposition of organic residues, however physical and chemical treatment is given to hasten the process. Depending upon composting methods, there are different kinds of compost and each has their advantages and disadvantages. These methods are as follows:Pit Manure/Anaerobic Compost, Coimbatore method, Indore method, Bangalore method, NADEP Composting, Vermicompost, Vermiwash, Biodynamic composting, Biodung composting, Padegaon method, Biogas-slurry method, Azolla compost, In-vessel composting, Spent Mushroom Substrate (SMS), Humanure, Biomineralizer. For efficient functioning of composting, certain environmental factors affect the composting process, so they require food (carbon and nitrogen), air, and water to make compost. Along with this, they also require a favourable temperature and ph for rapid composting. Other physical factors affecting the pace of composting include surface area, particle size and volume.

Biomineralizer is a microbial consortium that has been developed by Tamilnadu Agricultural University to speed up the composting process by increasing the mineral content of the compost. In order to degrade the different chemical constituents of solid waste, a consortium of microorganisms must be assembled. In a typical composting of solid waste, microorganisms establish themselves on their own in the solid wastes when the conditions are favourable. However, under normal circumstances, it takes a long time

for microorganisms to establish themselves in a compost pile. However, if the correct type of microorganisms is introduced into the compost pile, it begins working on the waste almost immediately, and the mineralization process begins to take effect. It is for this reason that a microbial consortium is being formed to degrade different chemical constituents in wastes, ensuring that the mineralization process is completed and that the compost is fully matured.

TNAU also discloses that the use of the biomineralizer consortium will shorten the time required for composting and will facilitate the rapid decomposition of organic biodegradable wastes into nutrient-dense compost. Crop residues are the non-economic plant parts that are left in the field after harvest and that are also discarded during the processing of the crop after it is harvested. Using crop residue management techniques such as composting, we can reduce the amount of money we spend on chemical fertilisers for crop cultivation, while also providing the following non-economic benefits: improving soil fertility and moisture, increasing soil stability, reducing soil and air pollution, and eliminating the thrash burning issues that are detrimental to the environment.

Need for the study

We have only recently become aware of the dangers posed by improper waste management, which has occurred in the last few years. Our current challenges include addressing waste accumulations from the past, as well as the enormous task of developing new guidelines and solutions to deal with the ever-increasing volume of waste. Large-scale effective waste management is expensive; it accounts for 20 percent to 50 percent of municipal budgets on a regular basis; therefore, it is critical to develop a solution that is long-term, cost-effective, and safe for the environment. Home composting may be a viable option for effectively managing waste in the home environment as effective waste management begins at home. Despite the fact that there are a variety of methods used at the household level, they are only utilised by a small number of households due to the fact that composting takes a long time and requires adequate space, both of which are lacking in urban households. In addition, the unpleasant odour and nuisance caused by flies and rodents produced by normal composting, discourage homemakers from participating in composting practices. Because of this, the investigator identified the need for a composting method using biomineralizer a recent innovation used for large scale composting that will be

convenient for homemakers also and acceptable to them. The purpose of this study was to determine whether or not it will be feasible to use biomineralizer for composting at the household level.

The study's objectives are as follows:

- To gather information on home waste disposal techniques and public knowledge of these
- To understand home composting techniques adopted by selected households
- To test the effectiveness of a biomineralizer in the composting of household organic waste.

Biomineralizer for composting is a new sector in waste management that researchers want to shed light on via their work.

“Eco-friendly future begins at home”

Let us all strive to start an eco-friendly future from household level.

II REVIEW OF LITERATURE

The literature pertaining to the study on "**Use of Biomineralizer for Composting Urban Kitchen Waste",** is reviewed under the following headings:

A. Waste

B. Composting

C. Biomineralizer

D. Artificial Intelligence in Waste Management

A. Waste

i. Meaning of Waste

Waste is unwanted or unusable materials. Waste is any substance which is discarded after primary use, or is worthless, defective and of no use.(https://en.wikipedia.org/wiki/Waste).Waste is defined as superfluous and has no further user value to its owner collected in a dedicated container and then composted. Sasikumar and Krishna (2012), suggest that waste can be considered as substance or objects which are disposed of or intended to be disposed of or are required to be disposed off. Very often, waste is defined as unwanted materials, leftovers from any human activities, refuse from plant, human or animal habitation. According to Basu and Xavier (2016), waste refers to eliminated or discarded substances that are no longer useful or required after the completion of a process. Basel Convention, disclose 'wastes are substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law'. The term usually applies to substances generated as a result of human activity.

Hosetti (2016), opine waste as any useless, unwanted discarded material that is not a liquid or gas is referred as solid waste or refuse. For e.g. it may be yesterday's news paper, junk mail, today's meal scraps, pieces of bread, roti, waste rice, racked leaves, dust, grass clippings, broken furniture, abandoned materials, animal manure, sewage sludge, industrial refuse or street sweepings etc.

Sasikumar and Sanoop (2017), perceive that waste can be considered as substance or objects which are disposed of or intended to be disposed of or are required to be disposed of. Very often, waste is defined as unwanted materials, leftovers from any

human activities, refuse from plant, human or animal habitation. Waste is also defined as superfluous and has no further user value to its owner. A conference of European Statisticians' discussed the conceptual issues concerning the overall definition of waste, i.e. what can be considered definitely 'waste' or a 'potential' new material or commodity.

Lingaraj (2012), believe that waste is often defined on a situational basis, so it follows that food waste's the same; professional bodies, including international organizations, state governments and secretariats may formally have their own definitions.

Abbasi and Ramasamy (2001), reveal waste, as anywhere in the world, known variously as an annoying headache, an unending problem or more correctly as an ever-growing pile of garbage. Gradually the perception is changing now, and waste is now being managed and looked upon as a 'resource', or 'urban ores', which contain recoverable materials and energy.

Waste in waste management refers to unwanted or unusable material that is produced through the activity of humans and can have different forms. Waste can be liquid, solid, or gas with each having its disposal method and way of managing the waste (https://www.toolshero.com/management/waste-management/).

ii. Waste Management a Challenge to the Society

According to Bhatt and Asheref (2012), solid waste management is increasingly becoming a critical issue for municipal authorities. Central and the state governments are supportive of local efforts to improve MSW (Municipal Solid Waste) management but this is essentially a municipal function and it is at this level that challenges have to be addressed."

Waste management (or waste disposal) includes the processes and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms. (https://en.wikipedia.org/wiki/Waste_management)

According to Basu and Xavier (2016), waste management refers to the collection, transport, processing/treatment or disposal and monitoring of waste materials. Such process is generally undertaken to reduce their impact on health, environment or

aesthetics. Waste management is based on 3 R strategies: reduce, reuse and recycle. Waste management can be defined as all the activities that are required to manage waste from the point of collecting the waste to recycling and monitoring (https://www.toolshero.com/management/waste-management/)

Kumar 2011, establish waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. Lemann (2008), state that waste management includes the formation, treatment and disposal of waste materials and their resulting products. Waste management reduces the effect of waste on the environment, health, and so on. It can also help reuse or recycle resources, such as; paper, cans, glass, and so on. There is various type of waste management that include the disposal of solid, liquid, gaseous, or hazardous substances.

There are many things that need to be taken into consideration when discussing waste management, such as disposal methods, recycling methods, avoidance and reduction methods, and transportation of waste. The process of waste management involves treating solid and liquid waste. During the treatment, it also offers a variety of solutions for recycling items that aren't categorised as trash. (https://www.indiatoday.in/information/story/waste-disposal-and-management-all-you-need-to-know-1718288-2020-09-04#:~:text=Importance%20of%20waste%20management%3A,%2C%20gaseous%2C%20or%20hazardous%20substances.)

Waste management is an important element of environmental protection. Its purpose is to provide hygienic, efficient and economic solid waste storage, collection, transportation and treatment or disposal of waste without polluting the atmosphere, soil or water system According to Hari (2010), waste materials that are organic in nature, such as plant material, food scraps, and paper products, can be recycled using biological composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process (such as methane) can be captured and used for generating electricity. The intention of biological processing in waste management is to control and accelerate the natural process of decomposition of organic matter (https://www.intechopen.com/chapters/18478).

iii. Need for Waste Management

It is essential to manage the wastes in an efficient manner for the following reasons.

Improves Human Health

In most cases, the improper management and disposal of different types of wastes can cause a variety of health issues to humans. These can include skin irritation, respiratory problems, and other illnesses. For example, wastes that release dioxins and other toxins are dangerous, especially when they're diffused into the air people breathe. Moreover, toxic chemicals from waste leaking into bodies and streams of water can also be harmful to people who consume that water on a regular basis.Due to these circumstances, people should be taught how to properly manage and dispose of their waste. A clean and waste-free home may make it easy for people to strengthen their immunity naturally by developing healthy habits (https://www.rapidrivermagazine.com/2021/5-reasons-why-waste-management-is-important/).

Preserves the Environment

Another essential reason for waste management is due to the fact that it helps preserve the environment. Typically, improper disposal of waste, including burning every type of rubbish that people come across, is not good for Mother Nature. This is because it pollutes the air and releases toxins that can lead to the destruction of the planet through the extreme climate changes the world is experiencing now. Since wastes emit greenhouse gases that rise to the atmosphere, these can cause strong storms, typhoons, and unbearable heat that can affect people on a daily basis. Moreover, poor waste management techniques can result in the contamination of air, water, and soil, which in turn can cause harm to the environment as well as communities. The problem of municipal solid waste has not only affected human health but also beauty and environment of city itself

Protects Animals and Marine Life

Just like humans and the environment, inappropriate handling of waste and garbage can have an adverse impact on animals and marine life.

Lowers Production Costs

Another reason why waste management is essential is its ability to lower production costs. One of the essential aspects of waste management is recycling, and when you do it, you're helping in the conservation of natural resources by reusing materials such as glass, plastic, oil, and paper.

Can Lead To Profits for Companies

For business owners and entrepreneurs, proper waste management can also be profitable in a variety of ways. When companies implement good recycling practices, this can lead to bigger profits by maintaining the efficiency of the supply chain. This is especially true for businesses like restaurants, food factories, and supermarkets. By planning and properly portioning ingredients and other materials with the use of good waste management techniques, business owners can enjoy a high level of profitability at the end of the day.(https://www.rapidrivermagazine.com/2021/5-reasons-why-waste-management-is-important/)

Ramulu and Shoba (2008), classified solid wastes as the organic and inorganic waste materials produced by households, commercial, institutional and industrial activities which have lost their value in the eyes of the first owner while some other person may find the same useful, if the (original) owner does not want it. It is then called a "waste".

iv. Types of Waste

Waste can be classified into five types which is all commonly found around the house. These include liquid waste, solid rubbish, organic waste, recyclable rubbish and hazardous waste.(https://4waste.com.au/)

1. *Liquid Waste*

Liquid waste is commonly found both in households as well as in industries. This waste includes dirty water, organic liquids, wash water, waste detergents and even rainwater.(https://4waste.com.au/)

Liquid waste can be defined as such liquids as wastewater, fats, oils or grease (FOG), used oil, liquids, solids, gases, or sludge and hazardous household liquids. These liquids that are hazardous or potentially harmful to human health or to the environment.(https://www.ewastedisposal.net/liquid-waste/)

2. *Solid Rubbish*

Solid rubbish can include a variety of items found in your household along with commercial and industrial locations.Solid rubbish is commonly broken down into the following types:

- Plastic waste – This consists of bags, containers, jars, bottles and many other products that can be found in your household. Plastic is not biodegradable, but many types of plastic can be recycled. Plastic should not be mix in with your regular waste, it should be sorted and placed in recycling bin.
- Paper/card waste – This includes packaging materials, newspapers, cardboards and other products. Paper can easily be recycled and reused so make sure to place them in recycling bin
- Tins and metals – This can be found in various forms . Most metals can be recycled.
- Ceramics and glass – These items can easily be recycled.(https://4waste.com.au/)

Solid waste is the unwanted or useless solid materials generated from human activities in residential, industrial or commercial areas (https://www.indiawaterportal.org/topics/solid-waste).

Municipal solid waste (MSW), commonly known as trash or garbage, is a waste type consisting of everyday items that are discarded by the public. "Garbage" can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately.(https://en.wikipedia.org/wiki/Municipal_solid_waste)

3. *Organic Waste*

Organic waste is another common household waste. All food waste, garden waste, manure and rotten meat are classified as organic waste. Over time, organic waste is turned into manure by microorganisms. However, this does not mean that you can dispose them anywhere. Organic waste in landfills causes the production of methane, so it must never be simply discarded with general waste.(https://4waste.com.au/)

Biodegradable waste includes any organic matter in waste which can be broken down into carbon dioxide, water, methane or simple organic molecules by micro-organisms and other living things by composting, aerobic digestion, anaerobic digestion

or similar processes. In waste management, it also includes some inorganic materials which can be decomposed by bacteria (https://en.wikipedia.org/wiki/Biodegradable_waste).

Organic waste is any material that is biodegradable and comes from either a plant or an animal. Examples of organic waste include green waste, food waste, food-soiled paper, non-hazardous wood waste, green waste, and landscape and pruning waste (https://www.cityofsignalhill.org/DocumentCenter/View/4118/organic-recycling?bidId=)

4. *Recyclable Rubbish*

Recyclable rubbish includes all waste items that can be converted into products that can be used again. Solid items such as paper, metals, furniture and organic waste can all be recycled (https://4waste.com.au/).

Recycling is the process of converting waste materials into new materials and objects. The recovery of energy from waste materials is often included in this concept. The recyclability of a material depends on its ability to reacquire the properties it had in its original state.(https://en.wikipedia.org/wiki/Recycling)

5. *Hazardous Waste*

Hazardous waste includes all types of rubbish that are flammable, toxic, corrosive and reactive. These items can harm you as well as the environment and must be disposed of correctly (https://4waste.com.au/).

According to Bhatt and Asheref (2012), industrial and hospital waste is considered hazardous as they may contain toxic substances, Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g. gases. Sasikumar and Kirshna (2012), interpret hazardous waste as waste generated during production or other activities by the society. Hazardous waste poses a substantial or potential hazard to human health or environment when not well managed..

Sasikumar and Sanoop (2017),declare that hazardous waste poses a substantial or potential hazard to human health or environment when not well managed. It possesses at least one of the four characteristics: ignitability, corrosivity, reactability and toxicity.

Products such as paints, cleaners, oils, batteries, and pesticides that contain potentially hazardous ingredients require special care when you dispose them off.

Household Hazardous Wastes (HHW) are products used in home, workplace and places of leisure and recreation. They can be flammable, corrosive, explosive or toxic, and harmful to you and the environment if they are not handled properly (https://www.enr.gov.nt.ca/sites/enr/files/brochures/household_hazardous_wastes.pdf)

6. Non-hazardous waste

Any urban solid waste which is biodegradable and non-bio-degradable but is not corrosive, toxic, ignitic or reactive is considered non-hazardous solid waste materials. Examples include such materials as yard trimmings, cardboard, packaging materials, slaughter house solid waste, and the like.(Sasikumar and Sanoop (2017)).

Any urban solid waste which is biodegradable and non-bio-degradable but is not corrosive, toxic, ignitic or reactive is considered non-hazardous solid waste materials, Examples include such materials as yard trimming, cardboard, packaging materials, slaughterhouse solid and the like (Sasikumar and Kirshna ,2012),.

Typical classification of solid waste was: suggested by Hosetti and Kumar (1998) and it is as follows.

- Garbage: Putrecible wastes from food, slaughterhouses, canning and freezing industries.
- Rubbish: non-putrecible wastes either combustible or non-combustible. These include wood, paper, rubber, leather and garden wastes as combustible wastes whereas the non-combustible wastes include glass, metal, ceramics, stones and soil.
- Ashes: Residues of combustion, solid products after heating and cooking or incineration by the municipal, industrial, hospital and apartments areas.

Traditionally these wastes are categorized into the following five types.

- Residential: It refers to wastes generated mainly from dwelling, apartments, and consisted of leftover food scrapes, vegetables, peeled material, plastics, wood pieces, clothes and ashes.

  According to Subhash (2010), Household Waste derived from residential neighbourhoods is ‘the largest component of urban solid waste. It consists of a large number of various elements difficult to separate such as food and garden

waste, paper, plastic cardboard, glass, leather, old clothes, furniture, vegetable peach, egg shells. newspaper and magazines.

- Commercial: This mainly consists of grocery materials, leftover food, glasses, and metals, ashes generated from stores, hotels, markets, shops and medical facilities.

  Subhash (2010), informs that commercial waste consists of shops, restaurants, hotels, business establishment, market wastes varied in totality but each specific sources may have only one type of waste material.

- Institutional: The wastes generated from schools, colleges and offices include, paper, plastics, and glasses.

- Municipal: This includes dust, leaf litter, building debris, and treatment plant sediments These arise from various activities like demolition, construction, street cleaning, land scraping, etc.

- Agricultural: This mainly includes spoiled food grains, vegetables, grass, litter etc , generated from fields and farm.

- Prabhakar (2001),surmise that household wastes, include garbage, trash, and sanitary wastes from septic tanks derived from households including residence, hotels, and motels

- Agricultural wastes includes wastes that are returned to the ground as fertilizer, but does not include silviculture wastes.

- Utility wastes from coal combustion including fly ash waste, bottom ash waste, slag waste, and fuel gas emission control waste. Exploration wastes from oil ,cement kiln dust wastes, spent sulfuric acid are samples of hazardous wastes from industries

v. Methods of waste disposal

Non-biodegradable and toxic wastes like radioactive remnants can potentially cause irreparable damage to the environment and human health if not strategically disposed of. Waste disposal has been a matter of concern, the main problem growth in population and industrialization. Here are a few methods of waste

disposal(https://www.indiatoday.in/information/story/waste-disposal-and-management-all-you-need-to-know-1718288-2020-09-04) .

Landfills

According to Lingaraj (2013), this is a term often mistakenly used by municipalities to refer to open dumping, presently the most common method of waste disposal, which causes problems of subsoil-water contamination. With available land for waste disposal becoming more and scarcer every year, efforts must be made to strictly minimize the wastes going to landfills, by segregating non-biodegradable waste for recycling and by composting of bio-degradable wastes. Landfilling should be used only as the last step in the waste-processing chain, not for untreated mixed wastes.

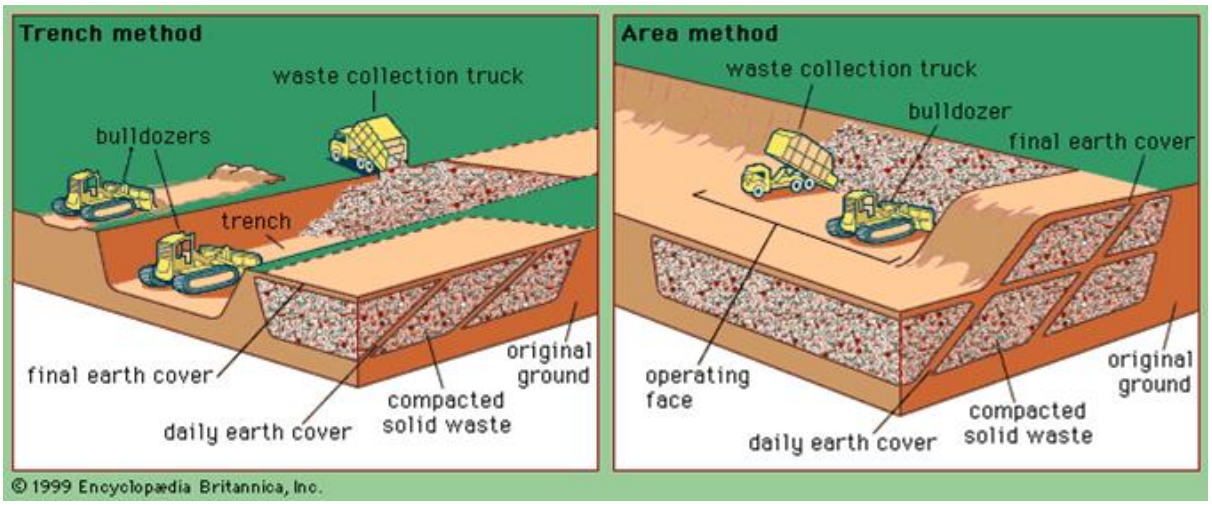

Figure 1: Landfill Disposal Method

Throwing daily waste/garbage in the landfills is the most popularly used method of waste disposal used today. This process of waste disposal focuses attention on burying the waste in the land.(https://www.indiatoday.in/information/story/waste-disposal-and-management-all-you-need-to-know-1718288-2020-09-04)

Subhash (2010) define, sanitary landfill as the use of solid wastes for land reclamation. Restoration to original level with solid wastes is a good example for sanitary landfill. This method of waste disposal differs from ordinary dumping in a way that the area is adequately compacted and covered with earth at the end of the day. The disposal of garbage in a well managed land, adopting scientific methods of operation is termed as sanitary landfill. Low lying areas can be used to raise the level so that cultivation or any other activities can be done. Some completed sanitary landfills have

been successfully converted into parks, playgrounds and other community land use project. Sanitary landfills are generally more common in advanced countries especially near urban areas where population densities are highest. In order to improve the environment, simple engineering techniques are also used so that landfill does not pose any threat to public health (https://byjus.com/biology/waste-disposal/).

Recycling

Recycling is the process of converting waste products into new products to prevent energy usage and consumption of fresh raw materials. Recycling is to reduce energy usage, reduce the volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions, and preserve natural resources for future use(https://www.indiatoday.in/information/story/waste-disposal-and-management-all-you-need-to-know-1718288-2020-09-04).

Figure 2: Recycling Method

Use and discarded culture is fast catching up with the Indian masses and this in turn has led to a spurt in especially plastic and paper waste and hence the growth of the recycling industry. As people become more aware of ecological or environmental imperatives and as the space available to landfill is shrinking, the need for recovering, reusing and recycling much of what previously thrown away or dumped is becoming more evident. Recycling and reuse of the waste helps to diminish the problem of waste disposal to some extent (Subhash 2010).

Recycling returns various materials to the production, cycle and saves natural resources along the way. Some materials like steel and aluminium can be recycled many times. In some developing countries, more than half of the urban waste may be recycled or reused.

Composting

Composting is an easy and natural bio-degradation process that takes organic wastes i.e. remains of plants and garden and kitchen waste and turns into nutrient-rich food for your plants.(https://www.indiatoday.in/information/story/waste-disposal-and-management-all-you-need-to-know-1718288-2020-09-04)

Figure 3: Composting Method

It is the process of promoting bio-degradation of the organic constituents in solid wastes. In this practice, organic portion of MSW is allowed to decompose under carefully controlled conditions. It is defined as the decomposition of heterogeneous organic matter by a mixed microbial population in the moist, warm and aerobic environment. These micro-organisms convert waste into humus. This results in the formation of nutrient-rich manure. Also, this process ensures that the nutrients are replenished in the soil. Besides enriching the soil, composting also increases the water retention capacity. In agriculture, it is the best alternative to chemical fertilizers (https://byjus.com/biology/waste-disposal/).

Incineration

Incineration involves the combustion of waste materials. With this method, the waste material is heated to very high temperatures and is converted into materials such as

heat, gas, steam, and ash.(https://www.indiatoday.in/information/story/waste-disposal-and-management-all-you-need-to-know-1718288-2020-09-04)

Figure 4: Incineration Method

According to Lingaraj (2013) Indian waste contains only 3 to 7% of combustibles, paper and plastic by the time the waste reaches the disposal site. This is principally because most of the burnable material is retrieved by rag pickers from the waste lying on the streets, dust bins and dump yards. Incineration is the process of controlled combustion of garbage to reduce it to incombustible matter such as ash and waste gas. The exhaust gases from this process may be toxic, hence it is treated before being released into the environment. This process reduces the volume of waste by 90 per cent and is considered as one of the most hygienic methods of waste disposal. In some cases, the heat generated is used to produce electricity. However, some consider this process, not quite environmentally friendly due to the generation of greenhouse gases such as carbon dioxide and carbon monoxide.(https://byjus.com/biology/waste-disposal/) Another term commonly used for this technology is energy recovery or waste to energy because the heat derived from incinerated waste

Waste Compaction

The waste materials such as cans and plastic bottles are compacted into blocks and sent for recycling. This process prevents the oxidation of metals and reduces airspace need, thus making transportation and positioning easy (https://byjus.com/biology/waste-disposal/).

Figure 5: Waste Compaction Method

Biogas Generation

Biodegradable waste, such as food items, animal waste or organic industrial waste from food packaging industries are sent to bio-degradation plants. In bio-degradation plants, they are converted to biogas by degradation with the help of bacteria, fungi, or other microbes. Here, the organic matter serves as food for the micro-organisms. The degradation can happen aerobically (with oxygen) or anaerobically (without oxygen). Biogas is generated as a result of this process, which is used as fuel, and the residue is used as manure. (https://byjus.com/biology/waste-disposal/)

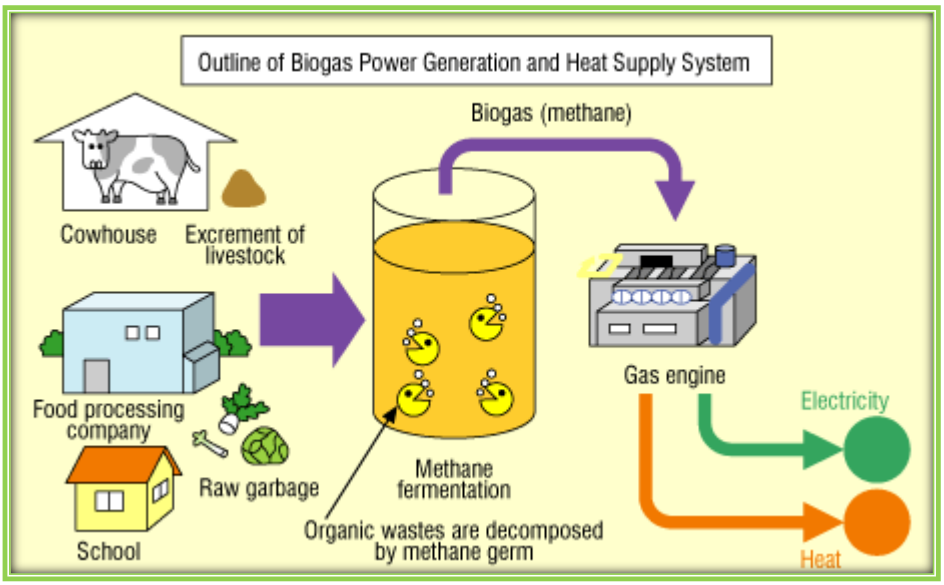

Figure 6: biogas method

According to Gasification is an energy efficient technique for reducing the volume of municipal solid waste and the recovery of energy in this process, combustible matter of garbage is allowed to dry op dewater and then is subjected to shredding.

Gasification process involves the partial combustion of a carbonaceous fuel to generate a combustible fuel gas rich in CO and H (Subhash 2010).

Pyrolysis

Pyrolysis has been proposed by Subhash (2010),as an alternative to incineration. Incineration of waste materials under oxygen deficient conditions is called pyrolysis. This process is superior to incineration because much of the energy content of the waste elements can be recovered here. Basically, it is a high temperature thermal process that gives a possible alternative to incineration. It takes place in a low-oxygen or oxygen free environment and produces byproducts that can be used as fuel. Pyrolysis can be used for the processing of discarded materials like rubber tires.

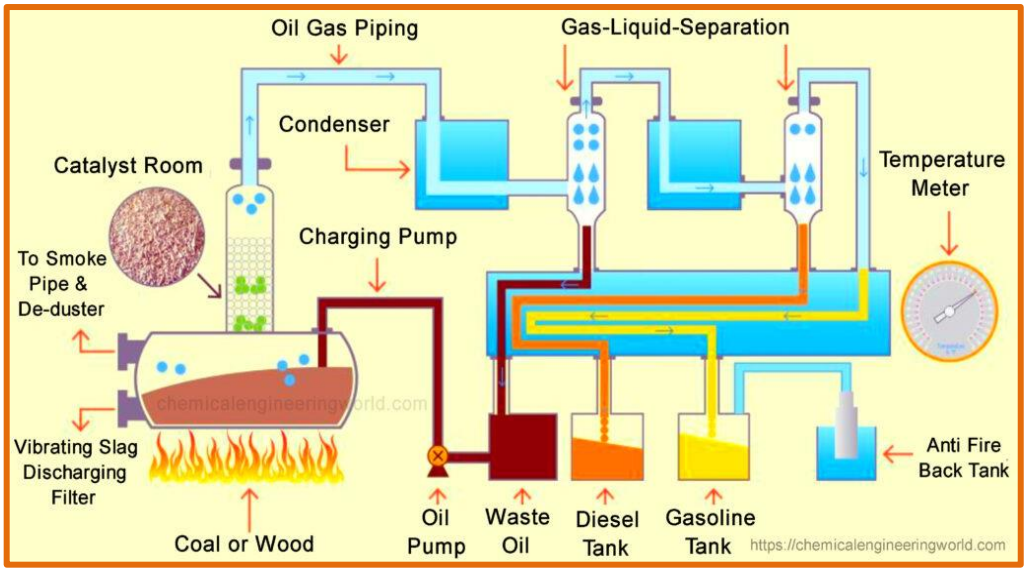

Figure 7: Pyrolysis Method

Pelletisation

Pelletisation is a physical process as revealed by Subhash (2010), which brings about resource recovery from waste. Pelletisation involves segregation of incoming waste into high and low calorific value materials, shredding them separately to uniform size, reducing its moisture content. Fuel pellets are referred as refuse derived fuel (RDF) are small cubes pieces made out of garbage. Production of refuse-derived fuel for incineration is a viable technology

Figure 8: Pelletisation Method

vi. Characteristics of the waste

According to Salahuddin (2011),as the population grows by leaps and bounds so will be an increase in waste generation and the need for its disposal has also increased. Although the Aligarh Municipal Authority is trying to manage this waste (from collection, transportation to final disposal) but only 70-80 per cent of waste reaches the final disposal destination. Rest of the waste stagnates either in municipal waste bins, which are either not present or if at all they are there, have turned into mere pieces of rusted metal. These dustbins are not cleaned frequently as a result of which waste spills over and spreads every where on the streets. Garbage is dumped in open plots/ field or along roadside, in the residential colonies increasing the risk of diseases and several other problems like waterlogging, choking drains, garbage mounds on roads etc.

vii. Waste trend

According to Sasikumar and Sanoop (2017),it is very essential for the government to have a good knowledge about the quantity, content and characteristics of the different waste produced in the urban local bodies (as households, waste resulting from economic activities, shops, establishments and institutions. etc.). Local authorities and even the Central government spend huge amounts out of the gross domestic product for collection, transportation and treatment of waste.

Even in major project studies probing the waste management policies and world trend undertaken by international organizations, researchers admit that though waste generation has been increasing worldwide, the limited availability and quality of data

hinder projections of future waste trend. It is extremely difficult to estimate the quantity of waste generated in the developed and developing countries due to lack of common definitions and waste categorization. The availability of waste data and calculation of waste indicators are very crucial for policy formation and decision making. Therefore, waste statistics is considered to be very important. In many countries, especially those which are referred to as developing countries and those countries which have developed recently due to industrialization, no organized reporting system about waste is. Data are collected mostly by indirect methods by analyzing and constructing from waste registers and indicators. Indirect data, as they are obtained currently in many underdeveloped countries including India, are a cheap way to get a rough idea about the situation, but estimates are not professionally done and therefore lack reliability. However, many developed countries, have satisfactorily developed, to a certain extent, a waste profile using modern techniques. Such type of waste stream analysis helps to forecast the future trend which can be of help to the policymakers to understand the consequences connected with environmental problems, and to develop and manage a scientific database.

B. Composting

i. Significance of composting

Compost is a mixture of properly decomposed organic matter that can be used as a supplement for soil conditioning and supplying the nutritional requirements of the crops. It helps in better plants growth and enhances the yield of the crop as informed by Singh, and Longkumer(2018)

Composting is the process of physical, chemical, and biological decomposition of large, bulky, coarse organic waste of plant or animal origin to a dark brown or black coloured, homogenous, brittle particulate. The matter obtained through this is called compost that can be used as a soil conditioner and source of nutrient to the plants. It naturally fortifies the soil and helps in enhancing the productivity of the soil.

According to Basu and Xavier (2016) it is a type of biologicalmethod of breakdown of organic waste such as leftover food, Vegetable residue, manure, leaves and twigs, grass trimmings, paper, worms, tea leaves and coffee grounds, etc. into an enormously useful humus like material by the action of various micro organisms such as bacteria, fungi and actinomycetes in the presence of oxygen. Given enough time all these

organic matters will decompose. Low temperature interferes with the progress of the process, as it lacks the required temperature to kill pathogens.

Compost is a combination of food waste and brown waste that is being decomposed through aerobic decomposition into a rich black soil.

Compost is a mixture of ingredients used to fertilize and improve the soil. It is commonly prepared by decomposing plant and food waste and recycling organic materials. The resulting mixture is rich in plant nutrients and beneficial organisms, such as worms and fungal mycelium(https://en.wikipedia.org/wiki/Compost).

Himadri and Dharamvir (2007), evince that compost manures are the decayed refuse like leaves, twigs, roots, stubble, bhusa, crop residue and hedge clippings, street, refuse collected in towns and villages, water hyacinth, saw-dust and bagasse. The process of decomposition is hastened by adding nitrogenous material like cowdung, night-soil, urine or fertilizers. A large number of soil micro-organisms feed on these wastes and convert it into well-rotted manure. The final product is known as compost.

Hari (2010), acknowledge that composting up cycles organic kitchen and yard waste and manures into an extremely useful humus-like, soil end product, permitting the return of vital organic matter, nutrients, and particularly bacteria, that are vital to plant nutrition to the soil. Composting is used in subsistence farming and home gardening for creating garden-ready soil and is becoming increasingly important and better understood as a tool for reducing municipal solid waste, and reducing the amount of green waste going into landfills. In urban areas with dwellings predominantly lacking individual yard space, there are indoor small scale composting alternatives, such ag vermicomposting and bokashi composting.

ii. Uses of composting

According to Hari (2010),compost is generally recommended as an additive to soil, or other matrices such as coir and peat, as a soil improver, supplying humus and nutrients.

It provides a rich growing medium, or a porous, absorbent material that holds moisture and soluble minerals, providing the support and nutrients in which plants can flourish.

Compost is a versatile product resulting from composting - the biodegradation of organic waste, industrially, commercially or domestically produced.

Compost is a beneficial ingredient in potting media, used up to 30 percent of the total mix. It is an excellent substitute for peat moss. The NPK content of compost can also reduce the need for chemical fertilizers.

The use of compost to control sediment run-off and fight erosion is a relatively new technology, now being adopted by local authorities, developers, farmers, and other major disturbers of soil as another tool to reduce topsoil loss.

Compost is used as a planting media for constructed or artificial wetlands.

When a landfill cell is closed, compost can be added to the soil used to cap the cell to encourage vegetation and reduce erosion.

Use of compost can not only restore functionality and beauty to riparian zones, but also mitigate future damage.

Lingaraj (2013),reveals the benefits of compost as it can be rich in nutrients. It is used in gardens, landscaping, horticulture, and agriculture.

The compost itself is beneficial for the land in many ways. Organic ingredients intended for composting can alternatively be used to generate biogas through anaerobic digestion.

Compost can be tilled directly into the soil or growing medium to boost the level of organic matter and the overall fertility of the soil.

Sajnanath and Sushama (2004) & Gupta (2008) summarized that composting would reduce the pressure on farmers to reduce the cost of cultivation due to increasing cost of fuel, labour and farm machinery and falling price of agricultural produces.

.Compost production from urban wastes should be looked from the angle of economic advantages as well as environmental and social perspectives like urban land availability for construction of landfill sites which is a major component for waste management. Expenses for transport of wastes to long distances, maintenance of landfill sites and others become exorbitantly high under such conditions. Composting of solid wastes (and treatment of liquid wastes) provides much greater benefits.

According to Sasikumar and Kirshna (2012), Compost is beneficial for crop production due to the following reasons: . Compost prepared from municipal solid waste contains 1% each of NPK. During composting, the plant nutrients are converted to such forms which get released gradually over a longer period and do not get leached away easily. It is known to contain trace elements such as Mn, Cu, Bo, Mo, which are essential to the growth of plants. . It is a good soil conditioner and increases the texture of soil, particularly in light sandy soil. It improves the ion exchange and water retaining capacity of the soil. Compost adds stabilized organic matter, thus improving the soil. It increases the buffering capacity of the soil.

iii. Methods of composting

Composting is a slow natural process in which mixed bacteria, fungi, insects and worms consume plant and animal wastes and convert them slowly to a soil-like substance very beneficial to plant growth. Compost provides energy, minerals, nutrients and micronutrients, useful microbes and water-retaining humus to soil. This improves the quality and pest-resistance of produce, makes crops drought-resistant and decreases irrigation water requirements, Compost can find a good market if properly promoted and made conveniently available to the farming community. Composting can be done by aerobic and anaerobic processes (Lingaraj 2013).

Singh, and Longkumer (2018) express that composting is basically a biological decomposition of organic residues, however physical and chemical treatment is given to hasten the process. Depending upon composting methods, there are different kinds of compost and each has their advantages and disadvantages. These methods are as follows:

1. Pit Manure/Anaerobic Compost
2. Coimbatore method
3. Indore method
4. Bangalore method
5. NADEP Composting
6. Vermicompost
7. Vermiwash
8. Biodynamic composting
9. Biodung composting,
10. Padegaon method,

11. Biogas-slurry method,
12. Azolla compost
13. In-vessel composting
14. Spent Mushroom Substrate (SMS)
15. Humanure
16. Biomineralizer

iv. Factors affecting the composting process

Singh and Longkumer (2018) describe certain environmental factors affect the composting process, so they require food (carbon and nitrogen), air, and water to make compost. Along with this, they also require a favourable temperature and Ph for rapid composting. Other physical factors affecting the pace of composting include surface area, particle size and volume. These factors affecting the process are detailed as below.

Figure 9: Factors Affecting the Composting

a. Organism: For every natural occurring substance, there is a corresponding microbial enzyme complex with the ability to convert it to carbon dioxide, humic material and waste. Presence of asufficient number of these assures quality compost production (Singh, 1987).

b. Organic waste: Organic wastes are the primary substrate subjected for decomposition. It provides food for organisms in the form of carbon and nitrogen. Organic materials rich in carbon tend to be dry and brown such as plant leaves, straw and wood chips. Any fresh and juicy materials will be usually higher in nitrogen, and older, drier, and woodier plant material will be higher in carbon. The organic material with higher nitrogen will decompose faster than those, which are high in carbon content.

c. Aeration: Aeration refers to the amount of oxygen in the system, and it is the key environmental factor. Organisms present in the compost pile can degrade organic

materials either aerobically or anaerobically. Many organisms including aerobic bacteria need oxygen to produce energy, grow and reproduce.

Aeration in a compost pile occurs naturally as the oxygen-deficient air present in a pile warmed up due to composting, by wind, moisture content, and porosity (spaces between particles in the compost pile).

d. Moisture Content: According to Gupta (2011),Moisture is essential for microbial activity. It influences the rate of the microbial population which helps in faster and proper degradation of composted matter. Maintaining adequate moisture content is essential since it provides the humidity required by micro-organisms for optimal degradation. The moisture content of 50-60 per cent is generally considered optimum for composting.

e. pH: The pH of most of the composting substrate is slightly acidic, i.e. 6.0. At the early stage there is a production of organic acid hence pH goes again acidic 4.5-5.0. As the decomposition process get over and temperature reduces and pH of the composted mass start increasing. It gets converted into alkaline pH 7.5-8.5 from acidic pH.The pH of the mature compost is 7.5-8.5 (Kakde,2017).

f. Temperature: Temperature is another important factor in the composting process and is related to proper air and moisture levels.. With the increase in the temperature of the pile, different groups of organisms become active. The temperature of the compost pile with substrates of appropriate particle size may rise to 65-750 C if oxygen, moisture, carbon and nitrogen is present in ample amount. According to Gupta (2011), temperature is related to the weather, therefore composting is more reliable and fast in summertime. Compost which may be ready in two summer months may require six months in winter.

g. Surface area: All the microbial activity is performed on the surface of the particle, so the surface area of the organic material exposed to soil organisms influences the rate of decomposition greatly. Composting materials should be shredded, chopped or otherwise reduced in size to increase the surface area to increase the rate of decomposition

h. Size and Shape of Compost System: Size is a factor in retaining compost pile heat. A compost pile must be of adequate size to prevent faster dissipation of heat and moisture, but it may be small enough to allow good air circulation

i. Time of Composting: The best times to build the compost pile is autumn and spring. In the autumn, many of the weeds and grasses will be flowering or started to go to seed so substrate of much higher C/N ratio will be available. In the spring, there will be again fresh green growth, which will have a lot more nitrogen (N).

Best Composting Tips given by Lingaraj (2013) are as follows

1. Mixture of cattle, sheep, and horse dung with vegetable wastes forms ideal feed for worms.
2. Addition of neem cake in small quantity enhances growth of worms.
3. Biogas slurry aged aerobically for 15 days enhances Vern composting process

C. Biomineralizer

i. The role of biomineralizer in composting

According to TNAU, biomineralizer is a microbial consortium which is developed to accelerate the composting process. The consortium of microorganisms is necessary to degrade different chemical constituents of solid wastes. In normal composting of solid wastes, microorganisms establish on their own in the solid wastes under right environment. But it takes long time for establishing microorganisms in the compost pile under normal circumstances. But if right type of microorganisms is inoculated into the compost pile, immediately it starts working on the waste and mineralization process starts working. That is the reason for formulating a microbial consortium to degrade different chemical constituents in the wastes and mineralization process takes place completely and the compost will be fully matured one.

Figure 10: Biomineralizer

ii. Fomulation of Biomineralizer

In the formulation of Biomineralizer all the organisms were grown in the respective broth and allowed to grow for the maximum population of 1 x 108 cells per ml .After reaching the maximum population, the grown cultures were mixed with sterilized lignite carrier separately at 40% moisture. In the case of Pleurotus, it was grown in sorghum seeds and grown cultures were kept as such with out mixing with any carrier material The other cultures which were mixed with carrier material were taken in equal quantities and mixed thoroughly. Plewotus cultures were spread over the mixture and mixed uniformly. Now the microbial consortium is ready for use. This microbial consortium is named as Biomineralizer. Mineralization is the convenient term used to designate the conversion of organic complexes of an element to the inorganic state. This process is carried out by consortium of microorganisms, it is designated as Biomineralizer This inoculum can be used for composting all the agro waster The quantity prescribed is 2 kg per ton of waste (https://www.quickcompany.in/patents/biomineralizer-for-composting-different-agro-wastes).

iii. Constituents of biomeneralizer

1. Bacillus sp - Bacterial inoculum
2. Pseudomonas - bacterial inoculum
3. Trichodermaviridie - Fungal inoculum
4. Aspergillusflavus - Fungal inoculum
5. Pleurotussajor-caju - Fungal inoculum
6. Strptomyces – Actinomycetes

Applications

The application of biomineralizer consortium will reduce the period of composting and facilitates the quick decomposition of the organic biodegradable wastes into nutrient rich compost. Crop residues involves the non-economic plant parts that are left in the field after harvest and also discarded during crop processing. Crop residue management through composting will reduce a portion of the cost spent on the purchase of chemical fertiliser for crop cultivation with the following the non-economic benefits viz., improving soil fertility and moisture, increasing soil stability, reduce the soil, air

pollution and eliminating the thrash burning issues that dooms the environment. Said by TNAU

The enriched compost can be applied at the rate of 5 tons per hectare, as basal application to the field. Whatever the compost derived from sugarcane trash, it can be ploughed back into sugarcane field to enrich the soil.

Limitations in Compost Making and Usage:

- The detrashed material should be shredded into small pieces for quicker composting.
- If the detrashed materials are put as such for composting, it requires longer time and uniform composting cannot be obtained.
- Many farmers don't have separate land for composting the sugarcane trash. In that case shredding and in-situ composting inside the sugarcane field can be done.(https://agritech.tnau.ac.in/org_farm/orgfarm_sugar.html)

iv. Advantages and Disadvantages of Various Compost Process

Table 1: Advantages and Disadvantages of Various Compost Process

Compost	No of days	Nutrients	Advantages	Disadvantages
Organic compost	30-45 days or even less	16.7-90.7% organic carbon, 0.5 per cent N, 0.15 per cent phosphorusand 0.5 per cent potassium	Enriches soil, helping retain moisture and suppress plant diseases and pests. Reduces the need for chemical fertilizers. Encourages the production of beneficial bacteria and fungi that break down organic matter to create humus, a rich nutrient-filled material.	Nutrients are so low that a huge quantity of manure has to be added for the desired dose of nutrients. Transport of a huge quantity of manure to the site of application is difficult. It increases the cost also. The rate of mineralization and the rate of release of nutrients, particularly of the nitrogen, is slow.
Compost using biomineralizer	16-30 days	28.6%-organic carbon, 0.35 to 0.42% nitrogen, 0.04 to 0.15% phosphorus, 0.50 to 0.42% potassium	Volume reduction of waste. Final weight of compost is very less. Composting temperature kill pathogen, weed	The product is weighty and bulky, making it expensive to transport. The nutrient value of compost is low compared with that of chemical fertilizers,

			seeds and seeds. Matured compost comes into equilibrium with the soil. During composting number of wastes from several sources are blended together. Excellent soil conditioner Saleable product Improves manure handling Redues the risk of pollution Pathogen reduction Additional revenue. Suppress plant diseases and pests. Reduce or eliminate the need for chemical fertilizers. Promote higher yields of agricultural crops. Facilitate reforestation, wetlands restoration, and habitat revitalization efforts by amending contaminated, compacted, and marginal soils. Cost-effectively remediate soils contaminated by hazardous waste. Remove solids, oil, grease, and heavy metals from stormwater runoff. Capture and destroy 99.6 percent of industrial volatile	and the rate of nutrient release is slow so that it cannot usually meet the nutrient requirement of crops in a short time, thus resulting in some nutrient deficiency The nutrient composition of compost is highly variable compared to chemical fertilizers. Agricultural users might have concerns regarding potential levels of heavy metals and other possible contaminants in compost, particularly mixed municipal solid wastes. The potential for contamination becomes an important issue when compost is used on food crops. Long-term and/or heavy application of composts to agricultural soils has been found to result in salt, nutrient, or heavy metal accumulation and may adversely affect plant growth, soil organisms, water quality, and animal and human health

			organic chemicals (VOCs) in contaminated air. Provide cost savings of at least 50 percent over conventional soil, water, and air pollution remediation technologies, where applicable.	
Vermi - compost	60 to 90 days	9.5-17.98% organic carbon, nitrogen 2-3%, potassium 1.85-2.25%, phosphorus 1.55-2.25%	Improve soil structure, texture, porosity, water holding capacity, drainage, and aeration and reduce erosion, improves plant growth by enabling the growth of new shoots and leaves, thereby increasing productivity, t helps to neutralize the pH of the soil. Vermicompost enhances the soil's microbial activity and adds beneficial microbes, lowers the pest and disease incidence. It is easy to apply and handle, economical and does not have a foul odour. It is free from any pathogens or harmful materials.	Odour- If not done properly, it releases a bad odour. Filling the compost bin with green plants forms ammonia and produces the smell. Adding carbon sources like paper helps to neutralize the smell. Time- It is a time-consuming process and usually takes 2-3 months for completing the process Maintenance- Temperature needs to be maintained for better action by earthworms. The bad odor attracts rodents and flies. So, the bin should be covered properly.

D. Artificial Intelligence in Waste Management

Artificial intelligence has revolutionized industries. But while most people have heard of self-driving cars and facial recognition software, many of us are unaware of the enormous impact AI has had for the waste management and recycling sectors (https://keymakr.com/blog/how-ai-is-transforming-waste-management/#:~:text=

The%20role% 20of%20AI%20in,trash%20receptacles%20throughout%20the%20city.&text=e%20uses%20machine%20learning%20to,immediately%20after%20it's%20thrown%20away.)

Smart waste management refers to any system that uses technology to make trash collection more efficient, cost-effective and environmentally friendly. Most of these systems are equipped with the Internet of Things (IoT), a monitoring technology that collects and tracks real-time data, to help optimize waste collection and spur future innovation (https://keymakr.com/blog/how-ai-is-transforming-waste-management/)

Smart waste management focuses on solving the previously mentioned solid waste management problems by using sensors, intelligent monitoring systems, and mobile applications. The first smart solution to make the waste collection process more efficient is using sensors.(https://evreka.co/what-is-smart-waste-management/)

i. Innovative Technologies Revolutionizing Waste Management:

1. Smart waste bins

When left to their own devices, people don't always bother to sort their waste into the proper waste or recycling bins. To help reduce improper recycling sorting, Polish company Bin-e designed a smart waste bin that uses artificial intelligence-based object recognition to automatically sort recyclables into separate compartments. After sorting, the machine compresses the waste and monitors how full each bin is (https://www.bigrentz.com/blog/smart-waste-management).

Figure 11: Smart Waste Bin

The role of AI in waste management begins with intelligent garbage bins. Waste management companies take advantage of Internet of Things (IoT) sensors to monitor the fullness of trash receptacles throughout the city. This allows municipalities to optimize waste collection routes, times, and frequencies(https://keymakr.com/blog/how-ai-is-transforming-waste-management/#:~:text=The%20role%20of%20AI%20in, trash %20receptacles%20throughout%20the%20city.&text=e%20uses%20machine%20learning%20to,immediately%20after%20it's%20thrown%20away.)

2. Waste level sensors

Homes and businesses across the country rely on routine waste collection services to dispose of their trash. Weekly services have been around for decades, but they aren't always the most efficient option.

To help minimize unnecessary trips to and from landfills, companies and communities can install waste level sensors in bins or dumpsters of any size. These devices collect and store data on fill levels, allowing collection services to predict how often bins need to be emptied. This also helps prevent public containers from overflowing and contaminating the surrounding area (https://www.bigrentz.com/blog/smart-waste-management).

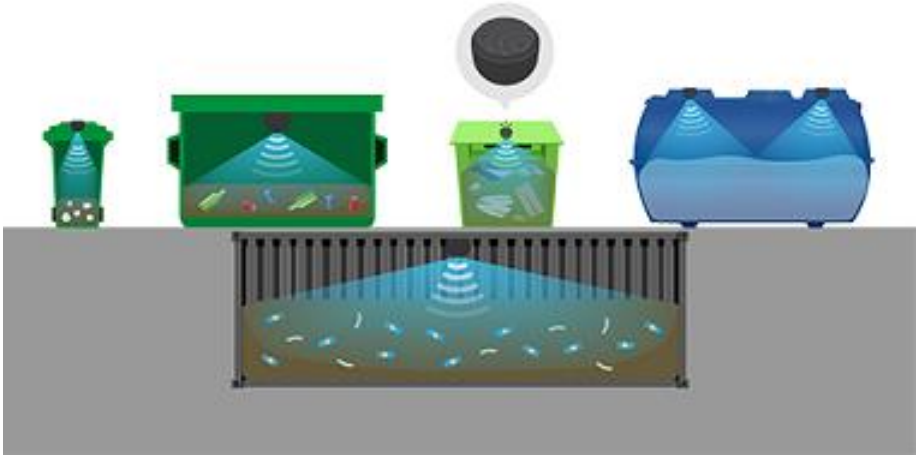

Figure 12: Waste Level Sensor

3. AI Recycling Robots

Recycling centres play a crucial role in reducing the amount of trash that ends up in landfills and waterways each year. However, a reduced workforce during the COVID-19 pandemic has left many centres struggling to keep up with demand. Fortunately,

recycling robots powered by artificial intelligence (AI) can help pick up some of the slack.

Figure 13: AI Recycling Robots

These robots are designed to accurately identify and sort recyclable materials, increasing efficiency and reducing the need for human workers. This not only saves recycling centres money over time, but also helps divert materials that would otherwise end up in landfills.(https://www.bigrentz.com/blog/smart-waste-management)

4. Garbage Truck Weighing Mechanisms

Like waste level sensors, weighing mechanisms installed in garbage trucks can help predict fill levels and reduce collection trips. They do this by measuring and storing the weight of waste containers, then using the data to predict fill levels over time. Cities can use this technology to more accurately predict how often they need to send their trucks out and reduce annual collection costs.(https://www.bigrentz.com/blog/smart-waste-management)

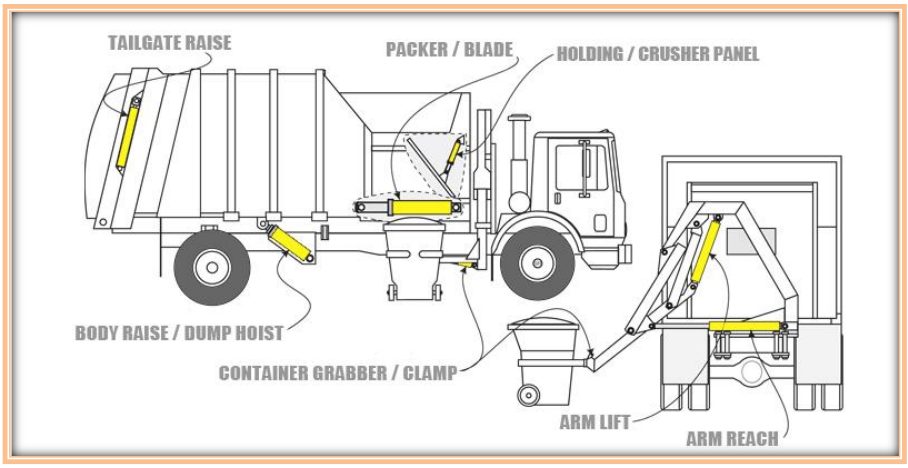

Figure 14: Garbage Truck Weighing Mechanism

5. Pneumatic waste pipes

As populations grow in urban areas, so does the need for waste management solutions that can accommodate increasing amounts of trash. Some cities are taking on this challenge by installing pneumatic waste disposal bins that connect to a series of underground pipes. Trash travels through the pipes to a waste collection plant where it can be sorted or hauled away. This system eliminates the need for traditional waste collection, reduces energy costs and increases overall efficiency (https://www.bigrentz.com/blog/smart-waste-management).

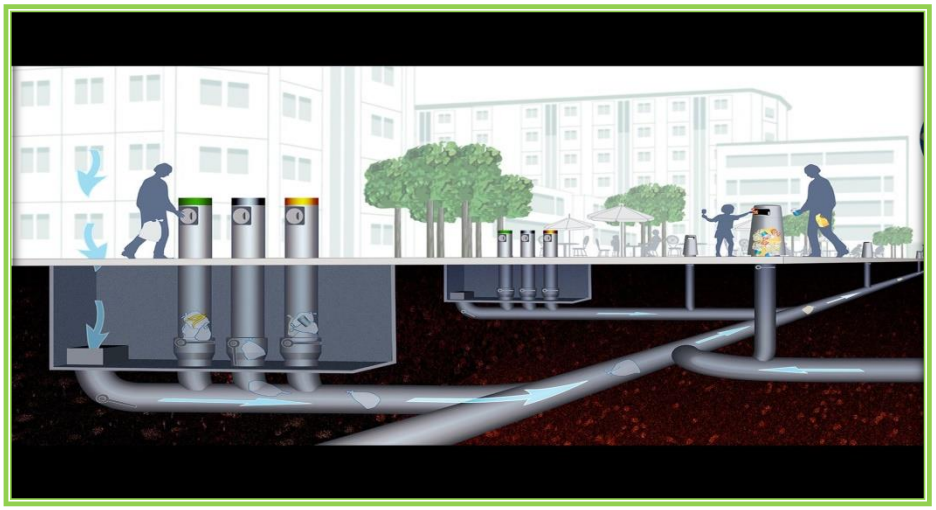

Figure 15: Pneumatic Waste Pipes

6. Solar-powered trash compactors

In an effort to increase collection efficiency and reduce trips to and from the dump, manufacturer Ecube Labs created a solar-powered trash compactor that can hold up to five times more than traditional trash bins. These machines compress trash as it

accumulates to increase bin capacity, and they collect and transmit data on fill and collection times to help streamline the collection process (https://www.bigrentz.com/blog/smart-waste-management).

Figure 16: Solar Powered Trash

7. E-waste kiosks

Electronic waste that is improperly disposed of can be harmful to both humans and the environment. Fortunately, many companies and organizations have started e-waste recycling programs that will accept — and even reimburse you for — old electronic devices.

ecoATM, a smart recycling company, took this idea one step further by creating a line of e-waste recycling kiosks that allow you to exchange your electronics for cash on the spot. While they won't always offer cash for devices that are broken or destroyed, they accept phones, tablets and MP3 players in any condition and ensure that they are recycled properly (https://www.bigrentz.com/blog/smart-waste-management/).

Figure 17: E-Waste Kiosks

8. Recycling apps

Sorting through contaminated waste is one of the biggest challenges for recycling centers. In an effort to limit unrecyclable materials entering these centers, organizations have released apps like Recycle Nation and Recycle that make recycling easier for individuals. These apps provide users with information on recycling rates and center locations, and their comprehensive lists of materials help users determine which items can be recycled.(https://www.bigrentz.com/blog/smart-waste-management)

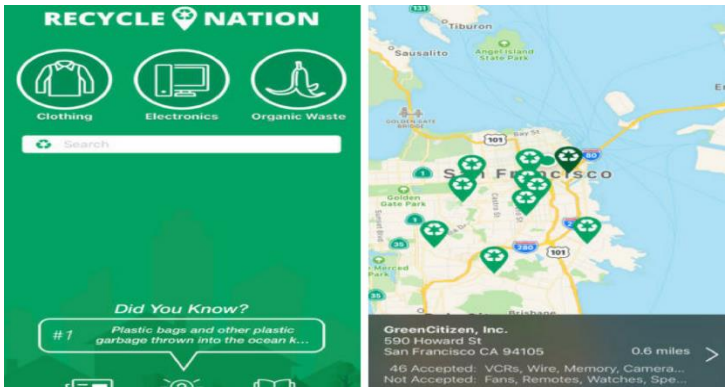

Figure 18: Recycling apps

9. Smart sorting

Until all trash bins are intelligent, waste needs to be sorted at a waste management facility. When it comes to the role of artificial intelligence in automated sorting, one statistic tells you all that you need to know: human workers sort between 30 and 40 recyclables per minute while AI-powered machines can handle up to 160. Moreover, machines can work around the clock.

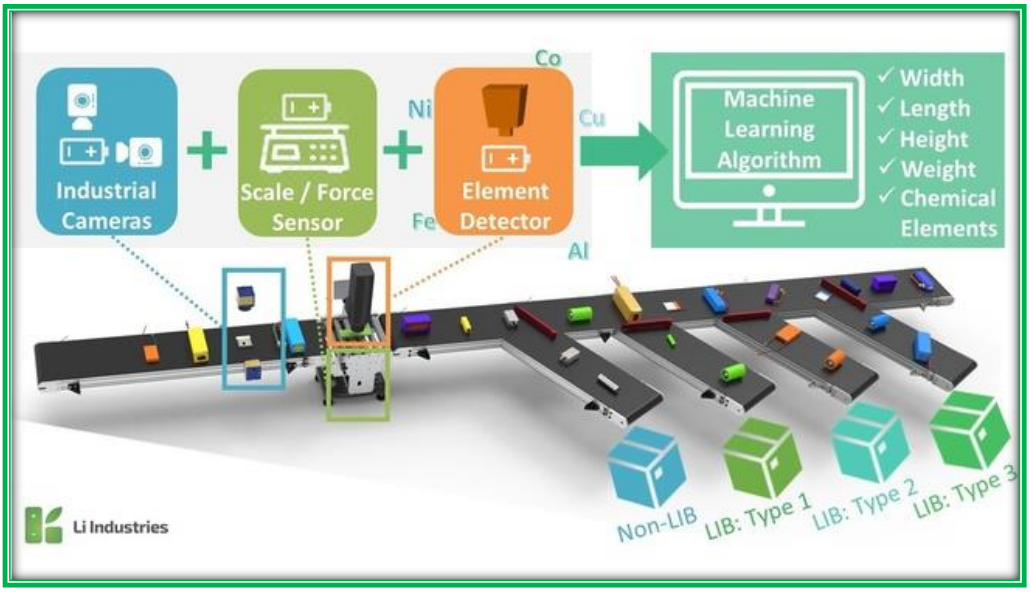

Figure 19: Smart Sorting

III DESIGN OF THE STUDY

The design of the study is critical in all types of research. It encompasses the approaches used to a study problem, the tools or techniques used to collect data and samples. Composting is the process of recycling organic materials that are usually considered waste. The majority of our household waste gets disposed of in landfills, where it rots and releases methane and carbon dioxide into the atmosphere. Composting organic waste can help to mitigate the environment's total impact. Composting improves the soil's ability to retain water, which is one of the most significant benefits. There are three kinds of composting namely, aerobic, anaerobic, and vermicomposting. The use of a biomineralizer is a revolutionary technology that involves the development of microbial consortia that accelerates the composting process. To breakdown the various chemical elements of solid wastes, a consortia of microbes is required. Microorganisms grow themselves naturally in solid wastes during normal composting. However, under normal conditions, it takes a long time for microbes to establish themselves in a compost pile. However, if the appropriate microbes are introduced into the compost pile, it instantly begins working on the trash and the mineralization process begins, according to the report given by TNAU.

The methodology involved in the conduct of the study entitled, "**Use of Biomineralizer for Composting Urban Kitchen Waste**" is as follows:-

- Phase 1: Conduct of Survey among Urban Households
- Phase 2: Experiment to Compare the Normal Compost Prepared with that of Compost Prepared using Bio-Mineralizer

The flow chart of the design of the study is given below in Figure 20.

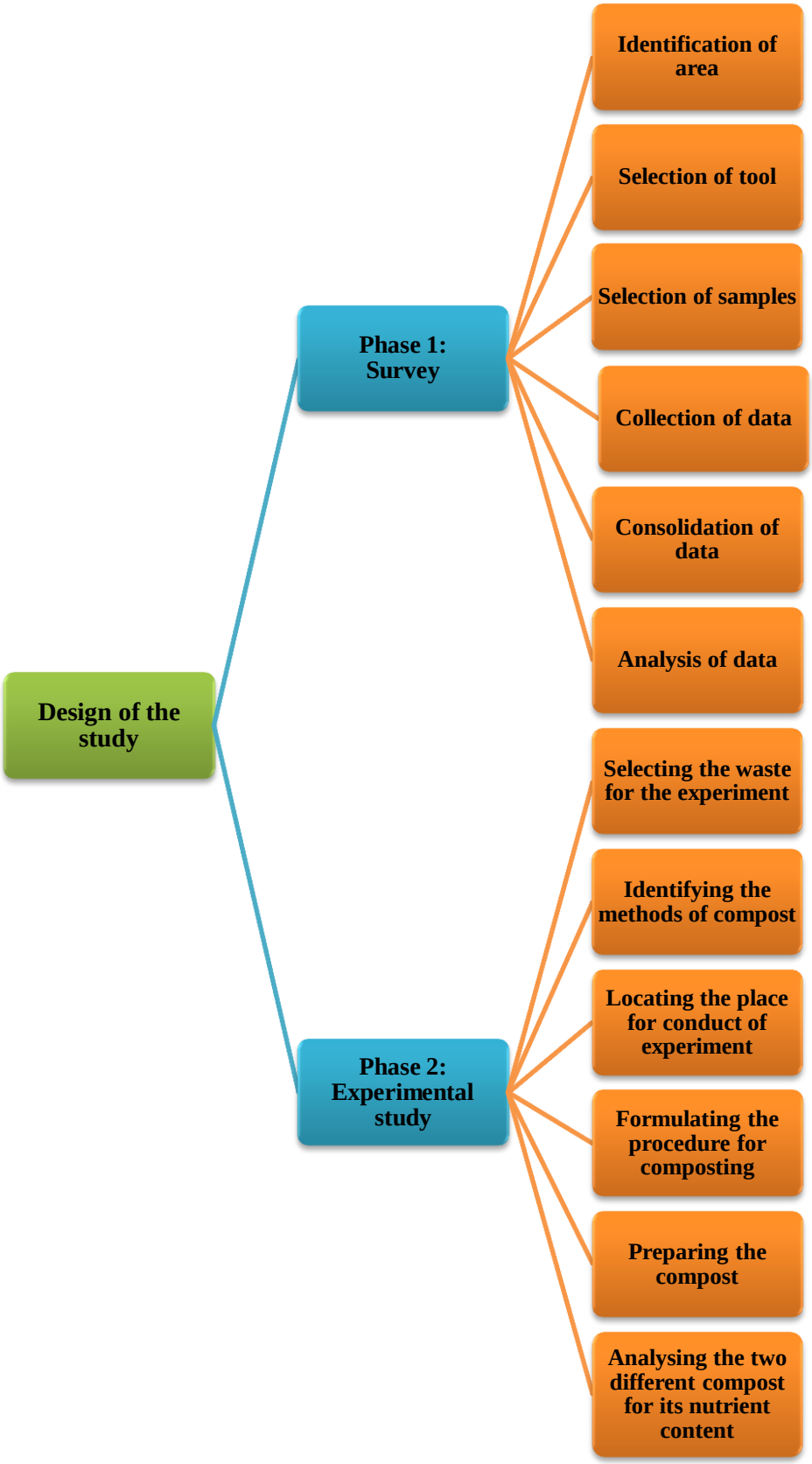

Figure 20: Flow Chart of the Study on use of Biomineralizer for Composting Urban Kitchen Waste

Phase I: Conduct of Survey among Urban Households

Prior to conducting the study, ethical approval was acquired from the parent institution "Avinashilingam Institution for Home Science and Higher Education for Women, Coimbatore." Appendix-1 contains the evidence for ethical clearance.

Survey research is one of the most important areas of measurement applied in social research. The broad area of survey research encompasses any measurement procedures that involve asking questions from respondents. Interviews are conducted by the interviewer based on what the respondent says (Debashis, 2009). Kenneth and Bruce (2006) reveal that survey research is used to evaluate the behaviour (past, present, future) and attitudes of your participants. Survey research falls into the category of correlational research.

Singh (2011), opines research survey interview is a conversation between interviewer and respondent for the purpose of finding some data and information from the respondent. A survey is a collection of data for gathering information from a group of individuals, representing the sample. This group represents a large population from which the sample is drawn (Tariq, 2009). The survey included the following aspects:

1. Identification of area
2. Selection of tool
3. Selection of samples
4. Collection of data
5. Consolidation of data
6. Analysis of data

1. Identification of area

Erode is a city in Tamil Nadu, India. After Chennai, Coimbatore, Madurai, Tiruchirapalli, Salem, and Tirunelveli, this is the state's sixth largest urban agglomeration. Additionally, it serves as the administrative centre for the Erode district. It is centrally located on the South Indian Peninsula, approximately 400 kilometres (249 miles) southwest of the state capital Chennai, approximately 80 kilometres (50 miles) east of Coimbatore, and approximately 50 kilometres (31 miles) east of Tiruppur. Erode is a major agricultural, textile, and business process outsourcing centre and is home to

some of the world's top producers of turmeric, hand-loom and knitwear, and food products.

Erode is famed as the "Turmeric City" or "Yellow City" due to the state's turmeric output. Additionally, it is one of the main markets in South India for coconut and coconut oil production. (https://en.wikipedia.org/wiki/Erode)Besides, it is the investigator's hometown. As a result, conducting the survey in Erode was considered simple and safe during the pandemic period.

2. Selection of tool

In research, tools and techniques refer to the statistical procedures used to gather, analyse, interpret, present, and organise data. Statistics provides a plethora of tools and approaches for analysing data and interpreting the results. (https://hackr.io/blog/what-is-data-analysis-methods-techniques-tools)

A questionnaire, as defined by Ranjth Kumar (2011), is a collection of questions and other prompts used to elicit information from respondents. Although they are frequently used to analyse the responses statistically, this is not always the case. A questionnaire is a series of organised questions used to instruct an observer, researcher, or investigator (Murthey, 2009). Panneerselvam (2014), informs that the success of survey methods depends on the strength of the questionnaire used. A questionnaire consists of a set of well- formulated questions to probe and obtain responses from respondents.

The investigator chose questionnaire as a tool for survey. The investigator prepared the questionnaire about the personal details of respondents, waste disposal methods adopted, attitudes and use of biomineralizer for composting urban kitchen waste.

3. Selection of samples

Singh (2011), informs that in purposive sampling: the units of sample are selected with a define purpose and certain units of the population will have a large probability of selection then other unit. Purposive sampling, also known as judgmental, selective, or subjective sampling, is a form of non-probability sampling in which researchers rely on their own judgment when choosing members of the population to participate in their surveys.(https://www.alchemer.com/resources/blog/purposive-sampling-

101/#:~:text=Purposive%20sampling%2C%20also%20known%20as,to%20participate%20in%20their%20surveys.)

The investigator through purposive sampling selected and interviewed the urban and semi- urban female in Erode district.

4. Collection of data

The term "data collection" refers to the process of gathering, measuring, and analysing correct insights for research purposes through the use of established approved methodologies. A researcher can evaluate their hypothesis using the data they have gathered. In the majority of cases, regardless of the subject of study, data gathering is the first and most critical stage in doing research. Responsible Conduct of Research (RCR) marked data collection as the act of acquiring and analysing data on relevant variables in a systematic manner that enables one to address stated research questions, test hypotheses, and evaluate outcomes. The data collection phase of research is universal across all disciplines, including physical and social sciences, humanities, and business.

Data gathering is a flexible method in studies. Gondane (2015), views that it usually requires intensive interviewing and/or observational methods, particularly participant observation approaches. Survey method of primary data collection is used in order to test concepts, reflect attitude of people, establish the level of customer satisfaction, and conduct segmentation research and a set of other purposes. Survey method can be used in both, quantitative, as well as, qualitative studies.(https://research-methodology.net/research-methods/survey-method/)

A preliminary survey of five houses was undertaken. The questionnaire was amended and various revisions were made based on the feedback from the respondents before it was finalised. During the epidemic, the researcher used an online questionnaire to collect information from 100 individuals in Erode. The questionnaire was framed to elicit information on personal details, source of information on waste management, types of waste generated, types of containers used for waste disposal, frequency of waste disposal and location of the waste disposed, details on segregation of waste and information on composting of waste. Open-ended questions and personal interviews were used in the survey, which was done online. The survey was conducted through WhatsApp or email, whichever was more convenient for the homemakers. The investigator confirmed that the homemakers received the questionnaire and that if they

did not respond after a few days, they were given a friendly reminder, and that she received the questionnaire within a certain time frame. The screen shot of the message sent to the respondents is given in Figure 21. The framed questionnaire for the survey is given in Appendix II.

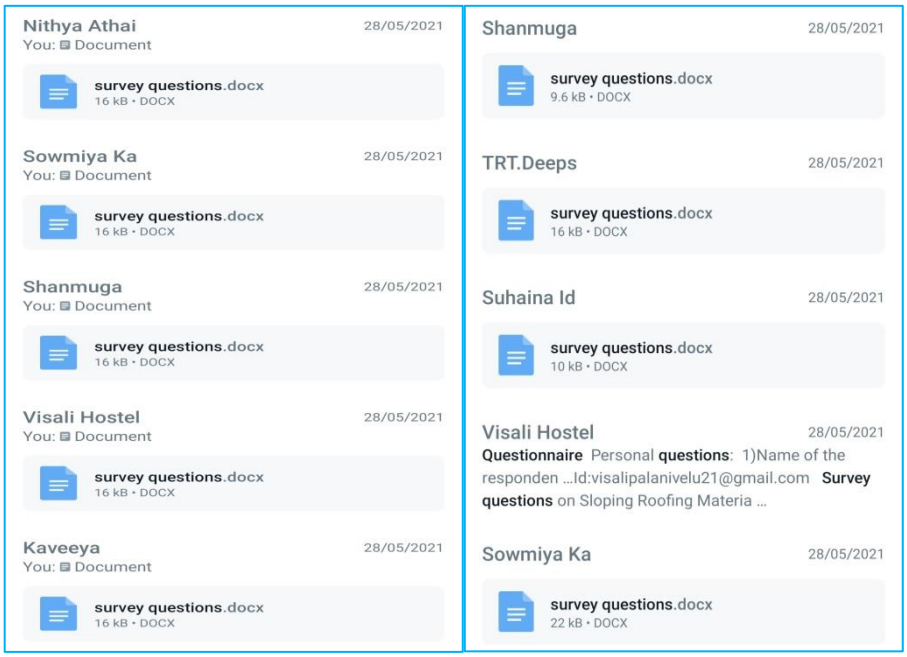

Figure 21: Screenshot of the Questionnaire Sent through WhatsApp

5. Consolidation of data

Lepre (2017) viewed data consolidation allows you to combine data from multiple worksheets into a single master worksheet. To put it another way, the data consolidation function summarises data from a sequence of worksheets or workbooks. In the integration and data management processes, data consolidation is a critical stage. It provides quick and easy access to all data management information, and having all data in one location boosts productivity and efficiency. Data consolidation is the process of taking all of your data from disparate sources throughout your organization, cleaning it up, and combining it in a single location, such as a cloud data warehouse or lakehouse environment(https://www.matillion.com/resources/blog/what-is-data-consolidation#:~:text=Data%20consolidation%20definition&text=Data%20consolidation%20is%20the%20process,data%20warehouse%20or%20lakehouse%20environment.)

The investigator consolidated the data by the information gathered which was then collated and tabulated in order to analyse the results.

6. Analysis the data

The process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and assess data is known as data analysis. Indeed, during the data collection process, researchers look for patterns in observations (Savenye and Robinson, 2004). Panneerselvam (2014) mentioned after data are collected, proper tools and techniques should be used for classification and analysis of data. After the completion of the survey, the investigator analyzed the data and discussed the results in Chapter IV.

Phase 2: Experiment to Compare the Normal Compost Prepared with that of Compost Prepared using Biomineralizer

Kenneth and Bruce (2006) defined experiment research incorporates a high degree of control over the variables of the study. This control, if used properly, permits you to establish causal relationships among your variables. This section describes the defining characteristic of experimental research and explains how these characteristic enable us to identify causal relationships in data.

The steps in experimental study:-

1. Selecting the waste for the experiment
2. Identifying the method of compost
3. Locating the place for conduct of experiment
4. Preparing the compost
5. Analysing the compost prepared

1. Selecting of Waste for the Experiment

The investigator collected the kitchen waste for the whole week from her house. It consisted of onion peel, fruit and vegetable peelings and other wastes, food waste, etc. The waste was collected in the form of dried solid waste and kept it in bucket. Required humidity was maintained. The waste wascut into small pieces of size less than two inches to hasten the decomposition.

2. Identifying the Methods of Composting

Composting is basically a biological decomposition of organic residues, however physical and chemical treatment is given to hasten the process. Depending upon

composting methods, there are different kinds of compost and each has their advantages and disadvantages (Singh and Longkumer, 2018). The popular methods of composting are as follows:

1. Pit Manure/Anaerobic Compost
2. Coimbatore method
3. Indore method
4. Bangalore method
5. NADEP Composting
6. Vermicompost
7. Vermiwash
8. Biodynamic composting
9. Biodung composting,
10. Padegaon method,
11. Biogas-slurry method,
12. Azolla compost
13. In-vessel composting
14. Spent Mushroom Substrate (SMS)
15. Humanure
16. Biomineralizer

The investigator chose anaerobic compost and compost using biomineralizer for comparison of quality of the compost prepared using the selected two methods.

3. Locating the Place for Conduct of Experiment

For anaerobic compost, the investigator prepared 3feet deep pit in their farm which is wet in nature to boost the composting process. For compost using biomineralizer, the investigator prepared grow bag which is suitable for mixing the waste periodically, to maintain humidity , avoid too much of sun light, etc and it was kept near the pit

4: Preparing the Compost

Aerobic composting and composting using biomineralizer were the two methods adopted for the experiment as given in Figure 22.

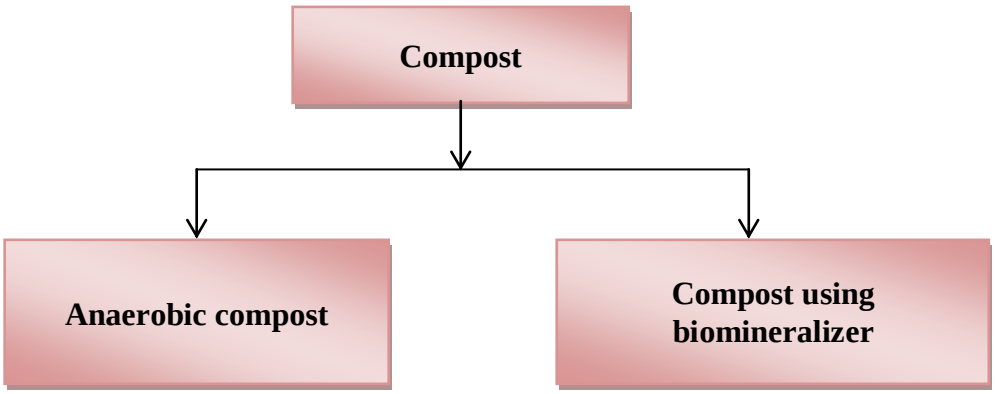

Figure 22: Selected Methods for Composting

a) Procedure Followed for Preparing for Aerobic Composting

The investigator collected the household waste for a period of two weeks. She left it to dry in a shade. She then thoroughly mixed the waste and divided it into two equal parts. One half of the waste was added in a pit dug in her farm for 3 ft deep and 2 ft diameter. Then the waste was sprinkled with little water to maintain the humidity. Then the collected waste was added to the pit and speckled with diluted cow dung water to induce speedy composting. Then the waste was covered with a layer of soil. The waste was checked for every 5 days. Once the compost is complete the investigator removed the surface layer and collected the sample for testing. The steps followed for aerobic composting is represented in Plate 1.

Collection of waste

Pit ready for composting

Adding waste into the pit

Spraying cow dung water to the waste.

Covering the pit for composting

Prepared compost

Plate 1: The Steps followed for Aerobic Composting

b) Procedure Followed for Preparing Compost Using Biomineralizer

The other half of the kitchen waste collected, was added to the grow bag and spread evenly in the grow bag .One layer of sand of approximately one inch thickness was spread in the grow bag.. 100 gm of biomineralizer was added to the grow bag. Water was sprayed to maintain the moisture in the grow bag. The kitchen waste was turned twice every day for a period of 15 days and once a day for next few days until the compost was complete. A sample of the prepared compost was collected and given for testing.The step wise procedure followed is shown in Plate 2.

Collected waste

Spreading a layer of sand in the grow bag

Adding the collected waste in the grow bag

Adding the biomineralizer

Spraying of water

Mixing the compost

Prepared Compost

Plate 2: Steps Involved in Preparing the Compost using Biomineralizer

5. Analysing the compost prepared

After completion of the compost it was assessed for

- Time taken for composting and
- Nutrient content of the compost prepared.

a) Time taken for composting

The investigator followed the procedure and noted down the number of days taken for completion of the compost and it is presented under Chapter IV Results and Discussion.

b) Nutrient content of the compost prepared

In order to assess the nutrient content of the prepared compost, 500 gms of the compost was collected from the compost pit as well as from the grow bag after thorough mixing of the compost prepared. It was collected in a sterile cover provided by the laboratory and given for analysis. The report of the analysis is given in Appendix III.

IV RESULTS AND DISCUSSION

The results of the study on **"Use of Biomineralizer for Composting Urban Kitchen Waste "**is discussed under the following topics

A. Results of the Household Survey

B. Results of the experiment conducted to compare the normal compost prepared with that of compost prepared using biomineralizer

A Results of the Household Survey

The results of the survey are presented in this section of the research.

1. Personal details of respondents
2. Source of Information on Waste Management
3. Types of Waste Generated
4. Types of Containers Used for Waste Disposal
5. Frequency of waste disposal and location of the waste disposed
6. Details on Segregation of Waste
7. Information on Composting of Waste

1. Personal details of respondents

The personal details of the selected respondents presented in the Table 2 included the age, sex and family type, number of family members and family income of the respondents.

Table 2: Personal Detail of Selected Respondents

Personal Information	Percentage of respondents N=100
Age	
• 20- 30yrs	55
• 30-40 yrs	33
• 40-50 yrs	10
• Above 50yrs	2
Family Type	
• Nuclear	60
• Joint	40
Family Members	
• 2-3	33
• 4-5	45
• Above 5 members	22
Family Income*	
• EWS	14
• LIG	37
• MIG	33
• HIG	16
Educational Background	
• below SSLC	20
• SSLC	25
• Diploma	10
• Degree	45

***According to TNHB, Income Eligibility Criteria**

- Economically Weaker Section (EWS) Upto Rs. 12,000/month
- Lower Income Group (LIG) Rs. 12,001-Rs. 18,000/month
- Middle Income Group (MIG) Rs. 18,001-Rs. 37.000/month
- High Income Group (HIG) Rs. 37,001-Rs. 62,000/month

A person's development is measured in terms of the year's requirement (https://www.merriam-webster.com/dictionary/age). When the age of the respondents was examined, it was discovered that the majority (55%) were between the ages of 20 and 30. However, only two percent of the respondents were over the age of 50. Because waste disposal is always associated with women, all of the respondents were female. Because of the rapid disintegration of the joint family system, 60 percent of respondents belonged to nuclear family. Approximately 45 percent of families had 4-5 members. This demonstrates that the selected families have adopted the small family norm. Since the survey was conducted in a semi urban area, the maximum of 37 per cent and 33per cent of the respondents, respectively, come from low and middle-income families.

The processes and actions required to manage waste from its inception to its final disposal are referred to as waste management (or waste disposal). This includes waste collection, transportation, treatment, and disposal, and also waste management process monitoring and regulation, as well as waste-related laws, technologies, and economic mechanisms. (https://en.wikipedia.org/wiki/Waste management. The following section discusses an attempt to collect information on waste management awareness in selected households.

2. Source of Information on waste management

According to the survey, 95 per cent of the households had a good understanding of waste collection, waste treatment, and waste disposal. Table 3 shows the information source from which the knowledge was obtained.

Table 3: Source of Information on Waste Management Obtained from Selected Respondents

Source of information	Percentage of Respondents* (N=100)
Electronic media	30
Print media	23
Meeting (lectures and talks)	18
Friends and relatives	12
Health personnel	9
Self-motivation	9
Others	7

* Multiple Responses

Table 4 revealed that various types of waste are generated by households on a daily basis. It was discovered that biodegradable kitchen waste was generated every day in the homes. The main source of information on waste segregation was electronic media. Thirty percent of households obtained information from electronic media such as the internet, television, radio and audio tapes played by municipal waste carrier vehicles. Twenty-three percent of households believed that the information provided in print media was adequate for them to understand waste segregation and its applications, which were followed by lectures and special talks on waste management organised in schools and by voluntary and government agencies in the interest of public welfare. Friends and relatives, followed by health personnel, had educated 12 percent and nine percent of the respondents on the importance of waste management, respectively. Because of environmental concerns, nine percent of respondents have expressed an interest in gathering waste management information. The overall message received from the various sources was about waste segregation, transportation, waste reduction, and waste recycling.

Waste management minimizes the impact of waste on the environment, health, and other factors. It can also assist in the reuse or recycling of resources such as paper, cans, glass, and so on. Waste management requires awareness of and recognition of behavioural factors associated with recycling. The study found that all homemakers understood the importance of recycling, waste disposal, or composting. Figure 23 depicts the print media used as the information source from which they obtained details on waste disposal, recycling, and composting.

Figure 23: Print Media Used as Information Source in Recycling Waste

Table 4 presents information on sources from which the respondents obtained details on waste disposal, recycling, and composting.

Table 4: Information Source from which the Respondents Obtained Details on Waste Disposal, Recycling, and Composting

Source of information on composting and recycling	Percentage of Respondents * N=100
Electronic media	70
Self motivation	70
Friends, relatives and neighbours	61
Health personnel	57
Others	51
Print media,	49
Meeting (lectures and talks)	49

* Multiple Responses

According to the findings of the survey, respondents were kept informed about safe waste disposal methods, composting and recycling techniques, and possible wastes by means of self-motivation (70%), electronic media (70%), friends, relatives, and neighbours (61%), health personnel who visited the houses (57%), others through women's clubs, print media such as magazines, journals, and news papers (49%), and lectures and special television programmes (49%).

2. Types of Waste Generated

Lagerkvist and Dahlén (2019) found that household solid waste is highly heterogeneous but also highly dependent on the socioeconomic status of the households (2019). Table 5 shows the types of waste generated in the surveyed households as revealed by the respondents.

Table 5: Types of Waste Generated in the Surveyed Households

Types of waste generated	Percentage of respondents* (N=100)
Kitchen waste	
o Vegetable and fruit peelings	100
o Leftover food	89
o Used tea/ coffee	46
o Coconut fibre	53
o Egg shell	65
o Expired foods	34
Paper waste, news papers, books, journals	96
Plastics	57
Metal, tins, cans, glass, ceramics	46
Textiles rags	18
Electronic items	5

* Multiple Responses

All respondents stated that kitchen waste in the form of vegetable and fruit peelings and their remnants is the most common waste collected in their homes, followed by food waste (89 percent), egg shells (65 percent), coconut fibre (53 percent), and used coffee and tea powders (46 percent). In addition, expired foods (34 per cent), paper waste, such as newspapers, books, and journals, is reported as waste in 96 percent of households. Plastic covers, old bottles, and broken plastic articles are discarded as waste in 57 percent of the households surveyed. Textile rags and electronic items were regarded as waste by 18 percent and five percent of the households surveyed, respectively.

4. Types of Containers Used for Waste Disposal

In collection of wastes containers play a very important role. Hence the researcher took an effort to collect the information on the containers used to collect the waste disposed. Table 6 reflect the type of containers used by the surveyed households.

Table 6: Types of Containers used to Dispose the Household Waste

Types of containers	* Percentage of respondents (N=100)
Old bucket/ paint buckets	45
Plastic bags	14
Tin/can	11
Garbage bag	19
Waste bin	18
Old metal container	5

* Multiple Responses

According to the survey, the majority of the surveyed families collected waste in their homes using only old buckets (45%), reused plastic bags (14%), and discarded tins/cans (11%). It is surprising to note that garbage bags were used by 19 percent of the surveyed households, demonstrating the urban influence in waste disposal in order to simplify waste disposal at the community level. In 18 percent of the households, a separate bin for waste disposal is present. The survey reveals the fact that people use only containers that are considered as waste to dispose their household waste.

From the survey it is observed 89 per cent of the families' surveyed possessed more than one container for disposal of wastes.

5. Frequency of waste disposal and location of the waste disposed

In many of the households emptying the waste bin will be the first activity in the morning by the homemaker. An attempt to gather information on usual method of emptying of the waste bins revealed the facts as shown in Table 7.

Table 7: Frequency of Waste Disposal and Location of the Waste Disposed

Details on waste disposal	Percentage of respondents N=100
Frequency of waste disposal	
Every day	44
Every alternate days	23
Once in three days	16
When ever required	15
Once or twice a week	2
Location of waste disposed	
Public bins	37
Municipal waste carrier vehicles	20
Dump in the backyard	18
Road side	10
Incinerate	9
Any method convenient	6

The survey revealed that there are a variety of disposal options for household waste available to homeowners. It is a fact that rubbish bins are available on all streets within a reasonable distance. Thirty seven percent of the sampled respondents emptied their trash cans in public containers located near their residence. In some areas, municipal waste collection vehicles collect daily household waste from each residence. Twenty percent of the respondents surveyed utilised this facility for waste disposal. Eighteen percent of households with a backyard composted it in their backyards. In areas without proper public waste bins, (10percent) the respondents dumped their trash on the side of the road, potentially polluting the environment. When necessary, nine percent of the families indicated that they frequently incinerate the collected waste, especially yard waste, in an open area. This method is also not considered a safe method of waste disposal. Therefore, it is essential that we educate them on proper waste disposal techniques.

When we separate waste, we reduce the amount of trash that ends up in landfills, thereby conserving space. When hazardous waste is separated and handled separately, air

and water pollution can be significantly reduced. It is essential that trash be placed in separate containers so that it can be properly disposed of. According to the survey, despite the government's efforts to emphasise the importance of waste separation, only 55 per cent of respondents adopted the practice. This is further evidence of the need to educate the public on proper waste disposal.

6. Details on segregation of waste

Waste segregation is the sorting and separation of waste, types to facilitate recycling and correct onward disposal. When waste is sorted correctly, it can save the money.

Table 8: Reasons for Segregating Waste by the Respondents

Reasons for segregating waste	Percentage of respondents * N=55
Protect the environment.	100
Protection of human health	96
Legal obligations	82
Cost savings	62

* Multiple Responses

It is reassuring to note that all individuals who practised waste separation did so to protect the environment. The protection of human health was of interest to 96 per cent of respondents. Before disposing of waste, 82 per cent and 62 per cent of the respondents, respectively, have made waste segregation mandatory due to legal requirements and to reduce labour costs.

The homemakers who do not practice segregation of waste revealed the following reasons as presented in Table 9.

Table 9: Reasons for not Segregating Waste by the Respondents

Reasons for not segregating waste	Percentage of respondent* (N=100)
Don't like to put our hands into waste	93
Not willing to pay the waste pickers	82
It is not our responsibility to segregate the waste	77
Not aware of the hazards of mixed waste	53
Not aware of different waste cycles	40

* Multiple Responses

Among the primary reasons cited by respondents for not sorting their trash, 93 per cent stated that they dislike putting their hands in trash for sorting because it makes them uncomfortable. In order to avoid this, it is necessary to sort the waste before disposal. Eighty-two percent of respondents disclosed that they were unwilling to tip waste collectors; consequently, they dispose of waste in municipal bins. It is disheartening to note that 77 per cent of respondents believed that waste separation was not their responsibility. Fifty three percent and 40 percent of households, respectively, were unaware of the dangers of mixed waste and the different cycles involved in waste disposal. This result also highlights the importance of educating the public about proper waste disposal.

7. Information on composting of waste

Composting is the natural process of recycling organic material, such as leaves and food scraps, into a valuable soil-enriching fertiliser. Composting is a method for treating solid waste in which organic material is decomposed by microorganisms in the presence of oxygen to the point where it can be stored, handled, and applied to the environment without risk. Composting is essential for reducing residential waste. The information on awareness on composting, source of information on composting, composting practices adopted, and the application of the compost prepared are discussed under this part of the study. It is highly encouraging to understand from the study that all the respondents were aware of composting. The information source on composting for the surveyed respondents is presented in Table 10.

Table 10: Information Source on Composting for the Surveyed Respondents

Source of information	Percentage of respondents * N=100
Elders in the family	75
Educational institution	60
Public meetings	56
Neighbours and friends	45
Electronic media	32
Books and magazines	27

* Multiple Responses

Composting is an ancient practice that was practised by our ancestors. Thus, 75 per cent of respondents had learned the procedure from their parents or grandparents. Sixty percent of respondents obtained the information from their educational institution. Other sources of information on composting obtained by the respondents included public meetings (56 percent), neighbours and friends (45 percent), electronic media (32 percent), and books and magazines (27 percent).

Though 78 per cent of the respondents accepted the fact that unsafe disposal of household waste is an environmental problem only 45 per cent were practicing composting at the household level as they understood the importance of composting.

Composting at the household level is a crucial method for managing organic waste, which typically constitutes the largest portion of household waste. Composting reduces waste's impact on the environment, and the resulting compost is essential for enhancing soil fertility and structure. Forty five percent of the respondents to the survey practiced composting in their homes. Forty percent of homemakers who composted used composting bins, 33 per cent composted on-site, 13 percent used old plastic buckets, and six percent each used grow bags and mud pots. This is illustrated by the Figure 24.

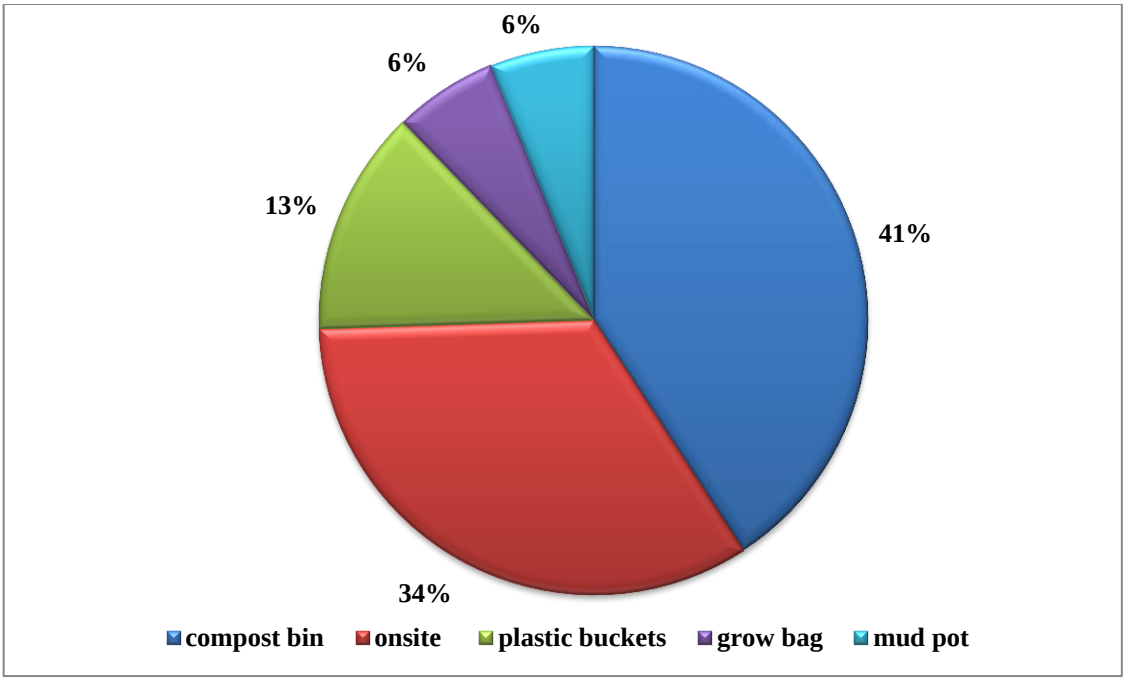

Figure 24: Composting Methods Followed by the Respondents

Respondents' stated reasons for adopting composting were for use in their gardens and environmental protection as represented in Figure 25.

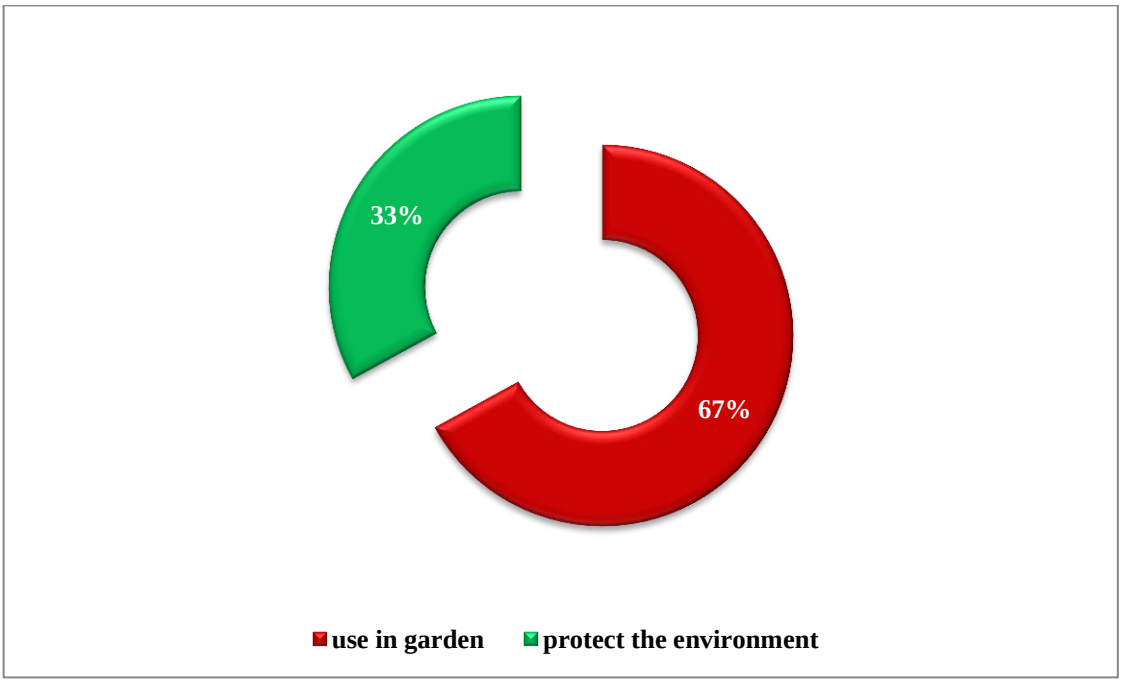

Figure 25: Reason Stated by the Respondents for Practising Composting

As composting is a time-consuming process, 46 per cent of those who practiced composting did so in a variety of ways to improve the process (Figure 26) It included the

use of earth worms (vermi composting) (36 percent), the addition of EM solutions (effective microorganisms) (5 percent), the use of curd (3 per cent) and Panchakaviya (2 percent) to speed up the composting process.. The additional substance used to induce composting by the respondents is shown in Figure 26.

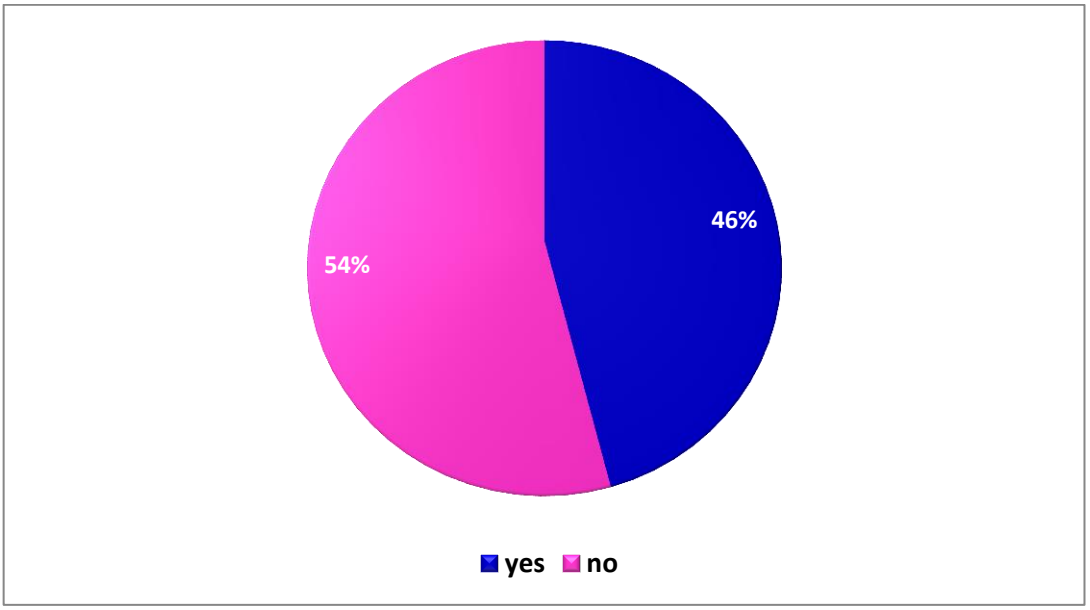

Figure 26: Families Using Additional Substance to Enhance Composting

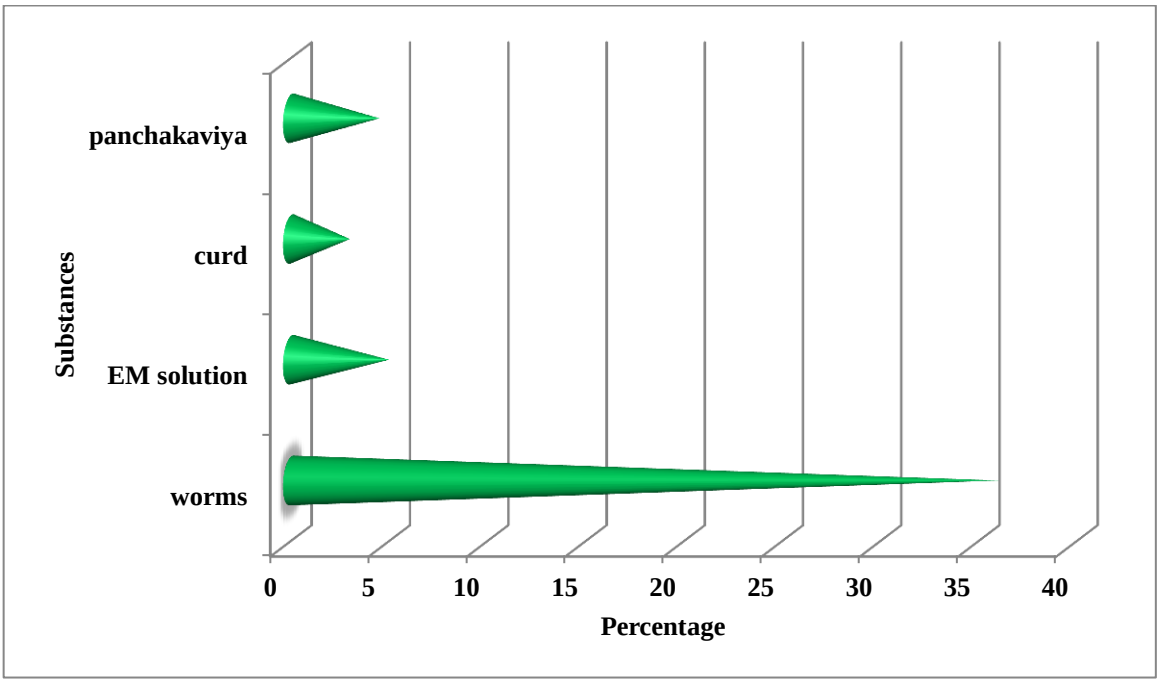

Figure 27: Additional Substance used to Induce Composting

Composting is the natural process of decomposition and recycling of organic matter into a humus-rich soil amendment known as compost. The resulting compost can be used fora variety of purposes. Table 11 provides information on how respondents utilised the prepared compost.

Table 11: Application of Compost by the Respondents

Applications of the compost	Percentage of respondents * (N=100)
Farm	56
Kitchen garden	33
Potted plants	22
Landscape	16
Others	7

* Multiple Responses

The resulting compost was utilised by the respondents in their own farms (56%), in kitchen gardens (33%) and for potted plants (22 %).

Sixty-six percent of homemakers have been practising composting for less than five years, indicating a recent increase in composting awareness as shown in Figure 28. Though it is a positive indicator of the adoption of waste management, it is necessary to educate homeowners on the benefits of composting and motivate more homemakers to practice composting.

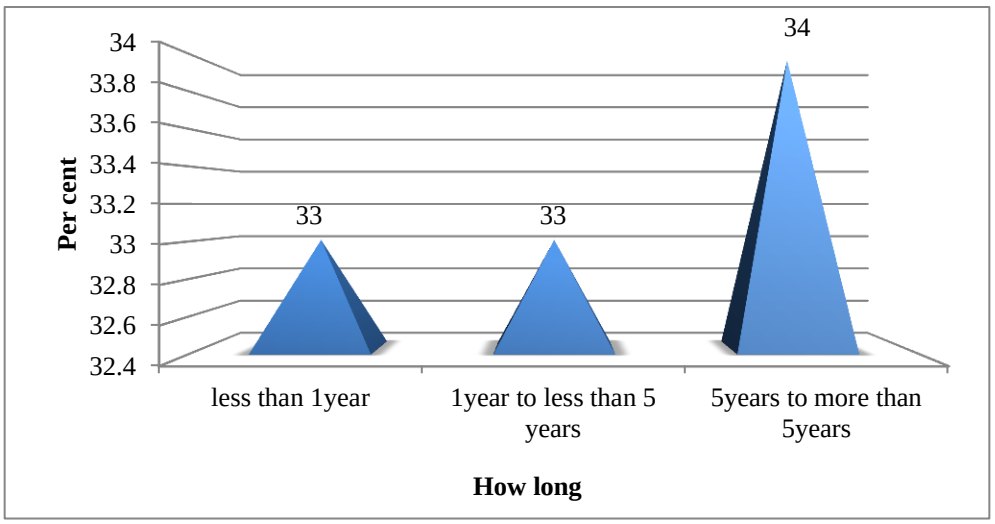

Figure 28: Period During which Composting is Practised by the Respondents

In simple terms, composting is a most useful natural process that any human-supporting, sustainable system needs. It helps to rebuild or maintain healthy, balanced soil by feeding the soil life and creating a steady replenishment of nutrients, and nutrient-rich soil makes for nutrient-rich food. However in spite of its various advantages only 45 per cent of the respondents who practice composting expressed the problems experienced by them while attempting to compost the household waste.

All respondents who practised home composting encountered few obstacles. Table 12 displays the experiences shared by respondents.

Table 12: Difficulties Encountered by the Respondents while Engaging in Composting

Difficulties encountered	Number of respondents (N=45)	Percentage
Unsightly appearance due to spill over of waste	30	67
Smelly compost bins	36	80
Nuisance of Flies and rodents	45	100
Excessive wet compost	10	22
Stop rotting before complete composting	15	33

* Multiple Responses

All of them stated that they had to deal with the annoyance of flies and rodents while composting especially their food waste materials. The smelly compost bins were a problem for 80 percent of the households surveyed. Sixty-seven percent of those who answered the survey said that an unsightly appearance caused by waste spill over was a problem.

Certain statements on Composting were given to the respondents to know about their attitudes on composting. The response from the respondents is given in Table 13.

Table 13: Attitudes of the Respondents on Composting

Attitudes	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
Composting takes up a lot of time and effort	73	10	7	5	5
Composting demands a high degree of technical knowledge	13	16	45	22	4
Composting requires a lot of space	7	10	44	20	19
Composting is not worthwhile unless there is a lot of waste	23	36	14	17	10
Composting bins attract flies and vermin	66	11	10	9	4
Compost bins are unsightly	45	23	11	12	9
My neighbours friends and relatives expect me to indulge in composting	11	35	10	19	25

Seventy-three per cent of respondents strongly agreed with the statement, "Composting requires a great deal of time and effort," since sorting and filling the compost requires special effort. Regarding the statements 'composting requires a high level of technical knowledge' and 'composting requires a great deal of space,' a maximum of 45 per cent and 44 per cent of respondents were unable to decide. No more than 36 per cent of respondents agreed that composting is not worthwhile unless there is a substantial amount of waste disposed. Maximum 66 per cent and 45 per cent of respondents strongly agreed with the statements 'compost bins attract flies and rodents' and 'compost bins are unattractive', respectively. Only 35 per cent of those surveyed agreed with the statement, "My neighbours, friends, and relatives expect me to compost." Hence it is impertinent to introduce a method of composting which will be favourable for the homemakers.

Composting, a biological process in which the organic wastes are decomposed under carefully controlled conditions resulting useful organic fertilizer. The benefits of composting as perceived by all the surveyed respondents are given in Table 14.

Table 14: Benefits of Composting as Perceived by the Respondents

Benefits	Percentage of respondents* N=100
Recycles Home Waste	36
Reduce the waste	36
Cost-Effective	35
Enriches soil	29
Reduce plant mortality rates	27
Conserves water	44
Suppress plant diseases	45
Reduces the need for chemical fertilizers	18
Improves plant nutrition and growth	45
Improves the yield	26

* Multiple Responses

Respondents' understanding of the benefits of composting is revealed by the fact that 45 percent of them believe it improves plant nutrition while also suppressing plant diseases. Forty-four percent of the respondents were aware that it conserves water by keeping the moisture content stable for a longer period of time. It is reported by 36 percent of those who answered the survey that it recycles household waste safely and also helps to reduce the amount of waste sent to landfills. The cost-effectiveness of obtaining rich organic manure was affirmed by 35 per cent of those who answered the survey questions.

In spite of the various advantages expressed by the respondents, the disadvantages in the process of composting also were expressed by the respondents. This is shown in Table 15.

Table 15: Drawbacks of Composting as Perceived by the Respondents

Drawbacks	Percentage of respondents * (N=100)
Unpleasant smell	78
Attract flies, rodents, etc	74
Needs time to compost	84
Involves plenty of work	57
Unpleasant physical appearance	77
Needs some space	55
Quality of compost depends on the type of waste and process	26
Requires large quantity of organic waste	48
Suitable for only certain kind of waste	53
It may be a nuisance for neighbours	39

* Multiple Responses

Despite the fact that composting has numerous advantages, it is a slow process that may take more than 45 days to complete decomposition. This was cited as a disadvantage by 84 percent of those who took part in the survey. In order to expedite the process, it is critical that we find a method that will work for everyone. The unappealing smell and appearance of the spill over were cited as a drawback by 78 percent and 77 per cent of those who answered the survey, respectively. Aside from the fact that spilled waste attracts flies and rodents (74 percent), the need for more space (55 percent), the fact that it is only suitable for certain types of waste (53 percent), the simple truth that it requires a large amount waste for an efficient process (48 percent), and the reality that it is a nuisance to the neighbours because of the unpleasant odour produced during the process (39 percent) were all mentioned as disadvantages by the respondents. For successful waste management at the household level, it is critical that a method be developed that is user-friendly for the homemakers and community as a whole.

TNAU's Biomineralizer technique, which was developed to speed up the composting process through the use of a microbial consortium, is a new technique for accelerating the composting process. The investigator made an attempt to determine whether or not the respondents were aware of the situation. The results of the survey revealed that none of them were aware of the composting process that involves the use of biomineralizer. As a result, the investigator felt compelled to learn more about the process. As a result, she decided to conduct an experiment on the process. The results of the experiment are presented in the following section.

Phase 2: Experiment to compare the normal compost prepared with that of compost prepared using biomineralizer

The experiment was carried out as given in the methodology to compare the time it took to complete composting and to examine its nutrients. Table 16 summarizes the findings.

Table 16: Number of Days Taken to Complete the Composting and the Nutrients Present in the Compost Prepared

Details	Aerobic composting	Composting using biomineralizer
No: of Days	67	35 days
Colour	Dark brown	Pale brown
Organic carbon	4.77	9.58
Calcium	0.38	0.75
Magnesium	0.128	0.279
Potassium	2.378	2.37
Nitrogen	1.01	1.26
Phosphate	1.32	5.14
Iron	2213	2030
Copper	3.12	1.67

According to the survey's findings, aerobic composting took an average of 67 days, whereas employing biomineralizer took 35 days. This will be encouraging to future homemakers who want to start composting. As a result, a composting biomineralizer awareness campaign should be launched.

When the nutrients present in the compost were evaluated, it was discovered that, with the exception of iron and copper, the compost made using bio mineralizer had more nutrients than the compost prepared using aerobic composting. As a result, more research may be done to determine its efficacy by applying it to plants and observing their growth.Due to time limitation the investigator could not launch an awareness campaign. Hence in future a follow study may be conducted for the benefit of the homemakers.

V SUMMARY AND CONCLUSION

India generates 62 million tonnes of waste each year. About 43 million tonnes (70%) are collected of which about 12 million tonnes are treated and 31 million tonnes are dumped in landfill sites. With changing consumption patterns and rapid economic growth it is estimated that urban municipal solid waste generation will increase to 165 million tonnes in 2030. (https://en.wikipedia.org/wiki/Waste_management_in_India#:~:text=India%20generates%2062%20million%20tonnes,are%20dumped%20in%20landfill%20sites.). Singh, 2020 discloses that household waste generated in residential neighbourhoods, is alarming. In recent years, the exponential population growth, high density of urban areas, diverse culture, changing food habits, and changing lifestyles have resulted in an unresolved problem in terms of Municipal Solid Waste Management (MSWM) in India, according to Subhash (2010), which constitutes the "largest component of urban solid waste."

As of now, India's waste management practice consists in collecting waste from sources through a community collective bin system, after which it is transported to a low-lying landfill system with intermediate treatment of Municipal Solid Waste (MSW).Waste minimisation and segregation at the household level would be beneficial in the pursuit of effective waste management. In order to achieve sustainability in waste management, it is necessary to choose a method that is environmentally friendly. A technique of this nature must be effective, efficient, and less expensive than many other alternatives. Composting is an efficient way of recycling waste. Compost, as viewed by Lingaraj (2013), has numerous advantages because it can be high in nutrients.

Home composting may be a viable option for effectively managing waste in the home environment as effective waste management begins at home. Despite the fact that there are a variety of methods used at the household level, they are only utilised by a small number of households due to the fact that composting takes a longer time and requires adequate space, both of which are lacking in urban households. In addition to the unpleasant odour and nuisance caused by flies and rodents produced by normal composting, homemakers are discouraged from participating in composting practices. Because of this, the investigator identified the need for a composting method using biomineralizer a microbial consortium that has been developed by Tamilnadu Agricultural University a recent innovation used for large scale composting that may be convenient for homemakers and acceptable to them. The purpose of this study was to

determine whether or not it will be feasible to use biomineralizer for composting at the household level. Hence the investigator took up this study on

"Use of Biomineralizer for Composting Urban Kitchen Waste" with the following objectives:

- To gather information on home waste disposal techniques and public knowledge of these
- To understand home composting techniques adopted by selected households
- To test the effectiveness of a biomineralizer in the composting of household organic waste.

The methodology followed for the survey involved two phases:

Phase 1: Conduct of Survey among Urban Households

Erode city was selected for the study. The investigator chose questionnaire as a tool for survey. The investigator prepared the questionnaire about the personal details of respondents, waste disposal methods adopted, attitudes and use of biomineralizer for composting urban kitchen waste. The investigator chose purposive sampling because she only interviewed urban and semi- urban female in Erode city. The investigator gathered data using a questionnaire distributed online to 100 respondents in Erode during the pandemic period. The investigator consolidated the data, the information gathered was then collated and tabulated in order to analyse the results. After the completion of the survey, the investigator analyzed the data and discussed the results.

Phase 2: Experiment to Compare the Normal Compost Prepared with that of Compost Prepared using Biomineralizer

The investigator chose anaerobic composting and composting using biomineralizer for the experiment. The investigator collected the kitchen waste for two weeks in her house. The waste was collected in the form of dried solid waste and kept it in bucket. For anaerobic compost, the investigator prepared 3feet deep and 2 feet diameter pit in their farm. For compost using biomineralizer, the investigator prepared a grow bag and left near the pit. The waste was thoroughly mixed and divided it into two equal parts. One half of the waste was added in a pit dug in her farm. The waste was sprinkled with little water and cow dung mixture and covered with mud and allowed to compost. The other half of the kitchen waste collected, was added to the grow bag.

100gm of biomineralizer was added to the grow bag. Water was sprayed to maintain the moisture. It was turned frequently and allowed to compost. After completion of the compost a sample of the both the compost was given to a laboratory to assess the nutrient content.

Results of the survey

It was discovered that the majority of the respondents (55%) were between the ages of 20 and 30 and belonged to a nuclear family. Since the survey was conducted in a semi urban area, maximum number of respondents (37% and 33%, respectively), come from low and middle-income families.

According to the survey, 95 per cent of the households had a good understanding of waste collection, waste treatment, and waste disposal. The main source of information for the respondent on waste segregation was electronic media. Similarly the majority of 70 per cent of the respondents were kept informed about safe waste disposal methods of composting and recycling techniques of possible wastes through electronic media. All respondents stated that kitchen waste in the form of vegetable and fruit peelings and their remnants is the most common waste collected in their homes, followed by food waste (89 percent). Majority of the surveyed families collected waste in their homes using only old buckets (45%), reused plastic bags (14%), and discarded tins/cans (11%). It was observed through the survey that 89 per cent of the families' possessed more than one container for disposal of wastes. The survey revealed that there were a variety of disposal options for household waste available to homeowners. It is reassuring to note that all individuals who practised waste separation did so to protect the environment. Before disposing of waste, 82 per cent and 62 per cent of the respondents, respectively, have made waste segregation mandatory due to legal requirements and to reduce labour costs.

Among the primary reasons cited by respondents for not sorting their trash, 93 per cent stated that they dislike putting their hands in trash for sorting because it makes them uncomfortable. Composting is an ancient practice that was adopted by our ancestors. Thus, 75 per cent of respondents had learned the procedure from their parents or grandparents. Though 78 per cent of the respondents accepted the fact that unsafe disposal of household waste is an environmental problem only 45 per cent were practicing composting at the household level as they understood the importance of composting. Respondents' stated reasons for adopting composting were for use in their

gardens and environmental protection. Because composting is a time-consuming process, 46 percent of those who practiced composting did so in a variety of ways to improve the process, including the use of earth worms (vermi composting) , the addition of EM solutions (effective microorganisms) , use of curd and panchakaya to speed up the composting process.. The resulting compost was utilised by the respondents in their own farms (56%), in kitchen gardens (33%) and for potted plants (22 %) . Sixty-six percent of homemakers have been practising composting for less than five years, indicating a recent increase in composting awareness.

All respondents who practised home composting encountered few obstacles. All of them stated that they had to deal with the annoyance of flies and rodents while composting their food waste materials. The smelly compost bins were a problem for 80 percent of the households surveyed. Certain statements on composting were given to the respondents to know about their attitudes on composting. Seventy-three percent of respondents strongly agreed with the statement, "Composting requires a great deal of time and effort". Maximum 66 per cent and 45 per cent of respondents strongly agreed with the statements 'compost bins attract flies and rodents' and 'compost bins are unattractive', respectively. Consequently, it is essential to develop an alternate composting method that requires less effort, does not attract flies, and does not stink.

Respondents' understanding of the benefits of composting is revealed by the fact that 45 percent of them believed it improves plant nutrition while also suppressing plant diseases. The cost-effectiveness of obtaining rich organic manure was affirmed by 35 per cent of those who answered the survey questions.

Despite the fact that composting has numerous advantages, it is a slow process that may take more than 45 days to complete decomposition. This was cited as a disadvantage by 84 percent of those who took part in the survey. The results of the survey revealed that none of them were aware of the composting process that involves the use of biomineralizer. As a result, the investigator felt compelled to learn more about the process.

Phase 2: Experiment to Compare the Normal Compost Prepared with that of Compost Prepared using Biomineralizer

The experiment conducted to observe the number of days taken for composting by the investigator found that aerobic composting took 67 days while biomineralizer

took only 35 days. This will inspire future homemakers to start composting. So a campaign on creating awareness on composting using biomineralizer is needed.

The compost made using a bio mineralizer has more nutrients than the compost made with an aerobic composter, except for iron and copper. To test its efficacy, more research could be done by applying the compost on plants and observe its growth.

Conclusion

This study investigated the utility of biomineralizers in diverting biodegradable waste from landfills, biodegradation processes, to small-scale composting. This work is important because it raises awareness of the significance of biomineralizers in recycling and reducing waste landfilling. Potentially, biomineralizer could reroute biodegradable household waste from metropolitan landfills to households with or without garden space. Composting at home is ss the only solution for biodegradable waste disposal. It is a volunteer activity, and local government may need to make ongoing promotional efforts to sustain high homeowner participation. As a result of this study, the author concludes that biomineralizers should be considered as part of a comprehensive plan for the collection, treatment, and disposal of biodegradable waste at the home and community level.

"When you refuse to reuse the waste it's the earth you abuse

Hence reuse the past, recycle the present and save the future"

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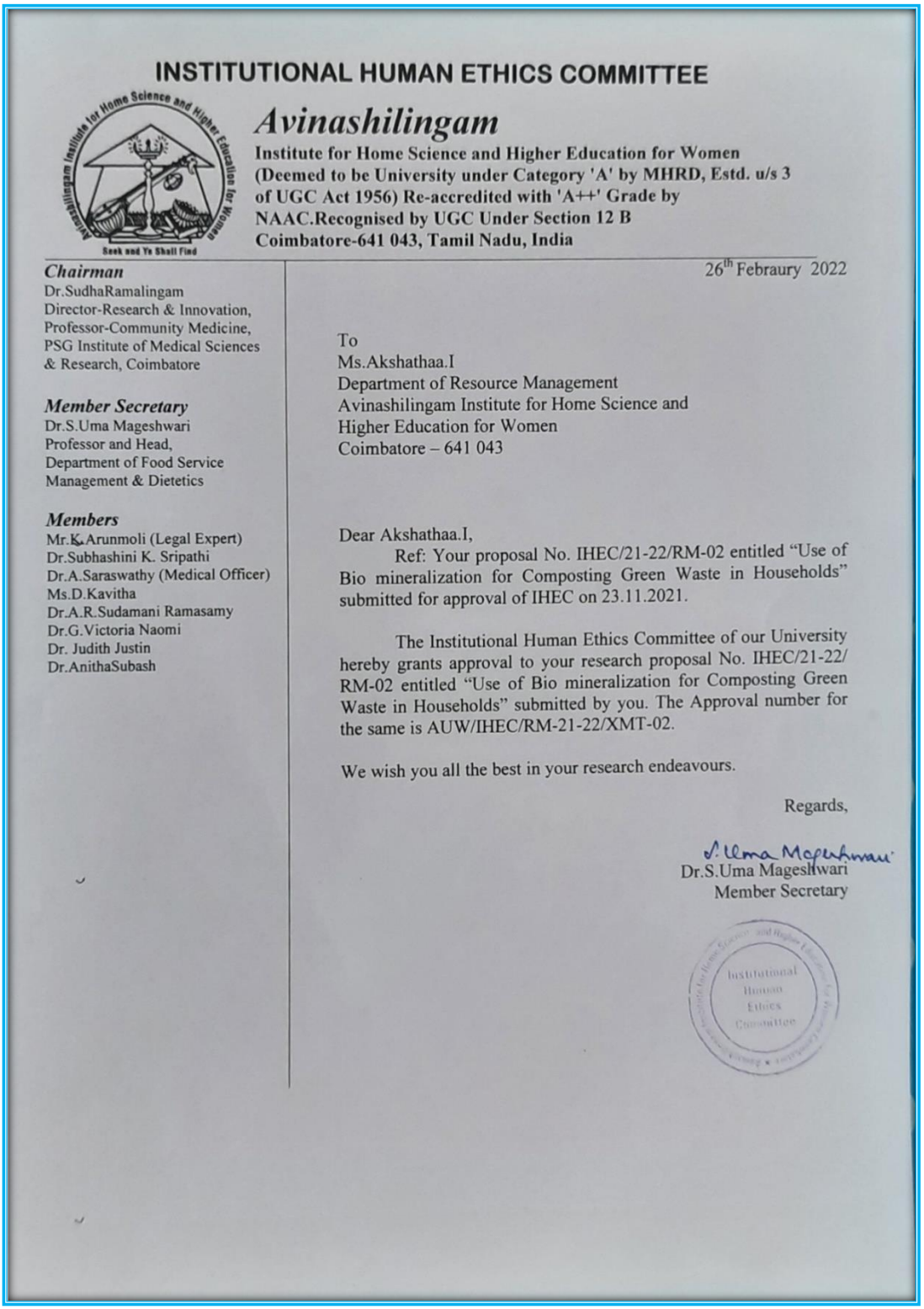
Appendix I

Ethical Clearance



INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.Recognised by UGC Under Section 12 B
Coimbatore-641 043, Tamil Nadu, India

Chairman
Dr.SudhaRamalingam
Director-Research & Innovation,
Professor-Community Medicine,
PSG Institute of Medical Sciences & Research, Coimbatore

Member Secretary
Dr.S.Uma Mageshwari
Professor and Head,
Department of Food Service Management & Dietetics

Members
Mr.K.Arunmoli (Legal Expert)
Dr.Subhashini K. Sripathi
Dr.A.Saraswathy (Medical Officer)
Ms.D.Kavitha
Dr.A.R.Sudamani Ramasamy
Dr.G.Victoria Naomi
Dr. Judith Justin
Dr.AnithaSubash

26th Febraury 2022

To
Ms.Akshathaa.I
Department of Resource Management
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Akshathaa.I,

Ref: Your proposal No. IHEC/21-22/RM-02 entitled "Use of Bio mineralization for Composting Green Waste in Households" submitted for approval of IHEC on 23.11.2021.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/21-22/RM-02 entitled "Use of Bio mineralization for Composting Green Waste in Households" submitted by you. The Approval number for the same is AUW/IHEC/RM-21-22/XMT-02.

We wish you all the best in your research endeavours.

Regards,

Dr.S.Uma Mageshwari
Member Secretary

Appendix II

Questionnaire

Personal questions:

1) Name of the respondent:

2) Age of the respondent:

3) Sex:

4) Type of family a)nuclear b)joint

5) Number of family members:

6) Educational qualification of the respondent:

7) Occupation of the respondent:

8) Family income:

9) Address:

10) Phone number :

11) Email Id:

Survey questions on Use of Biomineralizer for Composting Green Waste in Households:

1) Have you ever heard about waste management? Yes/no

2) If yes, in what way?

a) Electronic media
b) Print media
c) Meeting (lectures and talks)
d) Friends and relatives
e) Health personnel
f) Self motivation
g) Others:_____

3) Have you ever been educated on proper waste disposal ? yes/ no

4) If yes, how?_____

5) What type of waste comes out from your household?

- Kitchen waste
    - Vegetable and fruit peelings
    - Leftover food
    - Used tea/ coffee
    - Coconut fibre
    - Egg shell
    - Expired foods
- Paperwaste,news papers, books,journals
- Plastics
- Metal, tins, cans, glass, ceramics
- Textiles rags
- Electronic items

6) In what type of container do you collect waste?

a) old bucket/ paint buckets
b) plastic bags
c) tin/can
d) garbage bag
e) waste bin
f) Old metal container

7) How often is the waste container emptied?

a) Every day
b) Every alternate days
c) Once in three days
d) When ever required
e) Once or twice a week

8) Where do you usually put away collected wastes?

a) Public bins
b) Municipal waste carrier vehicles
c) Dump in the backyard
d) Road side
e) Incinerate
f) Any method convenient

9) Do you separate different type of waste at your home? Yes/no

10) Are you aware of composting the waste? Yes/no

11) If yes, how_____

12) Have you done composting on your own? Yes/no

13) If yes then how did you compost?

Compost Bin / Compost Heap /Other (Please Specify) _____

14) Were your reasons for composting? Environmental / For the garden

15) How long have you practicing the compost?_____

16) Have you used the compost that you prepared? YES/ NO

17) If yes, how?_____

18) Have you faced any problem in composting? YES/ NO

19) Please indicate the problem while composting?

a) Waste lying around b) Odor c) Flies d) Maintenance e) No problem

f) Others – Specify: …….

20) Please indicate how much you agree/disagree with the following statements about home composting, by ticking the appropriate box:

Reason	Agree	Undecided	Disagree
Composting takes up a lot of time			
Composting takes a lot of effort			
Composting demands a high degree of technical knowledge			
Composting requires a lot of space			
Composting is not worthwhile unless there is a lot of waste			
Composting bins attract flies and vermin			
Compost bins are unsightly			
People in my household think I should Compost			
My friends think I should compost			
My neighbours think that I should compost			

21) In your opinion:

Advantages of composting:

Recycles Home Waste	
Reduce the waste	
Cost-Effective	
Enriches soil	
Reduce plant mortality rates	
Conserves water	
Suppress plant diseases	
Reduces the need for chemical fertilizers	
Improves plant nutrition and growth	
Retain moisture	
Needs continue maintenance	

22) In your opinion:

Disadvantages of composting:

Unpleasant smell	
Attract flies, rat, etc	
Needs time to compost	
Involves plenty of work	
Unpleasant physical appearance	
Needs some space	
Quality of compost depends on the ingredient	
Efficiency depends on amount of organic waste	
Not suitable for all kind of waste	
Neighbours may misunderstand	

23) In your opinion is waste management an environmental problem? Yes/ no

24) Did you use any additional substance to induce composting?

a) Worms b) EM solution c) Other:_____

25) Are you aware of biomineralizer? Yes/NO

a) If yes, how: _____

b) Have you use it: _____

c) Give your feedback : _____

Appendix III

Report of the Analysis

Greenlink Analytical and Research Laboratory (India) Private Ltd.
S.F. No. 414/1, Tex Park Road, Opp. Good Luck Syndicate,
Civil Aerodrome Post, Coimbatore - 641 014. Tamilnadu, INDIA.
Tel : +91 422 2901999 | Mob : +91 95245 81999, +91 95249 81999
Email : enquiry@greenlinklabs.com, info@greenlink.in

NABL ISO / IEC 17025 Accredited
ISO 9001 : 2015 Certified

TEST REPORT

Report No.	GLARL/TRE/0954	**Date**	11.03.2022
Details of Customer			
Customer Name and Address	M/s Indogeo Consultancy Pvt Ltd S. F. No. 355/A2 D. No. 5, Dev towers, Trichy main road, Gandhigramam, Karur – 639 004.		
Customer Reference	-		
Details of Sample			
Sample Received Date	04.03.2022	Sampled By	Courier
Nature of Sample	Compost	Description	Natural Compost – Dark Brownish powder
Sample Code	GLARL/SA/03/22/0954	Received Condition	Good
Analysis Started on	07.03.2022	Analysis Completed on	10.03.2022

S. No	Characteristic	Unit	Result
1.	Total Organic Carbon (TOC)	%	4.77
2.	Calcium (Ca)	%	0.38
3.	Magnesium (Mg)	%	0.128
4.	Potassium (K)	%	2.378
5.	Total Nitrogen (TN)	%	1.01
6.	Phosphate (PO_4)	mg/kg	1.32
7.	Iron (Fe)	mg/kg	2213
8.	Copper (Cu)	mg/kg	3.12

****End of Report****

Authorized Signatory
(M.Amsaveni)
Technical Manager

Page 1 of 1

Greenlink Analytical and Research Laboratory (India) Private Ltd.
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Email : enquiry@greenlinklabs.com, info@greenlink.in

NABL ISO / IEC 17025 Accredited
ISO 9001 : 2015 Certified

TEST REPORT

Report No.	GLARL/TRE/0955	**Date**	11.03.2022

Details of Customer

Customer Name and Address	M/s Indogeo Consultancy Pvt Ltd S. F. No. 355/A2 D. No. 5, Dev towers, Trichy main road, Gandhigramam, Karur – 639 004.
Customer Reference	-

Details of Sample

Sample Received Date	04.03.2022	Sampled By	Courier
Nature of Sample	Compost	Description	Biomineraliser- Pale Brownish powder
Sample Code	GLARL/SA/03/22/0955	Received Condition	Good
Analysis Started on	07.03.2022	Analysis Completed on	10.03.2022

S. No	Characteristic	Unit	Result
1.	Total Organic Carbon (TOC)	%	9.58
2.	Calcium (Ca)	%	0.75
3.	Magnesium (Mg)	%	0.279
4.	Potassium (K)	%	2.37
5.	Total Nitrogen (TN)	%	1.26
6.	Phosphate (PO_4)	mg/kg	5.14
7.	Iron (Fe)	mg/kg	2030
8.	Copper (Cu)	mg/kg	1.67

****End of Report****

Green Analytical And Research Laboratory (India) PVT LTD CBE - 14

Authorized Signatory
(M.Amsaveni)
Technical Manager

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