

# Design and fabrication of portable kitchen waste shredder for compost manure

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**Abstract.** This project's goal was to design and construct a low-cost portable shredder machine that focuses on chopping of kitchen waste; later this finely chopped powder is used to render vermin compost. Food waste is a naturally occurring substance of high calorific and nutritive value for living organisms. Food waste is an unavoidable consequence of human activity. Economic growth, urbanization, and improved living standards in urban areas have increased the amount and variety of waste produced resulting in uncollected waste on streets and other public spaces. As a result, conventional techniques (Landfills) for degrading organic waste are insufficient and unsatisfactory. A prototype is design and developed with the user's needs and purchasing power in mind. The proposed prototype is built in such a way that kitchen waste is poured into a vessel having blades are driven by an electric motor to obtain chopped and powdered material. The proposed shredder's overall operation runs at a cutting speed between 18000rpm to 27000rpm. As we will put organic kitchen waste into the machine it will cut that waste into small pieces, at the first stage there will be a volume reduction of 10 -20%, and within 24-48 hours as moisture and water content will evaporate into the atmosphere. As organic waste consists of 70 -80 % of water content, this shows that simply there will be a reduction of 80-85% of organic waste as it will reach the final stage.

**Keywords:** - Composting machine, Waste shredding machine, Domestic waste shredder, Kitchen waste, Portable waste shredding machine.

## 1. Introduction

Organic waste includes kitchen waste. kitchen waste involves items like vegetables, fruits, eggshells, pasta, tea, coffee, and so on. Paper, cardboard, and wood are examples of organic waste. To dispose of all of these products, we typically build landfills, which require a large amount of land. To solve this issue we designed a shredder machine that promotes rapid composting, this process is mostly used for kitchen waste decomposition. An alternative layer of wet waste and dry waste was added to this process for rapid decomposition of materials. Since the pile will shrink in size throughout the decomposition process, the bin will not be complete. To avoid heat loss during the decomposition process, a thin piece of polyethylene plastic cover may be used at the top of the bin.[1],[2]. Composting is a great way to reduce waste, particularly when it comes to food waste rapid is a good way to transform organic wastes into soil amendments[3]. Compost is made from decomposed green waste that has been exposed to moisture, carbon/nitrogen, and oxygen. Main parameters such as pH, electrical conductivity (EC), carbon (C), and organic carbon (OC) would be tested to assess the compost's suitability for soil fertility.[4]. The carbon/nitrogen (C/N) proportion is a critical consideration in determining how quickly organic waste decomposes. Excessive C/N proportion implies poor mineralization due to nitrogen deficiency. [5]. As stated by the existent study, the organic substrate decomposed quickly, taking just 9–12 days. [6]. Rapid decomposition methods have opened the door to waste management entrepreneurship[7]. The consistency of compost was increased by mixing 20% fly ash with 50% biomass and 30% kitchen waste. Composting was facilitated through the use of jaggery as an activator[8].

All of the organic waste (kitchen waste) generated by us is deposited or disposed of in landfills outside of cities, which is extremely harmful and gives birth to various diseases. Daily, both domestic and commercial kitchens generate vast amounts of organic waste, which usually requires a variety of treatment and management options. However, either all of this waste is disposed of in a landfill which involves more effort to handle or it is burned without regard for its nutritional value. A portable shredder machine can be used for converting macro kitchen waste into small decomposable form, it decomposes and is used as organic manure. As a result, an initiative is needed in the development of a compact kitchen waster shredder that accelerates the composting process. Composting time is reduced by expanding the open area with aerobic yield debris. Traditional methods are only addressed based on coping strategies[9].

This project aims to shred organic kitchen waste from both domestic and commercial kitchens and use the resulting organic manure as a alternative for synthetic manure. Through preserving optimum levels of all essential parameters, the additional aim is to improve the amount of compost preparation and kitchen waste decomposition. Compost that has been prepared helps in maintaining a higher level of farm productivity and making it more viable. It also aids in the enhancement of substantial peculiarity such as granulation, tilt, aeration, and root penetration in order to improve water-holding ability.

## 2. Methods and Materials

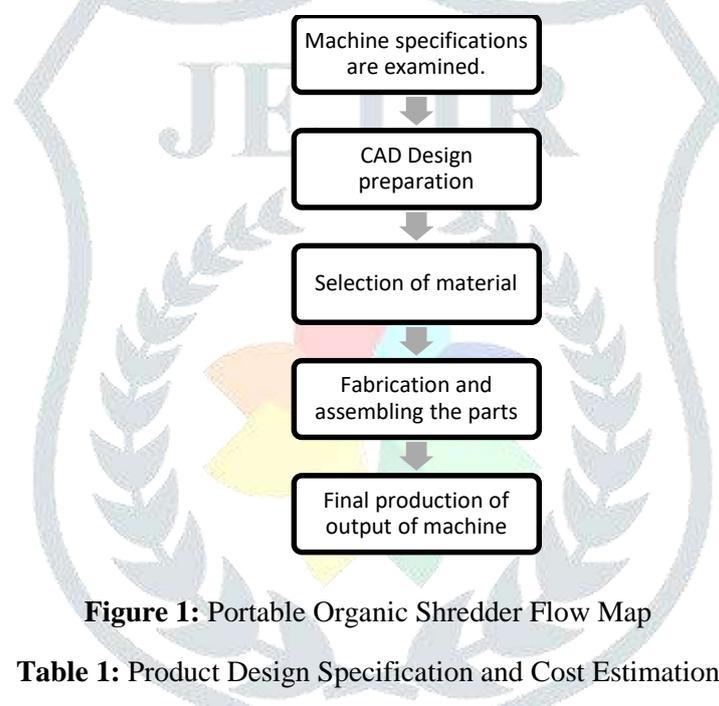
### 2.1 Problem formulation

There is an incidence in our locality when we noticed that how much waste we produce daily can be used for the amelioration of our society. Then we had surveyed a different area of our neighbourhood and considered developing a new prototype model that portable and produces shredded waste.

### 2.2 Working principle

- To begin, infuse the waste into the chamber at the machine's tip.
- It then makes contact with the cutter's tip.
- The cutter tips are connected to the motor shaft. These cutter tips chop the waste infused in the chamber, and the force generated by its rotation provides precise guidance to the waste matter, resulting in a perfectly chopped waste.
- Finely chopped matter was then dumped out of the chamber at the first disposal place.

A brief survey is needed to analyse the system specifications, since we want it to be lightweight and lightweight. Also, we want to use waste products (recycled products) to make the model, so materials have been selected, their availability has been tested, and they have been prepared for component fabrication and prototyping.



**Figure 1:** Portable Organic Shredder Flow Map

**Table 1:** Product Design Specification and Cost Estimation

S. no.	Classification	Details
1	Name	Portable kitchen waste shredding machine
2	Technique	Grinding along with Mixing by an electric motor
3	Shredder Process	Motor operated
4	Target Customer	Domestic and Commercial kitchens
5	Material	Electric motor(stainless steel), Aluminum for base structure, Pvc box for motor housing, Stainless steel cutter blades, Pvc container for top box
6	Manufacturing	Cutting, Joining, and Fabrication
7	Safety	Avoid sharp edges, Use all safety measures while operating the machine
8	Product life	3-4 years
9	Motor Specification	750 Watt, 3 speed AC motor, 20000 RPM (Approx.)
10	Top box	Dia.=180mm, height=230mm
11	Motor cover	Dia.=110mm, height=140mm
12	Working RPM	9000 RPM
13	Weight	10KG (Approx.)
14	Production Rate	50-60 kg of kitchen waste per hour
15	Cost	3600(Approx.)

2.3 Design Calculation

2.3.1 Torque Calculation

Power = 750W = 0.75KW

$$T = \frac{60 * P}{2 * \pi * N}$$

Where,

T = Transmitted torque

P = Power Transmitted

N = RPM of motor

$$T = \frac{60 * 0.75 * 10^6}{2 * \pi * 9000}$$

$$T = 795.77N - mm$$

2.3.2 Volume of Top Box

Internal diameter = 170mm; Radius = 8.5cm

Height of box = 220mm = 22cm

$$V = \pi r^2 h$$

Where,

V = volume of top box

r = internal radius of top box

h = internal height of top box

$$V = \pi (8.5)^2 * 22$$

$$V = 4991.03cm^3$$

2.3.3 Mass and volume of all components

Table 2 below represents the specifications of the designed component. The total mass of the designed component is coming out to be around 9928.6 grams or 9.928KG as shown in Table 2 which is handy to move from one place to another.

	Base	Motor	Motor housing	Blades	Top box	Nut
<b>Material</b>	Aluminium	Stainless steel	PVC	Stainless Steel	PVC	Steel
<b>Mass</b>	6827.4g	1618.4g	225.7g	28.5g	1201.8g	26.80g
<b>Volume</b>	2519.1cm <sup>3</sup>	209cm <sup>3</sup>	161.24cm <sup>3</sup>	3.6cm <sup>3</sup>	858.4cm <sup>3</sup>	3.4cm <sup>3</sup>
<b>Surface Area</b>	1977.4cm <sup>2</sup>	637.65cm <sup>2</sup>	1118.4cm <sup>2</sup>	43cm <sup>2</sup>	2986cm <sup>2</sup>	18.53cm <sup>2</sup>

Table 2: Mass, Volume, Surface area and Material of designed components

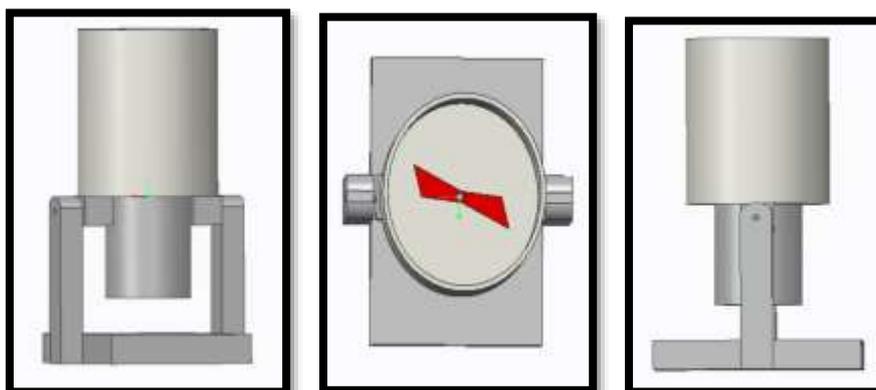


Figure 2: Orthographic views of the proposed model

**Table 3:** Fabrication of Portable Shredder



**Table 4:** Waste used for sampling

	Products		
<b>Original content</b>			
	Onion peel	Cauliflower	Beet greens
			
	Corn husk	Vegetable waste	Radish leaves

#### 2.4 Organic waste

Dry leaves were applied to bring the moisture content of the agricultural waste used for composting down to about 55-65 percent, despite the fact that food scraps have a moisture content of over 80 percent. Once a day, food waste and dry leaves in the ratio of nearly 1:0.28 (wet weight) were added to the compost bin. All food waste, plant waste, and kitchen waste is compressed to 50% in size as well as the kitchen waste was mixed by a shredding machine at. By doing this process volume of the waste was decrease almost by 50%. In the process mainly dry leaves are also added to increase the rate of waste decomposition by microorganisms.[10]

#### 2.5 Details of Shredding machine and composting process

Composting process generally take 3-5 months from beginning to the final stage, the waste material which was processed by shredding machine was observed for 4 months and it has been observed that the moisture content has been reduced by 55-65 %, there was also a reduction in the volume of waste. [10]

#### 2.6 Data collection and interpretation

A sample of well-mixed organic waste was taken once a week during the time of kitchen waste addition to assess the waste's properties and characteristics. Majorly properties like pH, moisture content; the temperature at different layers has been recorded weekly. For measuring pH 10g of sample of compost was mixed in distilled water of 50ml and kept for 10 minutes. Read the pH with the help of pH paper and record as compost pH in water (pHw). For measuring temperature a glass thermometer had been used, the temperature is measured on various layers of the compost. As per the observations, the temperature at the lowest region is highest and lowest at the topmost regions.

**Table 5:** Crushed Form obtained after shredding

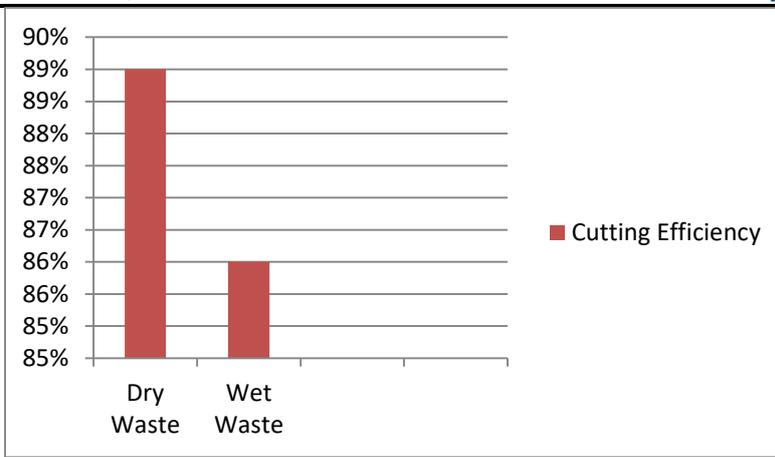


#### 2.7 Cutting efficiency of organic shredder

We discovered that the cutting efficiency of an organic waste shredder could reach 87 % as shown in fig.3 for both dry and wet waste during the experiment. This waste can later be used to make manure.

Si. No	Waste input feeding rate in gms	Shredded output in gms	Cutting efficiency	
1	Dry waste	500	446	89%
2	Wet waste	500	428	86%

**Table 6:** Cutting efficiency of waste shredder



**Figure 3:** Graphical representation of organic shredder cutting quality vs. quantity and time

**2.8 Major factors on which production of quality Compost**

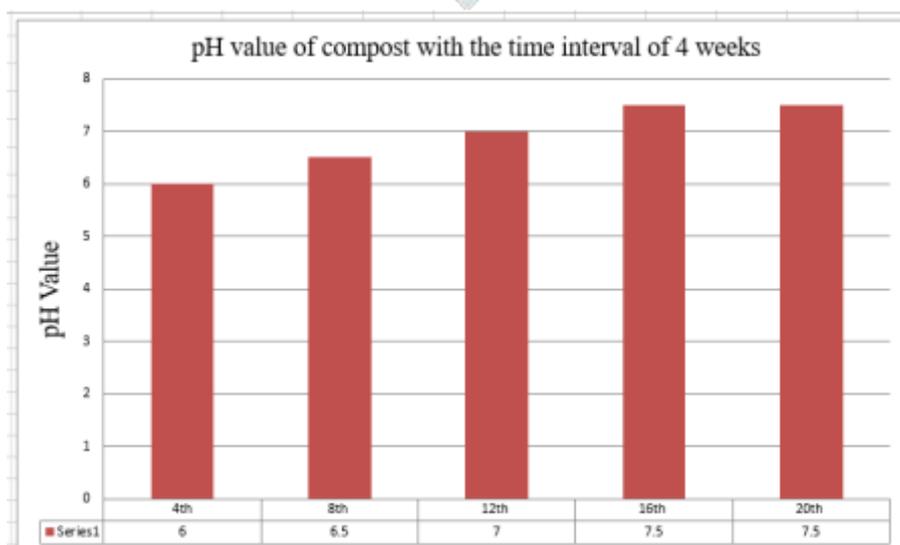
These are the certain factors on which the production of good quality of compost depends. Proper condition and factors like pH value, temperature, supply of oxygen, C/N Proportion, and moisture content are the key determining factors. Compost prepared by machine is examined and mentioned factors were observed within 4 weeks[11]. As per the observations below mentioned are the records-

**2.9 PH Value**

Proper pH is required for the reproduction and growth of the microorganisms which decompose food waste. As the value of pH is between 6 and 8 is considered to be the best for composting[12]. We have observed pH value as per our observations Table 7 represents the variation in pH with an interval of the period of 4 weeks. As the pH value at the beginning of the 3<sup>rd</sup> month i.e. week 12<sup>th</sup> is 7 which is a neutral value was showing signs of preparation of a good quality of compost.

**Table 7: PH values**

S. No.	Week of observation	pH value
1	4 <sup>th</sup>	6
2	8 <sup>th</sup>	6.5
3	12 <sup>th</sup>	7
4	16 <sup>th</sup>	7.5
5	20 <sup>th</sup>	7.5



**Figure 4:** Graphical Analysis of PH values

### 2.10 Carbon and Nitrogen Proportion

To increase the percentage of microbial cells, carbon and nitrogen are needed. They both act as an energy source to those cells. The Ideal ratio of C/N for composting is generally 25-35:1[11] or We may interpret it as 25 to 35 parts carbon for each component nitrogen by weight. As per our observations, the C/N ratio of prepared compost was 28:1, which was a sign of well-prepared compost.

### 2.11 Oxygen

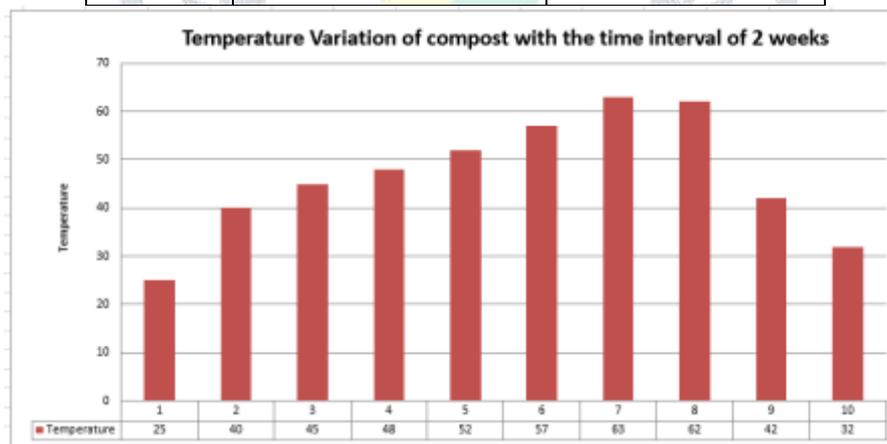
Since composting is an anaerobic digestion procedure, which means it is achieved in the presence of oxygen, oxygen is one of the most essential components for the composting process.[13] If there will be insufficient oxygen then there will be a rotten-egg smell produced due to hydrosulphide gas. So, it is necessary to maintain a concentration of oxygen in between 5-10 % for aerobic microbe's survival.

### 2.12 Temperature

It is very important to maintain the Temperature of compost at a certain level so that microorganisms can reach breeding conditions. The optimum range of temperature is 20°C to 70°C[14]. Observations are taken for over 20<sup>th</sup> week as shown below in Table 8 and fig.5. The temperature during composting process goes through three stages which are as warming stage, steep-warmth stage and freeze stage[11].

**Table 8:** Temperature variation

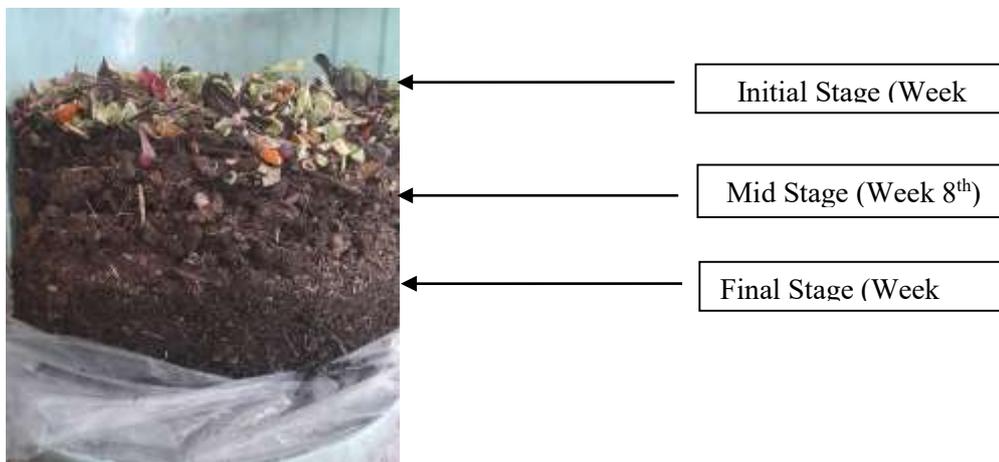
S. No	Week of observation	Temperature (°C)
1	2 <sup>nd</sup>	25
2	4 <sup>th</sup>	40
3	6 <sup>th</sup>	45
4	8 <sup>th</sup>	48
5	10 <sup>th</sup>	52
6	12 <sup>th</sup>	57
7	14 <sup>th</sup>	63
8	16 <sup>th</sup>	62
9	18 <sup>th</sup>	42
10	20 <sup>th</sup>	32



**Figure 5:** Graphical Representation of temperature variation

## 3. Result and Discussion

Figure.3 represents the pH values of the compost sample which was observed at the time interval of 4 weeks. The value of pH lies between 6 to 8, which shows that it is suitable for domestic consumption. As per Fig.5 the temperature range of compost from a minimum temperature of 27°C to the maximum temperature of 63°C was observed, Where the ideal temperature for compost is considered to be in between 20°C to 70°C on various stages of composting[14]. Observations show the C/N ratio as 28:1, slightly less than the standard value of 30:1 which was because of the presence of green vegetables. After the observations and analysis, it has been concluded that prepared compost was meeting with all the requirements essential factors and nutrients to the plants and crops.



**Figure 5:** Representation of three different stages of compost during the composting process.



**Figure 6:** Prepared compost of kitchen waste



**Figure 7** Kitchen waste compost used for domestic and agricultural purposes

### Conclusion

The organic waste from our kitchens is converted into compost in a short duration .pH value of compost lies between 6 to 8 which is as per the standard value of good compost and the C/N ratio is 28:1 which is less than the standard value i.e. 30:1, this is because of the presence of more green vegetables. These analyses represent that the prepared compost is suitable for agricultural purposes. The prepared compost can be used at homes as essential nutrition for plants and vegetables, apart from this compost can be used for selling purposes. As a huge amount of kitchen waste is also generated from restaurant and hotel, there it will be more beneficial, Composting is known to be one of the most hygienic biological waste disposal systems, so it plays a critical role in solid waste management. At the person level, this function aids in the proper handling of biodegradable waste. By introducing this low-cost portable shredder machine in places where biodegradable waste production is there, we can treat waste at a personal level

which leads to lesser demand of land for disposal of kitchen waste, lesser harmful gasses like carbon dioxide and methane will be there in our atmosphere which is produced during improper disposal of these waste. In this way, at the individual level, we can reduce the bad impact of kitchen waste on our society and environment on large scale.

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