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EVALUATION OF ORGANIC WASTE COMPOST MATURITY WITH SEASONAL VARIATION

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Abstract - *The management of the organic fraction of Municipal solid waste has become a major issue lately in the province of India. In order to comply with new government guidelines municipalities have to develop solutions to recover and recycle organic waste. In this study examines two solutions for treating organic waste: home composting using Continuous and Semi-continuous composting. The two methods are compared in terms of presence and quality of major elements in the soil and their environmental performance. The results from the study will use to compare whether the Continuous or Semi-continuous is more efficient, their environmental benefits. Hence semi-continuous composting can be adopted as it is very cost effective, eco-friendly and environmentally sound bio-degradable waste management technology. The participation rate of citizens is suggested to be a crucial parameter for the success of organic waste management in the two methods and it should be enhanced by different means to ensure the successful implementation of the solution. This study also determines the variation in composition as well as characteristics of municipal solid waste for Indian conditions. So for comprehensive management of this MSW, a proper combination of recycling and recovery, composting, energy generation and dumping on land should be adopted.*

***Key Words*: Household food-waste Composting, Organic waste management, Seasonal variation, Characteristics.**

1. INTRODUCTION

The Indian empire is facing a great challenge in the field of waste management all over the city. Although recycling is growing, and the quantity of waste thrown away in landfills is not declining due to the ever increasing rate of population and amount of waste generated. Also recycling helps conserve important raw materials and protects natural habitats for the future. In order to reduce the amount of waste ending up in landfills, the government of India introduced a new policy in 2016, this ministry released the solid wastage Management (SWM) rules. These rules replaced the Municipal waste rules, 2000 which had been in place for 16 years. Also Waste disposal is a rapidly growing problem In India across rural and urban households, communities and institutions like hostels, hospitals, convents and old age home etc. Rising quantities and poor management of organic waste leads to environmental and health issues. The methods for treatment and disposal of wastes mainly used in India include land-filling, Composting (aerobic and vermi-composting) and some waste-to-energy initiatives like incineration etc. Installation of waste-to-compost and bio-methanation plants would reduce the load of landfill sites. In this study adopted with Composting method: home-composting [1].

Compost is organic matter that has been decomposed in a process called Composting. This process recycles various organic materials otherwise regarded as waste products and produces a soil conditioner. Compost is rich in nutrients. Composting is an alternative for recycling biodegradable organic waste, transforming it into organic fertilizer that can be used as agricultural nutrients, avoiding its disposal in landfills. This study evaluated the composting of household organic waste as a substitution for cattle manure, with a view to its application in the fertilization to other plant growth. After maturation stage quality check is to be done [3].

For that here adopted home composting by using eco-friendly plastic barrel drum of standard size in litres of 3 in number for Continuous process of composting and compost bin of standard size of 2 in number for Semi-continuous process of composting. In Continuous process it include Aerobic, Anaerobic and Mixed of both Aerobic and Anaerobic process. Here the barrel drum is plastic with open top, during the compost process first and third drum are kept as aerobic condition so called Aerobic composting process and the second drum are kept to be closed (as anaerobic condition), it is provided together with the drum. Hence the process of composting is called Anaerobic composting process. After 45 days the third barrel having aerobic condition is changed to anaerobic compost so called Mixed type of both Aerobic and Anaerobic process. For semi-continuous composting process, it is different from continuous process. Mainly they are different in their kind of filling mode of operation. Initially the composters were filled within a seven day of frequency [4].

The quality test for major elements present in the compost are need to be check at 15th, 30th, 45th, 60th, 75th and final at 90th day regularly for both the cases. The final objective is to compare the best method of home-composting, namely Continuous and Semi-continuous process. Final objective is the comparison based on their efficiency, presence and quality of major elements in the soil after composting and their environmental performance [4].

It is evident that the success of household composting depends on the performance of the home composter and on the quality of the product, and experiments have been performed that take into consideration the performance of the domestic composter in relation to passive and/or forced aeration and batch and/or semi-continuous feeding [3].

1.1 Seasonal Variation in Composition and Characteristics of Indian Municipal Solid Waste

Municipal solid waste (MSW) generated by the community differs in quality as well as in quantity depending on several parameters like habit of the people, living standard, climatic conditions etc. In India the variation in the parameters is very wide and thus the quality as well as quantity estimation for a city or state cannot be simply extended for other locations to formulate an effective MSW management strategy. The estimation for the same city may also differ at different seasons of the year as well as months. Management of MSW constitute a major portion of budget of a municipality for its safe and hygienic disposal of MSW [5].

The municipal solid waste is collected in community bins kept open at top and thus exposed to the climate. The composition and the quantity of MSW generated from the basis on which the management system needs to be planned, designed and operated. In India, MSW differs greatly with regard to the composition and hazardous nature, when compared to MSW [5].

The focus of this study is to determine the variation in composition as well as characteristics of municipal solid organic waste for Indian conditions. The main objective is to determine the seasonal variation in waste characteristics. Generally they are four kinds of season and they are: Summer, Winter, Spring and Autumn.

1.2 Objective of the study

This study deals with the comparison between two types of composting process that is home-composting by Continuous and Semi-continuous composting process. Hence the seasonal variation in composition and characteristics of municipal solid waste is determined.

The specific objectives in the present study are:

- To compare the efficiency of both method of home-composting.
- To compare quality and presence of major elements in the soil.
- To determine seasonal variation in composition and characteristics of organic waste during composting process at different seasons.
- To compare the environmental performance.
- To enhance the health of the people living in the rural areas.
- Reduce environmental pollution due to burning of waste and making rural areas clean.

2. METHODOLOGY

The main advantage of these types of composting over other conventional method of composting is to convert bio-degradable waste into bio-fertilizer and pesticides and to promote recycle and reuse of the bio-degradable waste. They are of low cost methods because of being generated from agricultural waste, this can be easily processed, applied and reuse as compost soils without any adverse impact on the environment. It is eco friendly and innovation, sustainable kind of waste management method.

2.1 Continuous process of composting

1. Preliminary Setup Installation

Selection of site in which composting is to be done. Choose a secluded spot which has good airflow and easy access to water. The ground should be flat and well drained. The area may also enjoy partial shade during summers to prevent the bin from becoming too hot and suitable exposure to the sun during winters to maintain apt heat. Cleaning of the area and surrounding. Next, select a fitting compost barrel drum. Installation of set-up 55L Barrel drum of 3 in number. The compost drum should keep neat, preserve heat and discourage animals from poking their nose into the waste. Arrangements were made for Aerobic, Anaerobic and Combined (Aerobic and Anaerobic) composting process.

Fig -1: Barrel drum (55L)

2. Collection of organic wastes to be filled in.

It includes organic wastes from various Kitchens, Kitchen scraps, Vegetable shop, Fruit stall, Garden waste and Agricultural waste etc.

Fig -2: Organic waste

Fig -3: Vegetable waste

3. Preparation Process

It includes Separation, Shredding and Homogenisation of organic waste from inorganic waste were done. Combine Green and brown materials. Suitable quantity of soil was collected for mixing the organic wastes. A vigorous compost bin should be a mix of greens and browns. The key to making a good compost bin is a healthy balance of carbon and nitrogen.

Fig -4: Soil collected from Garden

4. Compost powder Addition

It includes, kitchen waste compost maker powder is used. The compost powder contains Bio D bacteria and it is used for the speed acceleration for composting. TSR Bio D bacteria is a consortium of live aerobic microorganisms specially developed for composting or degrading organic wastes like sugar factory press mud, distillery spent wash, cow dung, poultry manure, coir pith, sugarcane trash, bagasse, city garbage and other agricultural wastes. Compost fast is harmless to human beings, animals, birds and plants. It is fully biodegradable. During the process this powder were added continuously once in a week or time period within 5 to 7 days for better performance.

Fig -5: Speed Accelerator powder

5. Filling Stage

Mixing of organic waste with soil collected from the ground either using hand mixing or using tools. Then put a layer of leaves. Go on alternating between layers of browns or carbon rich material and greens or nitrogen rich materials. Filling and water the container. Stir up the waste by adding quantity of speed accelerating powder. Continue adding layers until the drum is full.

Fig -6: Barrel drum filled with organic waste

6. Watering and Maintain Compost Bin

Sprinkle water over the compost regularly so it has the consistency of a damp sponge. Don't add too much water, otherwise the microorganisms from the compost bin will become waterlogged and drown. If this happens, organic waste will rot instead of compost. Monitor the temperature of compost bin with a thermometer to be sure the materials are properly decomposing.

7. Harvest the compost

The compost is turned after 6 weeks and again after 12 weeks to allow air to penetrate so that the heap will heat up properly. Finished compost looks dark and crumbly and smells pleasant and earthy. After 3 months, the compost is finished and ready for application to soil.

Tests done for quality check for various elements in the compost includes routine analysis such as Temperature, Moisture content, pH, EC, N, P, K. The quality test for presence of major elements present in compost was done at 15^{th}, 30^{th}, 45^{th}, 60^{th}, 75^{th} and final at 90^{th} day.

2.2 Semi-Continuous process of composting

This method investigates the performance of food-waste composting using a simple and small-scale domestic composter. Six composting trials were conducted using food waste and wood chips (Wood Powder) in 10 litre plastic bin composter using different filling schemes.

1. Preliminary Setup Installation

Select the Compost bin. Installation of set-up, here adopted Compost bin of 10L of 2 in number. The compost bins should keep neat, preserve heat and discourage animals from poking their nose into the waste. Arrangements were made for Aerobic composting process.

Figure 7 below shows small, low cost plastic bins that are widely available in supermarkets were used in this experiment.

Fig -7: Composter Bin

2. Collection of organic wastes and Wood chips used to filled in the Compost bin

Wood chips were collected from wood mill. Then make it into powder form. Allow it to dry by sunlight.

Fig -8: Wood chips powder

3. Preparation Process

It includes reducing of food waste size manually into 1cm particles and manually mixed with Wood powder.

Fig -9: Organic waste after reduction of size

The compost operation was divided into six trials, food waste, composed exclusively of vegetables and fruits, was collected from small restaurants. The food-residue size was manually reduced to 1.0 cm particles and manually mixed with wood chips powder.

4. Drilling, Mixing of collected waste and powdered wood chips.

Drilling of holes is a necessary process. In order to facilitate natural aeration and the drainage of possible leachate during the composting process, 0.6 cm diameter holes were drilled in the sides of the compost bins

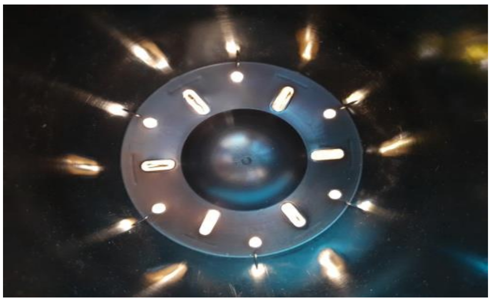

Fig -10: Hole drilled compost bins

Fig -11: Organic Waste after mixing

5. Filling stage of mixed components

Mixing of organic waste with Wood powder collected from the wood mill either using hand mixing or using mechanical mixer. Here the mixing process is done by hand mixing. Stir up the waste by adding quantity of wood powder. The food waste and wood powder was always 70:30 in wet mass. Adding layers until the compost bin is full.

Fig -12: Final stage after filling

6. Composting Operation

In this work, an exploratory study was conducted to investigate the performance of food waste composting using a small-scale domestic composter in semi-continuous and batch fill scenarios with new and reused wood chips powder.

In various trials, composters were filled in batch and semi-continuous composting systems. Wood chips in powder form (used as a structural material) were inserted in natural or reinserted following the composting cycle to improve aeration and moisture control.

Trial 1- The food waste and wood powder ratio was always 70:30 in mass. The composters were monitored in duplicate. A semi-continuous feed operating system was adopted. The composters were filled within a seven day frequency. The amount of mixed food waste and wood powder placed inside the composters when they were filled was enough to complete them and at the end, after filling dry weight is recorded. Add amount of water for activation of compost process, after that wet weight is measured and recorded. In this trial, manual turning of the mixture was done daily for better aeration. This process will continue for 15 days.

Trial 2- On the 15th day trial 2 is done and at the same day, test for presence of major elements in compost was done. On this day the batch compost was filled with 50% of food waste and wood powder from the remaining material in the compost at the end of Trial 1. Remaining 50% was filled with untreated wood powder. After filling, dry weight is recorded. Add amount of water after that wet weight is measured and recorded. Manual turning of the mixture was done daily and this process will continue up to 30 days.

Trial 3- On the 30th day trial 3 is done and at the same day, test for presence of major elements in the compost was done. On this day the batch compost was filled with 50% of food waste and wood powder from the remaining material in the compost at the end of Trial 2. Remaining 50% was filled with untreated wood powder. After filling, dry weight is recorded. Add amount of water after that wet weight is measured and recorded. Manual turning of the mixture was done daily and this process will continue up to 45 days.

Trial 4- On the 45th day trial 4 is done and at the same day, test for presence of major elements in the compost was done. On this day the batch compost was filled with 50% of food waste and wood powder from the remaining material in the compost at the end of Trial 3. Remaining 50% was filled with untreated wood powder. After filling, dry weight is recorded. Add amount of water after that wet weight is measured and recorded. Manual turning of the mixture was done daily and this process will continue up to 60 days.

Trial 5- On the 60th day trial 5 is done and at the same day, test for presence of major elements in the compost was done. On this day the batch compost was filled with 50% of food waste and wood powder from the remaining material in the compost at the end of Trial 4. Remaining 50% was filled with untreated wood powder. After filling, dry weight is recorded. Add amount of water after that wet weight is measured and recorded. Manual turning of the mixture was done daily and this process will continue up to 75 days.

Trial 6- On the 75th day trial 6 is done and at the same day test for presence of major elements in the compost was done. On this day the batch compost was filled with 50% of food waste and wood powder from the remaining material in the compost at the end of Trial 5. Remaining 50% was filled with untreated wood powder. After filling, dry weight is recorded. Add amount of water after that wet weight is measured and recorded. Manual turning of the mixture was done daily and this process will continue up to 90 days. At the 90th day test for presence of major elements in the compost was finally checked.

Finally the two methods (Continuous and semi-continuous methods) are compared in terms of their Efficiency, Quality and Presence of major elements in the soil (at each trials), Environmental performance and Rate of environmental pollution.

2.3 Steps for Evaluation of Seasonal Variation in Composition and Characteristics

1. Survey for basic information regarding waste generation and its disposal

Initially whole area was surveyed to obtain basic information regarding the waste generation areas, collection points and disposal sites. The organic waste is collected in community bins kept at different locations in the wards according to the convenience of habitats and municipal authorities for its transportation to the final disposal point. Generally the MSW is collected from different house through trucks, tractor with trolley, airtech refuse collector and transported to the disposal points. For this survey only a small quantity is needed.

2. Collection of MSW samples

In order to determine the composition and characteristic of MSW composite samples were collected from community dustbins as well as the final disposal points of MSW in polythene bags. The samples were collected by taking 2 grab samples of approximately 1kg each. The grab samples were then mixed thoroughly. The samples of MSW were collected during different seasons (Autumn, Winter and Spring).

3. Analysis of MSW samples for Composition and Characteristics

The mixed sample was the physically analyzed for its composition such as biodegradable, paper, plastic, metals and inerts (dust, stone pieces and others) and expressed as % of total sample weight. Characteristics of the MSW were also determined like Moisture content, Bulk density and Dry density. Analysis of MSW was carried out as per the standard procedures. The procedure and concept adopted for determination of different characteristics is mentioned below:

- Determination of Moisture Content
- Determination of Bulk Density
- Determination of Dry Density

4.3.1 Determination of Moisture Content

Approximately 20gm of properly mixed sample of MSW was taken in dish and the initial weight of the dish containing sample was taken. The dish containing sample was kept in oven at 105°C for 24hrs. Final weight of the sample is taken and moisture content is determined by following equation.

$$m=\frac{W1-W2}{W2}\times 100$$

Where,

m= Moisture Content (%)

w1= Initial wt of sample (in gm)

w2= Final wt of sample (in gm)

4.3.2 Determination of Bulk Density

A metallic cubical of 5cm×5cm×5cm was taken and the empty weight and volume of cubical was measured. Sample is filled up in the measuring cube and net weight of the sample was taken to determine the bulk density. The bulk density was obtained by dividing the weight of sample by volume of the container containing sample using equation.

$$\gamma=\frac{W2-W1}{V}$$

Where,

γ= Bulk Density (gm/cm^3)

W1= Weight of empty container in gm

W2= Weight of container with sample in gm

V= Volume of container (cm^3)

4.3.3 Determination of Dry Density

Dry density was estimated using Moisture Content and Bulk Density by following equation.

$$\gamma_d=\frac{\gamma}{1+m}$$

Where,

γ_d= Dry Density of substance (gm/cm^3)

γ= Bulk Density of substance (gm/cm^3)

m= Moisture Content (%)

4. Analysis the variation in Composition and Characteristics of MSW

Management of Municipal solid waste depends on the composition and characteristics of the waste that is generated by the community. The composition and characteristics of the waste is dependent on several aspects like season, living standard, location etc. A variation in quantity and quality of MSW generated by the community was also analysed to visualize the real situation.

3. RESULTS AND DISCUSSION

The Continuous composting and Semi-continuous composting methods were used for the present study to determine the presence and quality of major elements in the compost soil. The results of this study are discussed in the following section. The composting process was monitored for 90 days for both types of composting. For Continuous process and Semi-continuous process, composting process was monitored for 15 days in Trial 1, 30 days in Trial 2, 45 days in Trial 3, 60 days in Trial 4, 75 days in Trial 5 and 90 days in Trial 6 a total of 90 days of operation.

3.1 Results of Continuous Process of Composting

The permissible values of various parameters are, for Temperature 18-24°C, Moisture content 10-18%, pH 3.5-10, Electric conductivity 110-570 ms/m, Nitrogen 240-480 kg/ha, Phosphorus 11-22 kg/ha and Potassium 110-280 kg/ha.

Data of 15th day Observation

Table -1: 15th day Observation

Routine Analysis	Aerobic Composting	Anaerobic Composting	Combined Aerobic and Anaerobic
Temperature (°C)	19	21	19
Moisture Content (%)	8	8	8
pH	7	6	7
Electric conductivity(ms/m)	98	110	97
Nitrogen (kg/ha)	210	220	210
Phosphorus (kg/ha)	12	12	12
Potassium (kg/ha)	112	120	115

All the above parameters were ranges between allowable values. For all the 3 types, temperature varied between 19°C-21°C, moisture content remains constant, pH varied from 6-7.

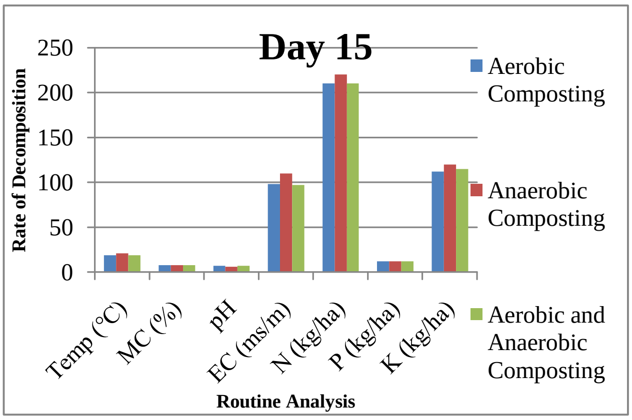

Chart -1: Effect of Routine Analysis at day 15

Data of 30th day Observation

Table -2: 30th day Observation

Routine Analysis	Aerobic Composting	Anaerobic Composting	Combined Aerobic and Anaerobic
Temperature (°C)	20	22	21
Moisture Content (%)	10	13	11
pH	7.1	7.7	7.5
Electric conductivity(ms/m)	115	210	120
Nitrogen (kg/ha)	223	250	220
Phosphorus (kg/ha)	14	14	14
Potassium (kg/ha)	120	190	120

All the above parameters were ranges between allowable values. For all the 3 types, temperature varied between 20-22°C, moisture content 10-13%, pH varied from 7.1-7.7.

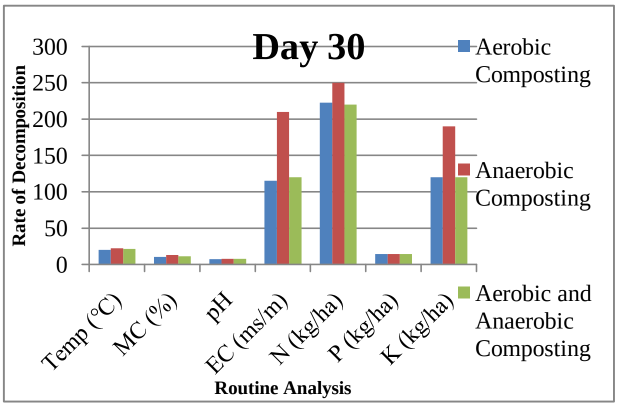

Chart -2: Effect of Routine Analysis at day 30

Data of 45th day Observation

Table -3: 45th day Observation

Routine Analysis	Aerobic Composting	Anaerobic Composting	Combined Aerobic and Anaerobic
Temperature (°C)	21	22	21
Moisture Content (%)	12	15	12
pH	7.2	7.5	7.5
Electric conductivity(ms/m)	250	260	250

Nitrogen (kg/ha)	242	290	240
Phosphorus (kg/ha)	15	19	15
Potassium (kg/ha)	140	190	132

All the above parameters were ranges between allowable values. For all the 3 types, temperature varied between 21-22°C, moisture content 12-15% and pH varied from 7.2-7.5.

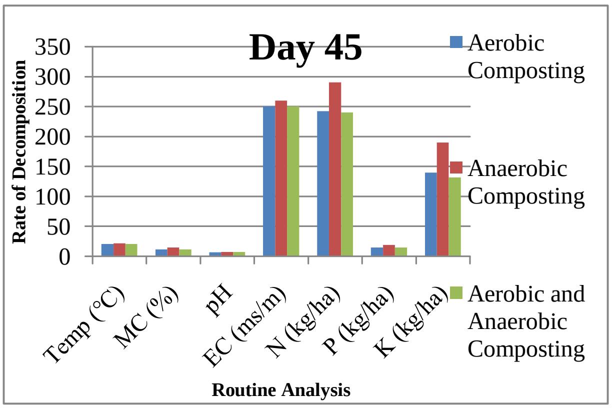

Chart -3: Effect of Routine Analysis at day 45

Data of 60th day Observation

Table -4: 60th day Observation

Routine Analysis	Aerobic Composting	Anaerobic Composting	Combined Aerobic and Anaerobic
Temperature (°C)	23	24	22
Moisture Content (%)	14	18	14
pH	8	8	8
Electric conductivity(ms/m)	280	300	270
Nitrogen (kg/ha)	300	310	310
Phosphorus (kg/ha)	17	20	15
Potassium (kg/ha)	150	200	143

All the above parameters were ranges between allowable values. For all the 3 types, temperature varied between 22-24°C, moisture content 14-18, pH remains constant throughout the process.

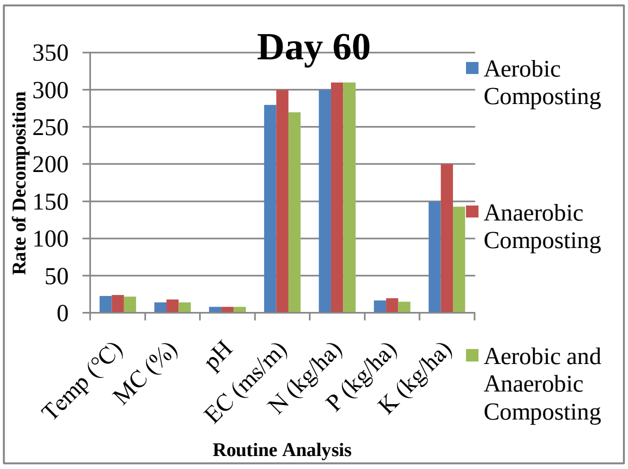

Chart -4: Effect of Routine Analysis at day 60

Data of 75th day Observation

Table -4: 75th day Observation

Routine Analysis	Aerobic Composting	Anaerobic Composting	Combined Aerobic and Anaerobic
Temperature (°C)	24	24	24
Moisture Content (%)	15	18	15
pH	8	8	8
Electric conductivity(ms/m)	320	330	310
Nitrogen (kg/ha)	305	330	320
Phosphorus (kg/ha)	18	21	17
Potassium (kg/ha)	180	240	160

All the above parameters were ranges between allowable values. For all the 3 types, temperature and pH remains same as constant, moisture content 15-18%.

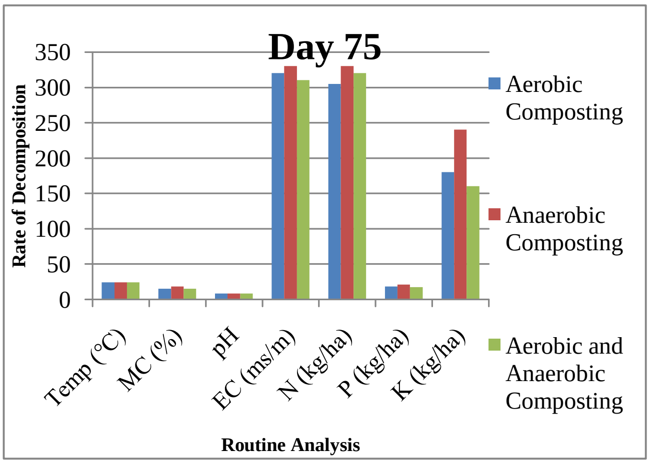

Chart -5: Effect of Routine Analysis at day 75

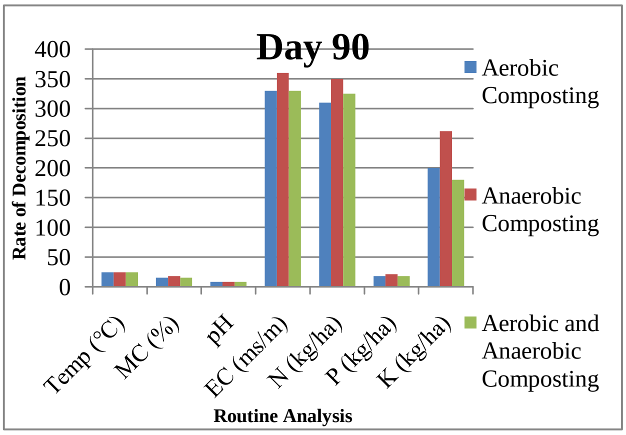

Chart -6: Effect of Routine Analysis at day 90

Data of 90th day Observation

Table -6: 90th day Observation

Routine Analysis	Aerobic Composting	Anaerobic Composting	Combined Aerobic and Anaerobic
Temperature (°C)	24	24	24
Moisture Content (%)	15	18	15
pH	8	8	8
Electric conductivity(ms/m)	330	360	330
Nitrogen (kg/ha)	310	350	325
Phosphorus (kg/ha)	18	21	18
Potassium (kg/ha)	200	262	180

All the above parameters were ranges between allowable values. For all the 3 types, temperature and pH remains as constant 24°C and 8, moisture content varied between 15-18%.

3.2 Results of Semi-Continuous Process of Composting

Results of quality check for presence of major elements in soil includes, test for Temperature, Moisture Content, pH, Electric Conductivity, Nitrogen, Phosphorous and Potassium

Data of 15th day Observation

Table -7: 15th day Observation

Routine Analysis	Aerobic Composting
Temperature (°C)	18
Moisture Content (%)	6
pH	5.2
Electric Conductivity (ms/m)	100
Nitrogen (kg/ha)	220
Phosphorus (kg/ha)	11
Potassium (kg/ha)	115

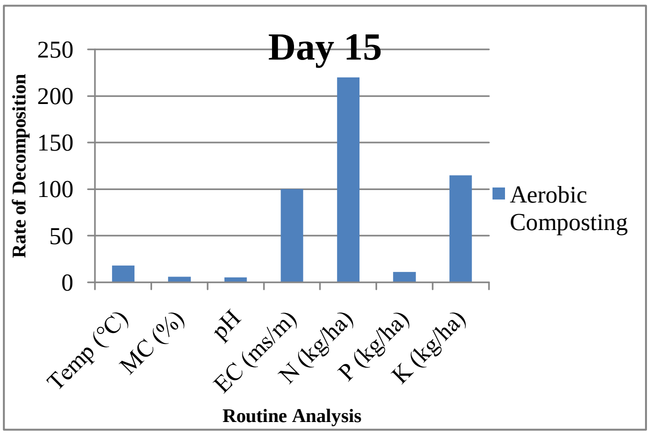

Chart -7: Effect of Routine Analysis at day 15

Data of 30th day Observation

Table -8: 30th day Observation

Routine Analysis	Aerobic Composting
Temperature (°C)	18.6
Moisture Content (%)	8.3
pH	5.9
Electric Conductivity (ms/m)	150
Nitrogen (kg/ha)	239
Phosphorus (kg/ha)	13.4
Potassium (kg/ha)	123

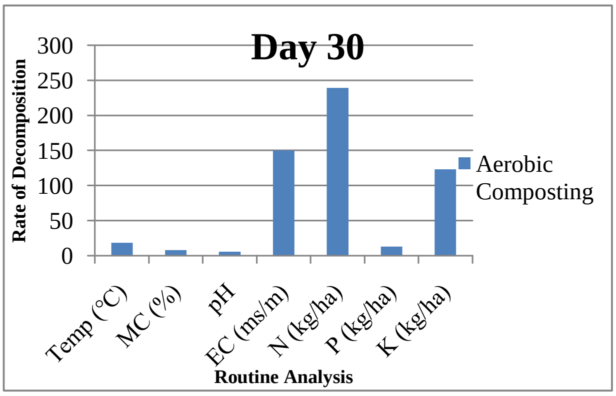

Chart -8: Effect of Routine Analysis at day 30

Data of 45th day Observation

Table -9: 45th day Observation

Routine Analysis	Aerobic Composting
Temperature (°C)	20
Moisture Content (%)	12.3
pH	7.6
Electric Conductivity (ms/m)	280
Nitrogen (kg/ha)	255
Phosphorus (kg/ha)	18
Potassium (kg/ha)	148

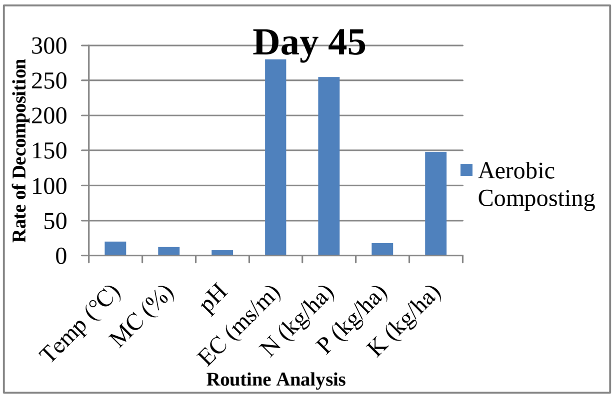

Chart -9: Effect of Routine Analysis at day 45

Data of 60th day Observation

Table -10: 60th day Observation

Routine Analysis	Aerobic Composting
Temperature (°C)	22
Moisture Content (%)	14
pH	8.2
Electric Conductivity (ms/m)	300
Nitrogen (kg/ha)	320
Phosphorus (kg/ha)	20
Potassium (kg/ha)	172

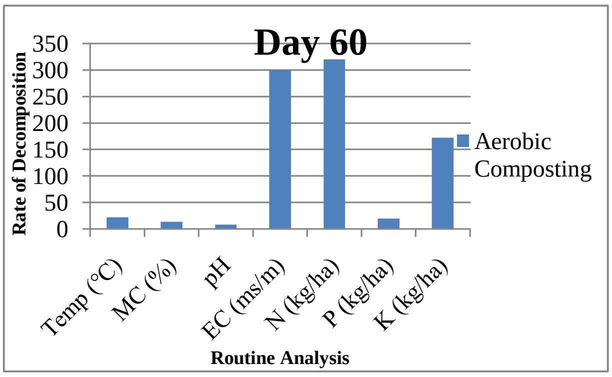

Chart -10: Effect of Routine Analysis at day 60

Data of 75th day Observation

Table -11: 75th day Observation

Routine Analysis	Aerobic Composting
Temperature (°C)	22.5
Moisture Content (%)	14
pH	8.5
Electric Conductivity (ms/m)	360
Nitrogen (kg/ha)	380
Phosphorus (kg/ha)	22
Potassium (kg/ha)	210

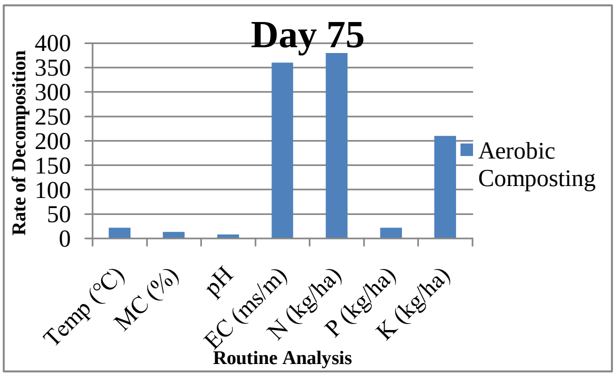

Chart -11: Effect of Routine Analysis at day 75

Data of 90th day Observation

Table -12: 90th day Observation

Routine Analysis	Aerobic Composting
Temperature (°C)	22
Moisture Content (%)	15
pH	9
Electric Conductivity (ms/m)	420
Nitrogen (kg/ha)	412
Phosphorus (kg/ha)	22
Potassium (kg/ha)	260

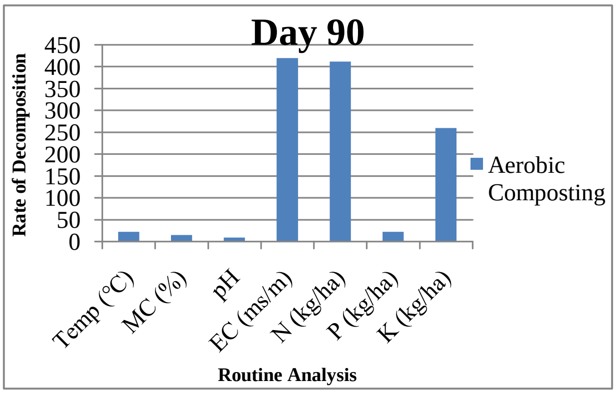

Chart -12: Effect of Routine Analysis at day 90

After each test, the final compost was sieved and particles smaller than 0.42mm were analysed as the final compound process. Low-level production of compost of about 3% of the final dry mass was observed in Trials 1 and Trial 2, while in Trial 6, 2% was obtained. In all trials moisture content is in between allowable value. As the temperatures throughout the experiment did not reach the thermophilic phase and were suitable for the growth of microorganisms, sanitization of the material (destruction of viable pathogens and weed seeds) cannot be ensured. However, the relatively long residence of the waste in the composter allows for these pathogenic microorganisms to decay naturally.

From Continuous composting process, Aerobic composting process is seen with best performance when compared to Anaerobic and Combined aerobic and anaerobic. From the above 2 methods of composting (Continuous and Semi-continuous), most efficient method is Semi-continuous composting process due to its fastest mode of operation in decomposition of organic waste, good in environmental performance, efficient and more viable method than other method. So as a result, using Aerobic type of composting from the continuous and semi-continuous the seed germination test was done.

3.3 Results of Different Seasonal Variation

Composition of MSW in Different Seasons

i. During Autumn Season

For Autumn season the average composition of MSW of biodegradable fraction is found to be 46%, paper 5%, plastic 6%, glass 0.07%, metals 0.08%, textile & leather 0.9% and inert materials 44%.

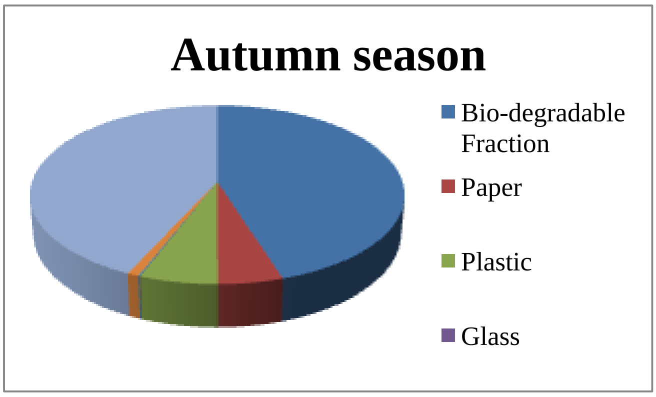

Fig -13: Average composition of MSW in autumn season

ii. During Spring Season

For Spring season the average composition of MSW of biodegradable fraction is found to be 40%, paper 5%, plastic 4%, glass 0.17%, metals 0.14%, textile & leather 0.74% and inert materials 54%. The Figure 6.28 below shows the average composition of MSW in Spring season of composting process.

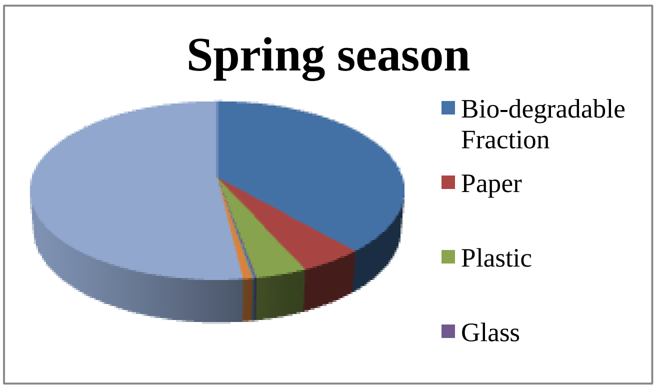

Fig -14: Average composition of MSW in spring season

iii. During Winter Season

For Winter season the average composition of MSW of biodegradable fraction is found to be 54%, paper 5%, plastic 7%, glass 0.8%, metals 0.2%, textile % leather 1% and inert materials 37%. The Figure 6.29 below shows the average composition of MSW in Winter season of composting process.

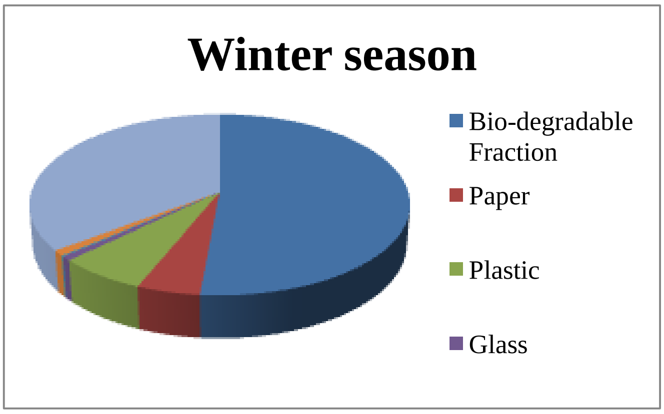

Fig -15: Average composition of MSW in winter season

Spring season March to May, any time of year is a good time to start composting but each season offers its own advantages. Starting a composting in spring offers the opportunity to take advantage of the warmer weather and the increasing activity of the composting microorganisms and compost creatures. Comparison of collected waste by composition and seasonal variation shows that in all three socio-economic levels slight variations are found among different fractions of organic waste in winter season.

For all studied seasons and economic levels, minimum waste is generated in the winter season as compared to spring and autumn. While using homemade compost, its best to add it in early fall so that by spring, it will have broken down and worked itself into the soil. Adding a thick layer of compost in the fall also helps to reduce weed.

Concerning MSW collection, transportation and dumping, the authors strongly suggest for a transfer station facility so that collected waste could be segregated on purely scientific grounds before the final dumping. The upshot of this study suggested a methodology of waste composition survey, the summary of quantification and characteristics of collected waste based on compostable and recyclable materials and the classification category list.

Characteristics of MSW in Different Seasons

Determination of Moisture Content

$$\text{Moisture Content, m} = \frac{W1 - W2}{W2} \times 100$$

Initial weight of sample, w1= 30.2g

Final weight of sample, w2= 23.3g

$$m = \frac{30.2 - 23.3}{23.3} \times 100 = 29.61 \approx 30\%$$

ii. Determination of Bulk Density

$$\text{Bulk Density, } \gamma = \frac{w2 - w1}{V}$$

Weight of container with sample-Weight of empty container, w2-w1= 150g

Volume of the container, $V = \pi r^2 h$

$$= \pi \times 2.5^2 \times 5$$

$$= 98.2 m^3$$

$$\text{Therefore, } \gamma = \frac{150}{98.2} = 1.527 \text{ g/cm}^3$$

iii. Determination of Dry Density

$$\text{Dry Density, } \gamma_d = \frac{\gamma}{1+m}$$

Bulk density of substance, $\gamma = 1.527$ g/cm^3

Moisture Content, m= 30%

$$\gamma_d = \frac{1.527}{1+0.3} = 1.174 \text{ g/cm}^3$$

The different characteristics of MSW as well as yearly average of these characteristics were calculated. The moisture content was observed to be 30%, bulk density was observed to be 1.527 g/cm^3 and dry density was observed to be 1.174 g/cm^3. The variations in characteristics of MSW with respect to composition are found to be significant for most of the parameters studied.

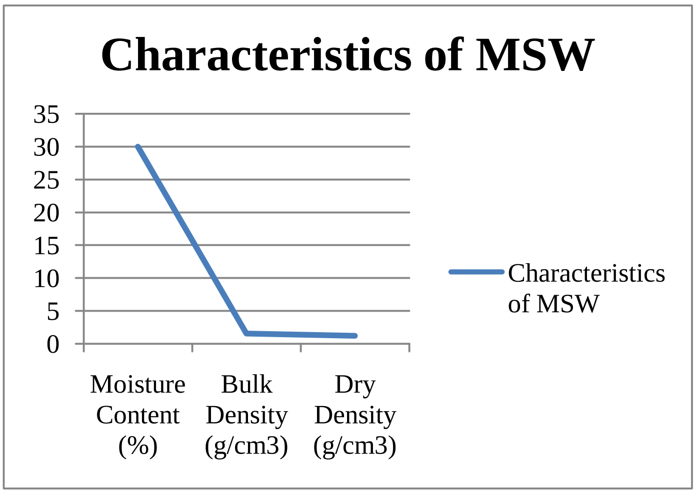

Chart -13: Different characteristics of MSW

4. CONCLUSIONS

This study analysed the best method of organic waste composting, seasonal variation and maturity level as its application. Few control measures are needed for the production of quality compost, as well as for selecting the adapted compost and its application strategy. Here the study is to analyse the effect of temperature, moisture content, pH, electric conductivity, nitrogen, phosphorus and potassium throughout many trials. This study demonstrated that, the stabilization of food waste is feasible in simple and small composters filled with food preparation waste and wood chips as a structural material. Even if the compound did not always suit agricultural use, its low production created beneficial waste-mass reduction. The control measures described above are relatively simple to implement and are cheap. This is the key to the correct interpretation of these compost quality parameters in order to choose the right compost for the intended use and the optimal application strategy.

The seasonal variation in characteristics of MSW was found to be 30% so none of the methods of MSW management (ie, dumping on land, composting, recycling and recovery, burning and energy generation) alone can be sufficient for efficient management of MSW. For comprehensive management of this MSW, a proper combination of recycling and recovery, composting, energy generation and dumping on land should be adopted. The seasonal variation in characteristics of MSW also gives an idea about the arrangements to be made for collection, transportation and disposal of different quantity of MSW generated in different seasons. In this study, spring season (March to May) at any time of year is good time to start composting, but each season offers its own advantages. To this end, manage materials that must be composted so that, throughout the year, this activity can be so rewarding with simplicity and comfort.

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