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An Investigation Study on Domestic Organic Waste Compost

Preeti Namdeo[1], Dr. Santosh Kumar Sar[2], Dr. Sindhu J. Nair[3]

Research Scholar [M.Tech. (Environmental Science and Engineering)], Department of Civil Engineering, Bhilai Institute of Technology, Durg, Chhattisgarh, India

Professor & Head, Department of Applied Chemistry, Bhilai Institute of Technology, Durg, Chhattisgarh, India

Professor & Head, Department of Civil Engineering, Bhilai Institute of Technology, Durg, Chhattisgarh, India

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ABSTRACT

Composting is used for repurposing organic waste. Life Cycle Assessment (LCA) is a prevalent method used to assess the environmental effects of a process at various phases within a system.

Food waste from households is disposed of in landfills, leading to a significant loss of resources and energy, contributing to the greenhouse effect, and endangering water sources. Composting is a widely used method for managing solid organic waste and may be utilised in every household to create high-quality compost.

Households contribute significantly to overall food waste and play a crucial role in tackling food waste disposal challenges. This paper focuses on creating home compost from kitchen waste, analyzing their nutrient content (moisture, NPK), and conducting laboratory tests Collection of Soil and kitchen waste was taken from local area of Kargi road Kota, District Bilaspur (CG) (LAT 22.290674, LONG 82.021537) and Domestic compost samples are also prepared inKargi road Kota, District Bilaspur (CG) .The Properties of samples of domestic compost were analyzed and examined after 7, 15, and 30 days

Keywords: N for Nitrogen, K for Potassium, P for Phosphorus.

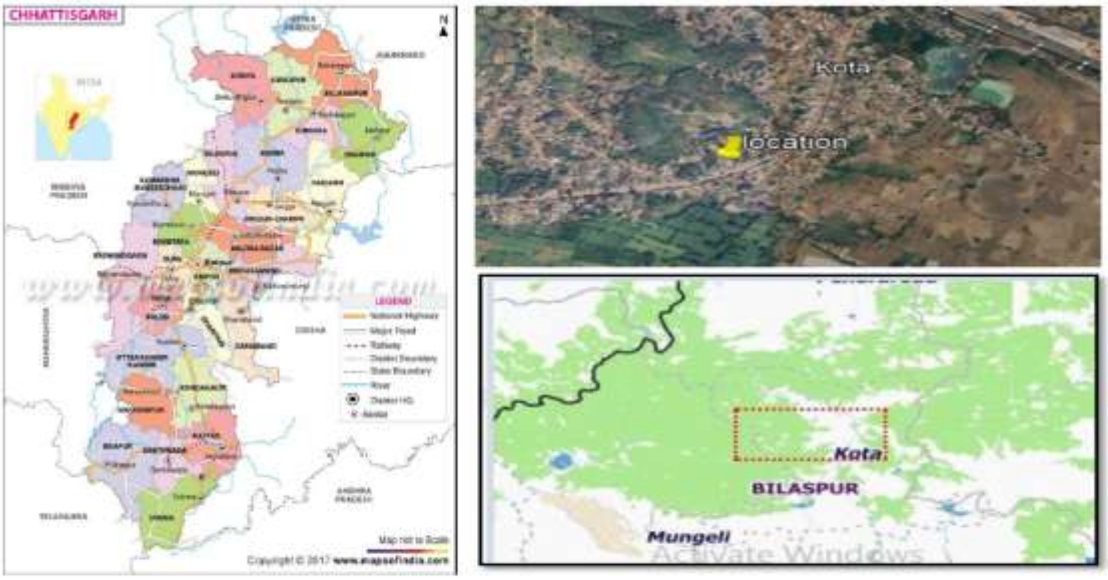

Fig. 1: Location of workplace

I. INTRODUCTION

1.1 Compost

Compost is prepared by decomposing plant and food waste, recycling organic materials, and manure.

When it comes to food waste and municipal organic waste (e.g., from gardens) collection, even in developed countries like Germany, where reduction of organic waste had become a policy of paramount importance and separate collection is mandatory since 2015, a lot of households are still not served with separated collection for the bio-bin (Sanjuan-Delmas ´ et al., 2021). To mitigate the hardships of separate collection and recovery of food waste, home composting is considered a viable, sustainable alternative for household biowaste treatment. Household composting results in high-quality compost, as food waste and other bio-sub products are separated first-handedly, at source, and treated and valorized in situ. The biowaste comes never in contact with other garbage that may contaminate it (Margaritis et al., 2018; Phu et al., 2021; Sasson and Malpica, 2018). Moreover, home composting and direct application of the product results into enhancing the soil quality at the locale, effectively diverting biowaste from landfills (Li et al., 2013).

1.1.1 Phases of Composting

Under ideal conditions, composting proceeds through three major phases:

1. **Mesophilic phase:** The initial, mesophilic phase is when the decomposition is carried out under moderate temperatures by mesophilic microorganisms.
2. **Thermophilic phase:** As the temperature rises, a second, thermophilic phase starts, in which various thermophilic bacteria carry out the decomposition under higher temperatures (50 to 60 °C (122 to 140 °F).)
3. **Maturation phase:** As the supply of high-energy compounds dwindles, the temperature starts to decrease, and the mesophilic bacteria once again predominate in the maturation phase.

1.2 Domestic Organic Waste Compost

1.2.1 Home Composting

Home composting is the process of using household waste to make compost at home. Composting is the biological decomposition of organic waste by recycling food and other organic materials into compost. Home composting can be practiced within households for various environmental advantages, such as increasing soil fertility, reduce landfill and methane contribution, and limit food waste.

1.2.1.1 History of Home Composting

While composting was cultivated during the Neolithic Age in Scotland, home composting experienced a much later start. Indoor composting, also known as home composting, was discovered in 1905 by Albert Howard who went on to develop the practice for the next 30 years.

J.I. Rodale, considered the pioneer of the organic method in America, continued Howard's work and further developed indoor composting from 1942 on. Since then, various methods of composting have been adapted.[4] Indoor composting aided in organic gardening and farming and the development of modern composting. It originally entailed a layering method, where materials are stacked in alternating layers and the stack is turned at least twice.

Fig. 2: Closed bin home composting using a polystyrene box

1.2.2 Kitchen Waste Composting

Kitchen waste composting is the act of using your kitchen waste and food scraps, which are organic materials (greens and browns), to create compost beneficial for enriching soil and growing plants and crops. Surprisingly, most people are unaware that food scraps are good sources of vitamins and minerals. These give the soil nutrients to become healthier, trickling down the minerals to the crops planted into it. Composting kitchen waste is a highly sustainable method. In addition, when it comes to making kitchen waste compost, expert knowledge is not required. Anyone can start making a compost pit. This is because composting is not a specialized skill exclusive to those with prior farming or agricultural experience.

Fig. 3: Kitchen wastes

1.3 Objectives of the Study

1. To prepare domestic compost and study its characteristic properties.
2. To perform the NPK Test and moisture test.
3. To study Comparisons of domestic compost samples in 7 days, 15 days and 30days.

II. MATERIALS

2.1 Materials, Proportioning and Properties Domestic Organic Waste

2.1.1 Home Compost

Table 1: Home Compost Material

Green material	Brown material
Fresh grass or leaves	Dry leaves
Fruits	Branches
Flowers	Paper likes newspaper
Coffee ground	Cardboard
Tea leaves	Corn cobs
Garden waste	Egg shells

Table 2: Material not used for home compost

Material	Reason
Meat / fish (including bones)	It Creates odor and attracts pests
Dairy products like (eggs, milk butter, etc.)	It Creates odor and attracts pests
Fats and oils	It Creates odor and attracts pests
Pet feces	Might have harmful parasites, bacteria, viruses, etc. to humans
Coal ash	Might have harmful substances to plants

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2.1.2 Kitchen Waste Compost

Kitchen waste compost material:

- Dead leaves
- Fruits peeling like orange banana etc
- Grass
- Waste house dust
- Nutshells
- Paper
- Bread
- Tea bags

Fig. 4: Kitchen waste

2.2Soil

From a general perspective, "soil" is a very broad term and refers to the loose layer of earth that covers the surface of the planet. The soil is the part of the earth's surface, which includes disintegrated rock, humus, inorganic and organic materials. For soil to form from rocks, it takes an average of 500 years or more. The soil is usually formed when rocks break up into their constituent parts. When a range of different forces acts on the rocks, they break into smaller parts to form the soil. These forces also include the impact of wind, water, and salts' reaction.

III. METHODOLOGY AND DATA ANALYSIS

3.1 Proportion Methods

In this method wastes are converted into compost as domestic organic waste using appropriate proportion of waste materials and composts are prepared and kept for25 to 30days.

The compost are taken out from bucket after its period gets over and is subjected to the Moisture, Nitrogen, Phosphorus and Potassium test and the values are taken for all prepared compost and by comparing their values we get the desired result.

3.2Domestic Organic Waste

3.2.1 Calculation of materials

- Weight of bucket – 0.405 kg
- Soil weight – 2 kg
- Kitchen waste weight – 6 kg

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- Water and curd slurry – 100 gram

Proportion of Domestic waste compost:
Final Total weight of domestic compost= 1.303 kg

3.2.2 Procedure Adopted for making domestic organic waste

1. First take the empty bucket and make small holes in the bucket and measure the weight of the bucket.
2. Fill 0.5 kg of soil in the bucket.
3. Then for 2nd layer fill 2 kg of collected kitchen waste in the bucket.
4. For 3rd layer fill 0.5 kg of soil into the bucket.
5. Then for 4th layer again put 2 kg of collected kitchen waste in the bucket.
6. For 5th layer fill bucket with 0.5 kg of soil.
7. For 6th layer fill the bucket again with 2 kg of collected kitchen waste
8. Then pour curd and waste slurry into the bucket for proper decomposer.
9. Then finally filled the bucket with 0.5 kg of soil.
10. Close the bucket and leave it for 25 days to prepare.
11. After 25 days the domestic organic waste compost is ready in wet condition then the domestic organic waste compost is taken out from the bucket and place it in open for 1 day and then it is refined with strainer.
12. Finally, Domestic compost is ready for us

Fig. 5:Domestic compost procedure

3.2.3 Oven Drying Method for Moisture
Lab Procedure:

1. Place the moist compost sample in the container and use weighing balance for weight of sample as W_1.
2. Hot air oven drying is maintained at a temperature of 80 degree Celsius.
3. After that compost sample is placed in oven drying.
4. Compost sample is kept for 24 hours in oven drying.
5. After 24 hours remove sample from oven and place it.
6. After the cooling of compost sample, again take weight of sample as W_2 and calculate the moisture content.

Calculation formula:

$$\text{Moisture content}(\%) = \left(\frac{(W_1 - W_2)}{W_1}\right) \times 100$$

Fig. 6: Oven Drying Machine

3.2.4 Kjeldahl Method for Nitrogen
Lab Procedure:

1. First step is making solutions:

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(a) Take 1 liter volume conical flask in making solution with 3.2 gm $KMnO_4$ and distilled water
(b) Take 1 liter volume conical flask in making solution with 25 gm NaOH and distilled water
(c) For mixed Indicator – 100ml ethanol+0.07 gm methyl red+0.1 gm Bromocresol green dyes
(d) Boric acid solution – 1 liter volumetric flask making solution with 20gm boric acid + 800ml warm water +20ml mixed indicator + NaOH
2. Sample prepared – Take 100ml conical flask – 5 gm compost sample + distilled water
3. In third step there are 3 basic procedures:
(a) **Digestion:** In digestion process organic compound react with H_2SO_4 and give $(NH_4)_2SO_4$

Compost sample + $H_2SO_4 \longrightarrow (NH_4)_2SO_4$

Compost + $KMnO_4$+ NaOH $\longrightarrow$ Ammonia

(b) **Distillation:** In distillation process used NaOH

$(NH_4)_2SO_4 + NaOH \longrightarrow Na_2SO_4 + NH_3$

$NH_3 + H_2O \longrightarrow$ NH4OH

$NH_4OH + H_3BO_3$(Boric acid with indicator) $\longrightarrow$ $NH_4(B(OH)_4)$ (Green colour)

$2NH_4OH + 4H_3BO_4 \longrightarrow 2(NH_4)_2B_4O_7 + 7H_2O$

(c) **Titration:** In Titration process $NH_4(B(OH)_4)$ react with 0.1 N H_2SO_4 standard solution and give Ammonium sulphate in pink colour

$NH_4(B(OH)_4) + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + H_3BO_3$(Ammonium sulphate)

$(NH_4)_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow 4H_3BO_3 + (NH_4)_2SO_4$

Calculation formula:

$$\text{Nitrogen}\,(\%) = \frac{(1.4 \times V \times N)}{W}$$

Where, V = Acid used in titration (ml)
N= normality of standard acid
W = Weight of sample (gm)

3.2.5Flame Photometer Method for Potassium
Lab Procedure:

1. First step is making solutions:
(a) Take 1 litre volume conical flask in making solution with 77.09 kg Ammonium Acetate and distilled water and also maintain pH Level=7
(b) Take 1 litre volume conical flask in making solution with 1.907 kg potassium chloride (KCL) and distilled water.
2. Second step is prepared compost- 5 gm compost sample +25ml ammonium acetate and after doing this shake 30 min and then sample is filter by filter paper
3. **Making 5 potassium standard solutions:** A volume include 5ml, 10ml, 15ml, 20ml, 25ml of the standard 100 ppm potassium solution were taken into the 100ml volumetric flask, respectively and separately.
4. After setup the machine will calibrate five standard solution and sample and distilled water can be used after calibrating each standard solution
5. 5 After calibrating the sample, machine will give the result in ppm.

Calculation formula:

$$\text{Potassium}\,(\%) = \frac{\text{Reading value in PPM}}{10000}$$

3.2.6Spectrophotometer or Colorimeter for Phosphorous
Lab Procedure:

1. First step is making solutions:
(a) Take 1 litre volume conical flask in making solution with 42 gm sodium bicarbonate and distilled water.
(b) Take 150 ml volume conical flask in making solution with 20 gm Ammonium Molybdate and distilled water.
(c) Take 50ml volume conical flask in making solution with 0.89 gm Ascorbic acid and distilled water.
(d) Take 100ml volume conical flask in making solution with 0.274 gm Antimony potassium tartrate and distilled water.
(e) Take 1 litre volume conical flask in making solution with 0.43 gm potassium disulphate and distilled water.
2. **Second step is making mixed Regent solutions:** Take 100ml volume conical flask in making mixed regent solution with 50ml sulphuric acid +15ml Ammonium molybdate + 30ml Ascorbic acid + 5ml Antimony potassium tartrate
3. **Making 5 standard solution:**A volume include 1ml, 2ml,3ml,4ml,5ml of the standard 100 ppm potassium disulphate and 16ml mixed regent solution were taken into the volumetric flask, respectively and separately
4. Preparation of compost -
(a) Compost sample – 2.5 gm compost sample +50ml Sodium bicarbonate + charcoal(a pinch) and after doing this shake 30 min and then sample is filter by filter paper
(b) Blank sample – 50ml Sodium bicarbonate + charcoal(a pinch) and after doing this shake 30 min and then sample is filter by filter paper
5. After the sample is ready, we will decolorize the sample:

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(a) 50ml volumetric conical flask - 10ml compost sample + Diphenly (Indicator) – yellow color solution
(b) Yellow color solution+ 5ml sulphuric acid – colorlesssolution ready
(c) 50ml volumetric conical flask - 10ml blank sample + Diphenly (Indicator) – yellow color solution
(d) Yellow color solution+ 5ml sulphuric acid – colorlesssolution ready
6. After colorless sample we will color the sample:
(a) 100ml conical flask - compost sample + 8ml mixed regent + distilled water = blue color
(b) 100ml conical flask - blank sample + 8ml mixed regent + distilled water = blue color
7. After setup the machine will calibrate five standard solution and sample (compost and blank sample)
8. After calibrating the sample, machine will give the absorbance value in ppm

Calculation:

$$\text{Phosphorous}\ (\%) = \frac{\text{Reading value in PPM}}{10000}$$

Fig. 7: Spectrophoto Metermachine

3.3Testing of Prepared Compost

3.3.1Domestic Organic Compost

Table 3: Strength test of Domestic organic compost after 7 days

S. No.	Content	Standard Value (%)	Achieved Value (%)
1	Moisture	10-25	12
2	Nitrogen	2.0	0.7
3	Phosphorous	0.5-1	0.8
4	Potassium	2.0	1.0

Table 4: Strength test of Domestic organic compost after 15day

S. No.	Content	Standard Value (%)	Achieved Value (%)
1	Moisture	10-25	11.75
2	Nitrogen	2.0	0.8
3	Phosphorous	0.5-1	0.8
4	Potassium	2.0	1.2

Table 5: Strength test of domestic organic compost after 30days

S. No.	Content	Standard Value (%)	Achieved Value (%)
1	Moisture	10-25	15.85
2	Nitrogen	2.0	0.8

3	Phosphorous	0.5-1	0.9
4	Potassium	2.0	1.2

Graph of Domestic Compost:

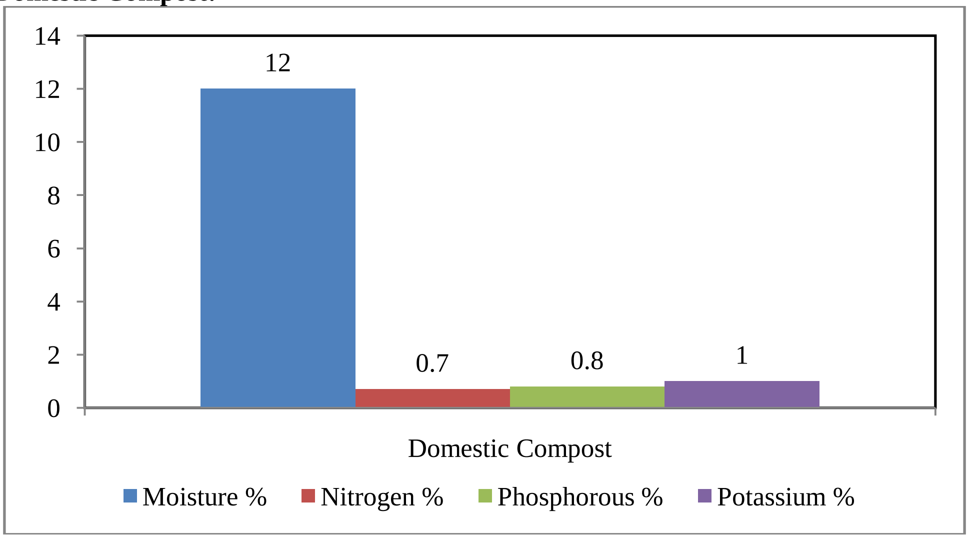

Fig. 8: Domestic Compost after 7 Days

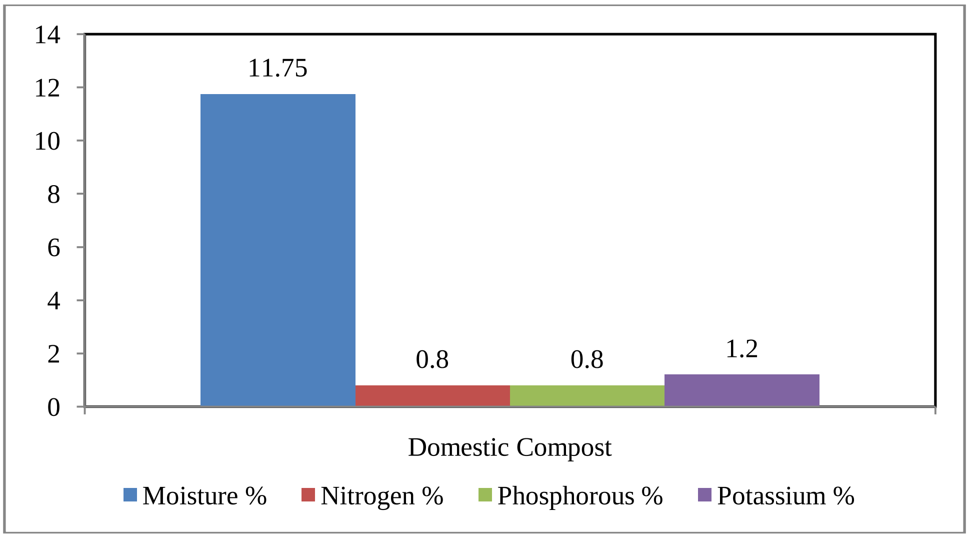

Fig. 9: Domestic Compost after 15 Days

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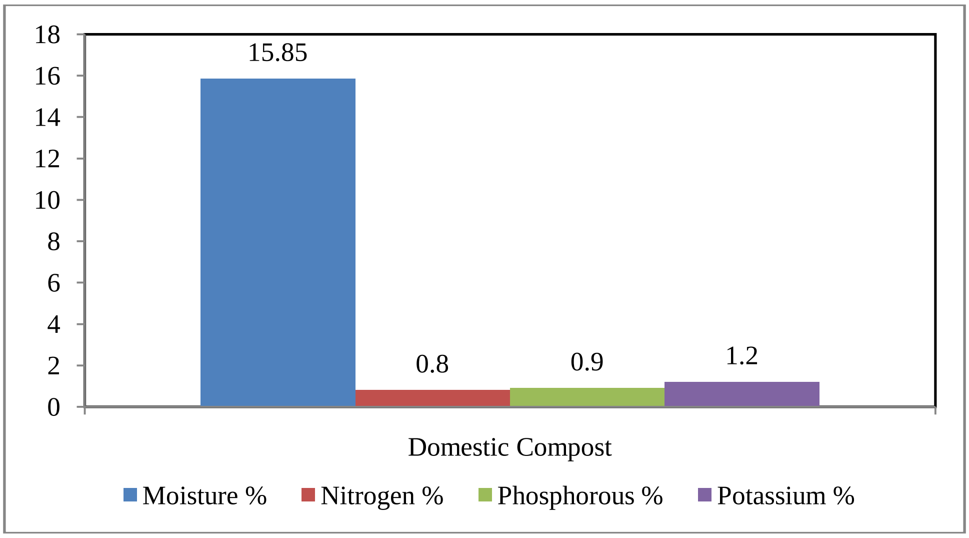

Fig. 10: Domestic Compost after 30 Days

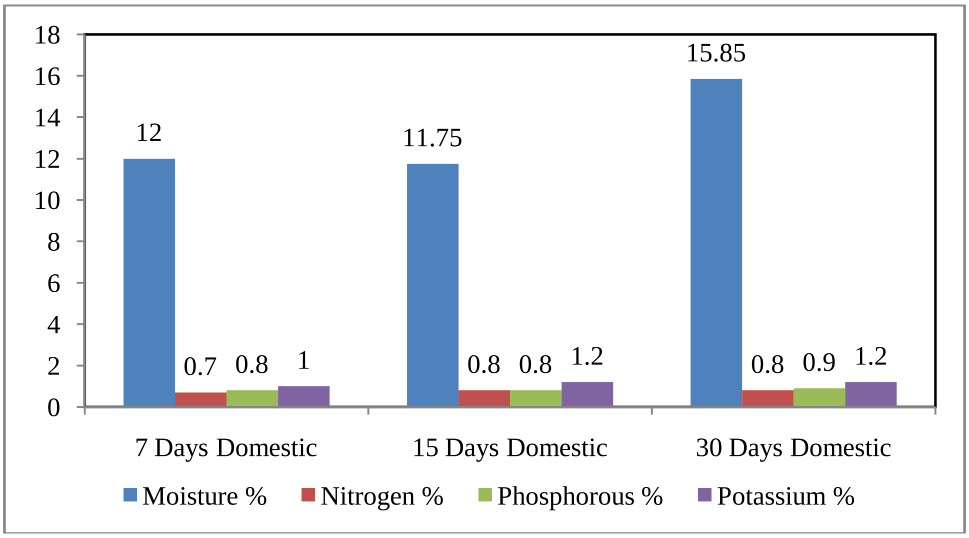

Fig. 11: Comparison Graph of Domestic in 7 Days, 15 Days and 30 Days

IV. RESULTS AND DISCUSSIONS

4.1Domestic Compost

- After the samples are preparedand tested after 7 days the Moisture content is found to be 12%, Nitrogen content is found to be 0.7%, Phosphorous content is found to be 0.8%and potassium content is found to be 1.0%.
- After the samples are preparedand tested after 15 days the Moisture content is found to be 11.75%, Nitrogen content is found to be 0.8%, Phosphorous content is found to be 0.8%and potassium content is found to be 1.2%
- After the samples are preparedand tested after 30 days the Moisture content is found to be 15.85%, Nitrogen content is found to be 0.8%, Phosphorous content is found to be 0.9%and potassium content is found to be 1.2%

4.2Comparison Result of Domestic Compost

After 7 days:

- Moisture in domestic waste compost – 12%
- Nitrogen in domestic waste compost – 0.7%
- Phosphorous in domestic waste compost – 0.7%
- Potassium in domestic waste compost – 1.0 %

After 15 Days:

- Moisture in domestic waste compost – 11.75%
- Nitrogen in domestic waste compost – 0.8%

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- Phosphorous in domestic waste compost – 0.8%
- Potassium in domestic waste compost – 1.2%

After 30 Days:

- Moisture in domestic waste compost – 15.85%
- Nitrogen in domestic waste compost – 0.8%
- Phosphorous in domestic waste compost – 0.9%
- Potassium in domestic waste compost – 1.2%

V. CONCLUSION & APPLICATION

5.1 Conclusions

- The Moisture content of Domestic compost is firstly increase in 7 days then decrease in 15 days and then increase in 30days.
- The Nitrogen content of Domestic compostincreases in 7 days, 15 days and 30days.
- ThePhosphorous content of Domestic compostincreases in 7 days, 15 days and 30days.
- The potassium content of Domestic compost increases in 7 days, 15 days and 30days.

In this papera thorough research is conducted which involves the entire parametersrequired for domestic composting, the design consideration their criteria for selection and the quantity of wastes required are all included in this paper. This paper provides the basis for the process of domestic composting and N, P, K testing Therefore the Domestic compostis suitable to make and can be easily prepared with low cost and it helpsfor recycling the wastes and increase the productivity for plants growth when used.

5.2 Application of Compost

1. Application of Compost in Agriculture: The demand on agricultural products leads to the use of intensive agricultural systems, which ultimately deteriorate soil health and bring several environmental problems .The effect of compost application onto soil highly depends on both soil and compost (feedstock) intrinsic properties, along with the compost application rate.

Fig. 12: Compost used in agriculture field

2. Application of Compost as Growing Media: Growing medium substrates have to provide adequate physical and chemical properties for plants. Additionally, plants were grown successfully in growing media containing up to 50% composted sewage sludge and demonstrated that it can provide advantages such as increased nutrient provision.

3. Compost Application as Bioremediation Agent for Contaminated Soil: As a result of various human activities, a wide variety of pollutants including, but not limited, to petroleum and related products, pesticides and chlorophenols, are continuously entering the soil, thereby posing a huge threat and risk to human health and natural ecosystems.

5.2.1Application of kitchen waste compost

- Environmental impacts of food waste compost application on soil.
- Application of effective microorganism in food waste composting.
- Application of food waste compost on soil microbial population in groundnut cultivated soil.

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