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Preparation of Organic Compost from Kitchen Waste and its Efficiency: Managing Waste at House-Hold Level

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Abstract

Composting is one of the feasible waste disposal methods used by municipal corporations. This study was aimed to assess the use of kitchen waste in home composting, which can be used in home gardens as plant fertilizer, which is more economical and non-hazardous than commercial chemical fertilizers. Solid waste like vegetable scraps, fruit peels, tissues, newspapers, dry leaves and twigs were used as raw materials for composting in a plastic bag and bucket. A plant growth study was carried out to check the efficiency of compost in plants. Plant with compost from plastic bucket shows the highest efficiency compared to other. We performed different tests to estimate the physio-chemical properties of compost and showed that the prepared compost was a dark brown color. Total C: N ratio was 10.1,13.2 and 3.1 in sample 1, sample 2 and control, respectively. The pH of the compost was alkaline after two months of composting. The results revealed that compost in plastic bag has less nutrient content. Nutrient loss can be a significant drawback of home composting.

Keywords: Composting; Plastic Bag; Plant Growth study; Physio-Chemical Properties; Nutrient Loss.

INTRODUCTION

Solid waste management in metropolitan cities is becoming a challenging task for authorities due to increasing waste generation and its cost of management. Nearly 14-30% of total waste is house-hold waste. There were chances that when one throws this garbage, it ends up in the landfills, taking up rooms and polluting the environment. Wastes are often managed improperly; e.g., wastes were dumped by the roadsides, disposed of in rivers or oceans and directly burnt. These practices draw unwanted breeding of pests and insects, releasing harmful gases and offensive odors that contribute to global warming. This garbage can is used for home composting purposes rather than dumping. Home composting is the process of using the house-hold waste to make compost at home. Materials like food scraps, vegetables or fruit peels, cardboards and tissues were organic waste generated at home which can be biologically decomposed. Home composting can be practiced within house-hold for various advantages, such as reducing the waste disposal cost, a convenient way to handle waste and a free-soil amendment.

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The waste produced doesn't have proper disposal and as of today, solid waste is usually dumped and contains many toxic substances. This problem can be substituted by composting, biodegradation and bioremediation. Biotechnological methods can be used in the advancement of solid waste management. The increased population leads to a drastic increase in waste production, affecting society (Lagerkvist and Dahlen, 2019). The importance of waste management cannot be neglected. Improper waste management and disposal affect humans and the environment. (T. Odonkor *et al.* 2019) a study assessing solid waste management among house-holds in a large Ghanaians district. They selected through random sampling, cluster and systematic sampling of 600 for the study. Results indicate that the communal waste collections bins were far from the homes and some respondents confirmed only a few garbage bins between 11-15 minutes before the refuse site. The distance between houses and the disposal site is around 1-2 hrs. (T. Odonkor *et al.* 2019). In conclusion, bins were few in the community, which leads to improper waste collection.

Sago bark waste is abundant in sago processing; this release of waste cause pollution and harms aquatic life. (Wahi, R., Bidin, E.R., Mohamed Asif, N.M. *et al.* 2019) Sago Bark waste used composting to produce compost for agricultural purposes. The physio-chemical and phytotoxicity of the prepared compost were observed to be evaluated and assessed towards aromatic lettuce via seed germination. (Wahi, R., Bidin, E.R., Mohamed Asif, N.M. *et al.* 2019). The results show the compost color was dark brown. Total C: N observed 21.63, 13.38,4.91 during the first, second and third months respectively. The pH was alkaline after three months. The GI for studies vegetables was more than 100% after five days after germination.

Tiquia, S., Richard, T. & Honeyman, M. 2000) studied the loss of nutrients in composting process in their research article. Hoop manure was composted in windrows with nitrogen mass balance during the feeding process. Treatments include with and without turning and manure spreader. It resulted in greater C, K and Na losses in the turned windrow treatment. C has a higher loss in turning windrows, whereas the nitrogen loss does not affect turning. But the composting in the windrow was faster than without turning. It was found that a low C: N ratio during initial composting affects nutrient content. P, K and Na loss were high due to run-off and leaching from the hoop manure. Nutrient loss due to volatilization, run-off and leaching during compost may significantly contribute to groundwater pollution. Composting is a sustained technology, though it has many shortcomings that have reduced its usage and efficiency, such as low nutrient, odor production, pathogen detection and lengthy process duration. Composting can be helpful in agriculture, but the only challenge is the long duration. They discuss methods of proper waste management, long-duration composting and the reason behind them. The development of odor trapping techniques, extraction of mono-fertilizers from compost, tests for heavy metals and pathogens through strips. Activators and slow degradable raw materials, when added to compost, show improvement in compost's nutrient quality. These aid in the enhancement of composting quality. (Ayilara *et al.* 2020)

MATERIALS AND METHODS

Solid waste like vegetable scarps, fruit pulp and peels, coffee or tea bags, twigs and fresh and dry leaves were collected for raw material in composting.Two different containers were selected; plastic bag and bucket that were available at every house-hold as a garbage bins. It is cheap, requires no tools and is reusable. Photographs of containers are depicted in fig. 1.

a) b)

Fig. 1: container - a) plastic bag b) plastic bucket

Preparation of compost

Step 1: Setting the container plastic bag and bin were selected with desirable size and holding capacity. These two containers were located in a dry and shady spot. Step 2: Material gathering; the next step in home composting was to gather the waste for the compost layers. These were tea bags, shredded papers, tissues, vegetables and fruit scraps. To maintain a proper C:N ratio, collecting 2 parts of brown matter to one part of green compost matter is advisable. Shredding and cutting the materials before adding them to containers aid in faster decomposition. Step 3: Materials were added to the bin. Starting with a layer of dry leaves, some water was added to moisten and then some fresh leaves and top soils were added. Cover the containers (plastic bag and bin) with plastic bag. There were no holes in the bin; thus, holes were created in them to cover for aeration and drainage. Step 4: maintenance since we were following aerobic composting, it requires a large container and essential turning of the pile in intervals.

The efficiency of compost through plant growth

We conducted three separate plant growth studies to compare how the prepared composts from different containers affect plant growth when used as fertilizer for the soil.

Fig. 2: labeled pots

Malabar spinach or Basella alba, commonly known as poi plants seeds, were sown in pots. It is an edible fast-growing vine that tastes somewhat like spinach. In summer, these plants grow well, while in colder climates, growth slowdown and burgundy buds appear. Three separate pots were labeled, such as pot 1, 2, 3 having different prepared compost. In pot 1, we added 75% compost (prepared in the bag) and 25% garden soil; in pot 2, we added 75% compost (prepared in the bucket) and 25% garden soil; last, pot 3 was kept as control which had only garden soil. Seeds were sown 0.25 inches deep; usually, seeds take 10-12 days to germinate. For better growth, it needs a pH between 5.5 to 8.0. they were watering the plant regularly to keep the soil moist. Data were analyzed statistically. Plant height, internodal length and leaf counts were plant growth parameters that weremeasured after germination from different pots-keeping all the pots in the same setting to minimize any variation in temperature, lighting, pests and other environmental factors. The stages of plant growth, from germination to elongation, have been shown in fig. 3.

Fig. 3: Stages of plant growth

Physio-chemical test on prepared compost

Fig. 4: Packaged samples

*-Tests performed on the sample followed standard methods given in Schedule – IV [see clause 2(h) and (q)] Part – A and B FCO-1985

The collected samples performed physiological parameters including odor, nutrient content, bulk density, electrical conductivity, C:N ratio, pH and pathogenicity tests*.

RESULTS

Compost process

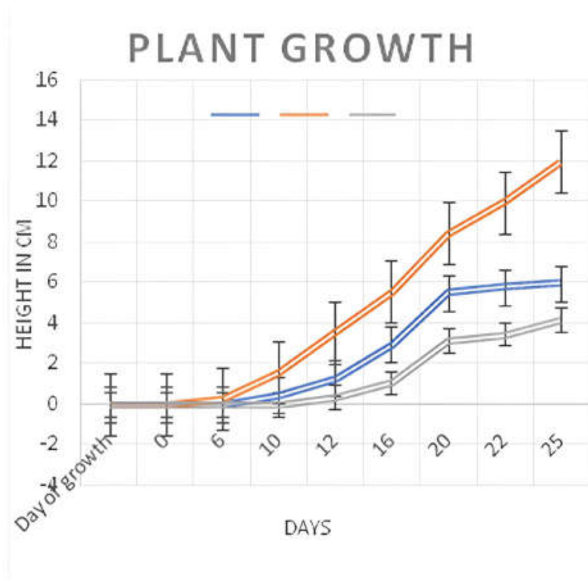
In 1st week, Scraps started to produce a foul smell Release some amount of water; In 3rd week, some bugs and mites were observed and pH* was found to be slightly acidic to neutral. 5th weeks Pile was settled down from its original height. Moisture content was high. 7th week, Maggots and worms were observed and pH* was found to be too neutral. 10th week's compost is a little dusty No ammonic smell present, but just a rotten unpleasant odor.12th week compost had a texture like dark soil with no foul odor and small organic pieces observed.

Fig. 5: Weekly observation in compost

*Litmus paper was used for pH determining during weekly records at home. The pH decreased from 6.7 in the first month to 8.3 in the mid-third month of composting. A normal pH measurement for compost is between 6.5-8 because of the low acidification; the microbes will be active as it related to an anaerobic condition inside the compost

Plant growth study

The graph shows how plant height changes with time. (In orange) the straight-line graph obtains for the plant in pot 2, whereas plants in pot 1 and 3 (blue and grey) show straight lines, but it becomes uniform after time. Not any significant difference in height.



Graph 1: Plant rate in the height of Malabar spinach plant

Pot 1 - compost from bag

Pot 2 - compost from bucket

Pot 3 - soil as control

Pot 2, seed germinatefaster than the other two pots.

The growth rate of the plant in pot 2 was best as compared to other plants in pot 3; the leaves were paler and yellowish

Statistical methods studied other parameters such as leaf count, internodal length and plant height. In table 1, Ho: internodal length does not affect plant height. HA: internodal length affects plant height. Table a, b and c shows p-value between 0.01< p> 0.001. Interference that there is solid evidence against the null hypothesis. The statistically significant value of p< 0.05 Elongation of internodes involves many cell divisions followed by cell elongation. At this point, growth in thickness involves some radial cell division and cell enlargement.

Table 1: Plant growth parameters in the different pots containing compost

Pot - 1		
Day of growth	**Height of plant (cm)**	**Internodal length (cm)**
0	0	0
6	0	0
10	0.5	0
12	1.3	0
16	3	0.2
20	5.5	0.2
22	5.8	0.3
25	6	0.8
27	6.7	0.9
31	7.5	1.5
Mean	**3.36**	**0.39**
test p-value	**0.0032**	

(A)

Pot - 2		
Day of growth	**Height of plant (cm)**	**Internodal length (cm)**
0	0	0
6	0.3	0
10	1.6	0
12	3.6	0.4
16	5.6	0.5
20	8.5	0.9
22	10	1.5
25	12	1.7
27	12.4	2.5
31	13	2.6
Mean	6.7	1.01
Test p-value	**0.0019**	

Table Cont...

(B)

Pot 3		
Day of growth	**Height of plant (cm)**	**Internodal (cm)**
0	0	0
6	0	0
10	0	0
12	0.4	0
16	1.1	0
20	3.2	0.6
22	3.5	0.9
25	4.2	0.9
27	5	1.4
31	5.8	1.6
Mean	2.32	0.54
Test p-value	**0.0078**	

(C)

Results show that compost in pot 2 significantly affects the growth of Basella-producing plants with better height, some leaves, internodes and stems. Thus, compost prepared in the bucket has the highest efficiency.

Physio-chemical analysis

Table 2: Physio-chemical parameters of prepared compost

Tests (Quality characteristics)	S1 (Compost from plastic bag)	S2 (Compost from plastic bucket)	S3 (Soil)	Range
odour	Absence of foul odour	Absence of foul odour	Absence of foul odour	Absence of foul odour
colour	Dark brown to black	Dark brown to black	Dark brown to black	Dark brown to black
Particle size (passes through 4mm sieve)%	92.32	90.12	99.25	Above 90%
Moisture %	24.5	26	18.92	25-40
Bulk density g/cm3	1.09	1.08	1.02	Less than 2.0
Conductivity dsm-1 in 20% sol	1.09	2.04	3.8	Not more than 4.0
pH in 10% sol	8.3	8.7	7.3	5.5-8.5
C:N ratio	10:1	13:1	3:1	5-25:1
Total organic carbon%	2.48	4.76	1.61	12.0
Total nitrogen as N %	0.3	0.4	0.5	0.4-1.5%
Total phosphate as P2O5 %	0.3	0.2	0.3	0.3-0.9%
Total potash as K2O %	0.5	0.2	0.3	0.3-1.9%

The moisture content of all samples was below than range. Excess turning and heat can make the moisture vapourised and make the compost dry and hard. Total organic carbon content was below the range. Sample 2 has less phosphate and potash percentage than other samples. Sample 1 had less nitrogen content. Results show that control had the highest nutrient content followed by sample 1 and lastly by sample 2.

DISCUSSION

Moisture content may be low due to excessive turning, which results in drying out. Below range may limit the activity of microbes and if the high result in anaerobic process and foul smelling. Anaerobic process will produce methane gas and hydrogen sulphide, which were greenhouse gases; thus, they should monitor well. Moisture can be maintained by if compost is too soggy- adding some dry leaves or paper waste and if it is too dry- sprinkle some water and turn it well. Tequila *et al.* found that moisture was less in hoop manure due to moisture soak-up in bedding and N- losses in the deep bedded hoop were the leading cause of gas emission. (Thelosen *et al.,* 1993; Groen estein and Van Faassen, 1996). Dewes (1996) reported that N loss starts immediately after the animal waste was excreted. As the compost was stored in unsealed, there is potential for leaching and volatilization losses. Nutrient loss may be happened due to leaching or drying out since potassium and phosphorus were minimal and vulnerable to volatilization. Nitrogen is especially susceptible to volatilization when ammonium is transformed to ammonia. Some of the N loss can be attributed to microbial denitrification of NO, N2O and N2. (Thelosen *et al.,* 1993). Consistent and extensive application of organic compost may lead to the accumulation of heavy metals and toxicity. Heavy metals can reduce soil microorganisms' growth, morphology and metabolism, consequently affecting soil fertility (Bragato *et al.,* 1998). Chiroma *et al.,* 2014) suggested that regular consuming of heavy metals by plants can affect environment and human due to accumulation through food chain. They suggested that lime, bamboo charcoal and natural zeolite tended to reduce availability and leachability of heavy metals. (Singh & Kalamdhad, 2013) advised that before adding composted manure in agricultural fields; metals should be assessed. Odour is one of the problems in composting, so some odour trapping device can be built in the container.

DNA sequencing techniques enable a proper understanding of microbial behaviour and enzyme functioning in composting. Major function of these enzymes included in waste production, greenhouse gas production and odour production. The addition of bulking agents can prevent nitrogen loss in the manure composting. Peat moss, rice hull was some of bulking agents have been used in past as they have high water and cation absorption capability. (Barrington and Moreno 1995).

CONCLUSION

Home composting may be an effective disposal method, but nutrient loss is a significant drawback of home composting as most of the nutrients, especially N, is lost during the composting period. Among the two composts, compost prepared in a plastic bin shows the highest efficiency in physio-chemical properties and this compost has a significant positive effect on the growth of Basella Alba. It concluded that home composting can help to ensure environmental sustainability since it lowers the waste disposal cost and gives a soil amendment that can be used in home garden, therefore saving the cost of external fertilizers for plants. This compost will increase the land's health, productivity and beauty.

Home composting can be a solution to every community's solid waste management. Our long-term goals include a study on microbial activities in compost, limitations of composing and its solution. Future plans include a society composting plan in which organic waste from every house-hold can be converted into compost that can be reused in home gardens and excess can be sold in the market. Here each house can get 1 rupee per day giving organic waste, but this plan more innovative construction as well as waste management tools and microorganisms.

Conflict of interest

There are no conflicts to declare

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