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Title of the Article: influence of Organic Waste on Nutrient Composition of Compost and the Impact of Sawdust on Composting Process.

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Abstract

To improve soil health and fertility use of compost is a better idea than chemical fertilizers. Compost is a product of the degradation of waste organic matter. The choice of organic waste to get a good quality of compost is needed for the proper recycling of organic waste. So, the present study was to identify the effect of the type of organic waste on the physical properties and nutrient content of compost. The experiment was conducted with four types of organic waste (Fruit waste, vegetable waste, cooked leftovers, and farm waste). The analysis shows that type of organic waste in composting influences the nutrient content of compost but the physical properties of compost are not much affected by the type of organic waste. It was observed that waste from cooked leftover food contains more nutrient content than other waste. So this waste is more suitable for composting. During the study effect of sawdust as a bulking agent was also observed. Sawdust significantly affects the composting process as it accelerates composting and also affects the quality of compost.

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Introduction

With the increase in population and urbanization, there is also an increase in the production of organic waste across the globe. This is an alarming issue for the environment because the generated waste could be responsible for different kinds of environmental pollution. In India, about 40% of food produced is wasted per year because of improper management of the food chain. This loss of food takes place even before the food reaches the consumer.[1] Every person in an Indian home throws 50 kg of food per year according to the Food Waste Index report 2021.[2] These organic wastes are rich in nutrients like carbon, nitrogen, phosphorus, and potassium. The disposal of this waste would waste resources and also harm the environment.[3] Composting has

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been traditionally used to degrade organic waste into a stable product that could be used as organic fertilizer. It recycles organic waste.[4] The application of this organic fertilizer on land improves soil health and provides nutrients to plants 5. However, the emission of greenhouse gases and the use of immature products are the drawbacks of using composting in agriculture.[6] The use of immature compost on farmland leads to a negative impact on the plant due to the competition for oxygen between the plant root and the compost.[6] The process of composting depends on many factors which also affect the quality of the final compost. The C/N ratio is one of the important factors. A high C/N ratio restricts the activity of composting microbes so the whole process slows down while a too-low C/N ratio causes the loss of nitrogen in form of ammonium. In the same manner, PH affects the process. A low PH makes the pile acidic and a high makes it basic but effective composting needs a neutral range of PH. The temperature in composting shows the activity of microbes which increase in the thermophilic stage of composting and gradually decrease during the maturation stage.

Adding mineral additives to composting is attracting attention due to the improvement in the process and the quality of the end product.[7] Using additives focus to reduce the emission of harmful gases like CH_4, NH_3, N_2O, CO_2, etc., and also reducing the period required in composting.[8] Different kinds of additives were being used for composting which showed positive responses to the process.

Due to the continued cropping over the years the nutrient content and organic matter content of soil reduces.[9] Compost is applied to the soil to improve these nutrient contents (NPK) and organic matter.[10] In day-to-day life, lots of waste is generated in households and agriculture that can be used to prepare compost. This compost is effective in improving soil fertility and crop productivity. But little knowledge is available about the nutrient content of compost when the source of organic waste is varied. So, the presented study is to focus on the impact of the type of organic waste which is used as raw material in composting on the nutrient content of compost. As well as it was also noticed that sawdust is useful in composting as a bulking agent.

Materials and Methods

Experiment location

The current experimental study was conducted at the campus of Bhartiya Skill Development University From January 2021 to April 2021. The lowest temperature (15^0C) and highest 33^0C were observed at the experimental site.

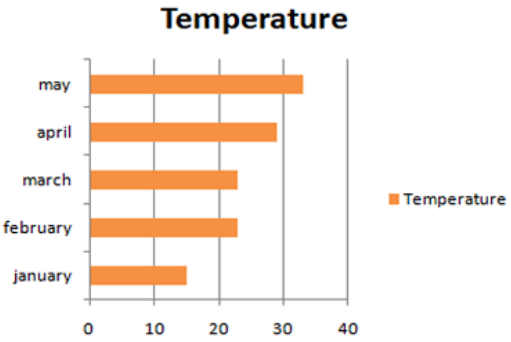

Fig. 1: Temperature pattern at the experimental location during study

Preparation of Composting Piles and Experimental Setup

Four different types of waste were used for the composting process. The type of waste is differentiated based on its generation source. Fruits waste, vegetable waste, farm waste, and cooked leftover food were separately used for the windrow type of composting. All four types of waste were put into windrow piles separately. In each pile, a thick layer of fertile soil was made for the availability of active microorganisms which initiate the degradation of organic matter.[11] In each pile, 30 kg of organic waste was put in layer form. Dry leaves were also used in each pile to maintain the C/N ratio. C/N ratio plays a major role in composting process which should be maintained at about 30:1 on average for active composting.[12] To enhance the process and to get good quality compost, bulking agents are helpful. Different types of bulking agents are already used by different researchers which showed the positive effect of bulking agents on composting.[13] In our study, we used sawdust as the bulking agent which was put in all composting piles in very fewer amounts.

Fig. 2: Showing Composting Piles of all four types of waste

Characteristics of Raw Material used for Composting

Table 1: Physical characteristics of raw material

Type of waste	PH	Organic matter (%)	C/N ratio
a) Fruits waste	7.2	79	38:1
b) Vegetable waste	7.6	84	35:1
c) Farm waste	6.6	90	27:1
d) Cooked leftover waste	7.5	88	40:1

Table 2: Chemical characteristics of raw material

Type of waste	Total Nitrogen (g/kg)	Phosphorus (g/kg)	Potassium (g/kg)
a) Fruits waste	18.5	.04	.92
b) Vegetable waste	23.9	1.12	1.36
c) Farm waste	26.8	.36	.42
d) Cooked leftover waste	9.6	.11	.76

Piles Monitoring and Observation of Composting

Many physical factors affect the rate of the composting process. So to obtain compost with less time duration and of high quality, these factors should be monitored. In the current study these factors were monitored as discussed below.

Moisture

While monitoring the composting process it is necessary to provide the proper moisture that is needed by the composting microbes. For active composting, the moisture content should be maintained at 40-60%.[14] In our study, we maintained it by pouring water regularly. In starting phase we need to pour water on each alternate day because of the activity of the thermophilic microbes but after 2 months it was required to pour water once a week which indicated the mesophilic phase of composting.

Aeration

Windrow type of composting is an aerobic process that takes place in the presence of oxygen. So oxygen is one of the major requirements in windrow composting. All the degradation of organic matter is done by aerobic microbes. Monitoring of proper aeration of composting piles is necessary for accelerating composting process.[15] For the current research, we manually turned each composting pile with the help of a hoe so that oxygen is available to each part of the organic matter.

Temperature

Temperature is also an influencing factor in composting process. It is necessary to monitor the temperature so that the composting microbes might not get destroyed because of the high ranges of

temperature.[16] To maintain the temperature it was checked regularly and balanced by pouring water as well as turning composting piles with a hoe. In the presented study the temperature range of each pile was maintained at 25^0-50^0 C.

C/N Ratio

The ratio of carbon and nitrogen in composting is very important for the working of microorganisms. Carbon is essential as a source of energy for microorganisms and nitrogen is needed for the synthesis of protein. Previous researches suggest that carbon is consumed 15-30% more than nitrogen in composting process.[12] In the current study to maintain the C/N ratio, dry leaves were used.

Sampling of Compost

For the laboratory analysis of all compost prepared in the current study, three samples were taken from each compost pile in sealed bags and marked according to their labels. These samples were analyzed in a lab for their physical and chemical properties.

Quality Analysis of Compost

In agriculture, compost is useful for soil and plant growth because it contains the essential nutrients that plants required to uptake from the soil.[17] The quality of compost is directly linked to the nutrients that it contains. Mainly the macronutrients that compost contains are Nitrogen, Phosphorus, and Potassium. Plants need to absorb these nutrients from the soil for their growth.[18] For the quality assessment of all four types of compost, we analyzed the following characteristics of compost.

P^H Evaluation

For evaluation of P^H suspension of 25g compost made in 50ml distilled water for each compost sample. Shake it for 2 hours on a rotary shaker. Using the Buchner funnel filter it in a vacuum. P^H was calculated by P^H meter from the filtrate.

Organic Matter Evaluation

10gm of each compost sample was put in a crucible, oven for 6 hours at 105^0 C. took in the muffle furnace to burn at 650-700^0 C for 7 hours. After this kept the sample to cool down at room temperature in the desiccator for 12 hours. For the calculation of organic matter, the formula is.

$$\text{Organic matter \%} = \frac{initial\ weight - final\ weight}{weight\ of\ sample\ taken} \times 100$$

$$\text{Total Carbon \%} = \frac{total\ organic\ matter}{1.724}$$

C/N Ratio Evaluation

The ratio of carbon and nitrogen was calculated by dividing the total carbon value by the total nitrogen value.

Total Nitrogen Evaluation

Nitrogen in compost is present in the form of both organic and inorganic. The calculation of total nitrogen in the current study was done by the Kjeldahl method.

Phosphorus Evaluation

10gm of the oven-dried sample of each compost was taken individually in a crucible and heated at about 650 – 7000 C for 7 hours. Cool it and kept in the desiccator. Put the content in 30ml of 25% HCl. Heated it for 10-15 min. After 4 hours filtered it and washed with distilled water to remove the acid. Put 250 ml of the filtrate in a volumetric flask. From this filtrate, phosphorus was calculated by the gravimetric quinoline molybdate method.

Potassium Evaluation

It was evaluated by drying the sample compost at 650 – 7000 C and dissolved in concentrated HCl.

Use of Sawdust as a Bulking Agent

To improve the process of composting and the quality of compost, bulking agents are effective.[19, 20] In the current study, sawdust was used in each composting pile as a bulking agent. 1kg of sawdust was used per 30 kg of organic waste. It was observed that because of the presence of sawdust the process gets quick acceleration for composting. To observe the effect of sawdust on each type of waste two composting piles were prepared for each type of organic waste. One pile with sawdust and another without sawdust. As temperature and PH are the major factors that influence composting, these factors were monitored to identify the effect of sawdust in composting.

Statistical Analysis

The result obtained practically were compiled for statistical analysis. Statistical analysis of results is done to ensure whether the changes in results with the type of waste are truly due to the different types of waste or occur by natural variation. One-way ANOVA was used for the analysis of variance. The hypothesis proposed for the current study was if the different types of waste used in composting affect its nutrient composition and the physical parameters of compost. The analysis was done on a 5% probability. For this, the independent variable is the different types of waste used for composting and the dependent variables are the properties of compost.

Results and Discussion

All four types of waste used for research produced compost successfully. The Time taken by each type of waste varies from others to some extent. Waste from fruits converts into compost taking 12 weeks which is the minimum for all four types of compost. Fruits waste contains more amount of sugar in its composition which is more easily degradable in presence of microbes as compared to other waste.[21] Waste from the farm took 13 weeks to produce compost. Farm waste required maximum time to convert into compost. This is also supported by the literature that farm waste contains lignin and cellulose that restrict the degradation process of microbes.[22]

Physical Properties

Based on experimental tests it was seen that fruit waste and vegetable waste were showing the same C/N ratio (11:1). Waste from cooked leftover food contains max. C/N ratio of 13:1. Cooked leftovers also showed more organic matter content (8.18%) than the other waste. PH for compost from fruits waste was max. that is 8.41 (slightly basic) otherwise all the compost were neutral.

Table 3: Physical properties of all composts

Piles	PH	C: N ratio	Organic matter
Fruits waste	8.41	11:1	6.18%
Vegetable waste	8.17	11:1	6.56%
Farm waste	7.2	12:1	5.98%
Cooked leftover waste	7.93	13:1	8.18%

Chemical Properties

Analysis of all four compost on basis of their macronutrients that are nitrogen, phosphorus, and potassium was done to identify which type of waste material gives compost containing more macronutrients. Analysis tests were done according to the Fertilizer Control Order-1985, India. Comparing the result of the analysis with the standard values of Fertilizer Control Order-1985 shows that the waste from cooked leftover food produces compost that has more macronutrients than the others waste used for the study. That means compost from cooked leftover food is more useful for the plants' growth in sense of macronutrients.

Table 4: N, P, and K values of all compost

Piles	Nitrogen	P_2O_5	K_2O
Fruits waste	.32%	.14	.26%
Vegetable waste	.34%	.18%	.32%
Farm waste	.28%	.12%	.24%
Cooked leftover waste	.42%	.19%	.36%

Compost Stability and Maturity

For the application of compost on soil or agriculture, it is necessary to analyze the stability and maturity of the compost produced. There are several parameters to identify the stability and maturity of compost. Some of the parameters are temperature,

color, odor, and moisture of the compost.[23] At the end of 4 months, we get mature compost from each windrow pile. For their stability and maturity analysis temperature was checked which does not show fluctuation anymore, so it indicates the stability of compost. The color of all composts was light brown to dark brown and all of them were an earthy smell. These are also signs of stable and mature compost. The moisture was also up to the range of maturity and stability.[24]

Fig. 3: Showing compost obtained

Statistical Result

In the current study one-way ANOVA test is used to check the significant effect of the type of organic waste in composting on the physical and chemical properties of compost. Based on a one-way ANOVA test the analysis of variance suggests the rejection of the null hypothesis. There is a significant relationship between the type of organic waste and the nutrient composition of the compost. But in the case of physical parameters, it indicated that the null hypothesis cannot be rejected. The physical parameters are not significantly affected by the type of organic waste.

Table 5: ANOVA results for Physical Properties

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	161.3734	3	53.79114	73.20866	5.54E-08	3.490295
Within Groups	8.817176	12	0.734765			
Total	170.1906	15				

Table 6: ANOVA results for Chemical Properties

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	18.7104	3	6.236801	14.96831572	0.000233	3.490295
Within Groups	5.000002	12	0.416667			
Total	23.71041	15				

Effect of Sawdust

P^H Assessment

With the start of composting PH of all the piles starts increasing. It was seen that the composting piles that contained sawdust shows less increment in PH as compared to the piles without sawdust. It was the fruit waste that shows max. P^H during composting with a rose of 9.1 without sawdust and the least was shown by farm waste with a rose of 8.9 without sawdust during composting. Fruits waste with sawdust during composting showed an increase in P^H of 8.4 and farm waste with sawdust showed an

8.2 rise in P^H. After 3 weeks PH of all piles gradually start decreasing and stabilized in the range of 7.2 – 8.41 in the final compost. In the current study, sawdust had an effective influence in lowering the PH during the composting process.

Temperature Assessment

Temperature is one of the important factors in composting which differentiates the 3 stages of composting.[25] During composting temperature rises due to the thermophilic stage up to 50^0 C. The piles with sawdust show an early increase in temperature than the piles without sawdust and piles without sawdust also show fluctuation in temperature. After the completion of 5 weeks temperature of piles starts decreasing due to the maturation stage of composting. Composting piles with sawdust shows early maturation and stabilization of temperature as compared to piles without sawdust.

Table 7: Duration of composting

Types of waste	Time without Sawdust	Time with Sawdust
a) Fruits waste	12 weeks	10 weeks
b) Vegetable waste	12.3 weeks	10 weeks
c) Farm waste	13 weeks	10.3 weeks
d) Cooked leftover waste	12.5 weeks	11 weeks

The use of sawdust as a bulking agent also improves the quality of the final product, compost. This is also supported by Oluchukwu *et. al*.[26] Temperature is a parameter that is closely related to the quality of compost as an optimal temperature is necessary for the removal of pathogens from compost and to improve the activity of compost microbes.[15] However, P^H is also related to the quality of compost because good-quality compost shows neutral P^H. neutrality in P^H is also necessary for composting microbes.[27] In this way, both temperature and P^H are related to the quality of compost and are affected by the use of sawdust in composting.

Conclusion

From the current study, this can be concluded that all the composts from different organic waste were prepared successfully. Different parameters which affect composting were monitored. Physical and chemical analysis of 4 compost was done by following Fertilizer Control Order- India. Results show that compost from cooked leftover food contains more macronutrients (NPK) than other types of waste. Statistical analysis by one-way ANOVA suggested that the nutrient quality of compost is significantly affected by the type of organic waste used in composting but the physical properties of compost do not show significant relation with the type of organic waste used for composting. The same findings were also noted by Jahan *et.al*.[28] The current study also reported the positive impact of sawdust as a bulking agent in composting. It reduces the period of composting as well as improves the quality of the final compost. Sawdust dust had an effective influence on the PH and temperature of composting. Sawdust reduces the increase in P^H as well as restricts the fluctuation of temperature. In the present study, It causes early decomposition of raw material and maturation of compost. Analysis of all compost suggests that cooked left over food waste as a raw material in composting gives better results than other waste from the point of view of nutrient (NPK) quality.

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Conflict of Interest

The author(s) declares no conflict of interest.

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