"REUSE OF FOOD WASTE BY DECOMPOSING BY ROTATING DRUM METHOD"

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Abstract–*The main purpose of this research work is to reuse of food waste by decomposing by rotating drum method. By adopting this method, we can reuse of waste food as manure to our gardening by investing less money for one time. According to the United Nations Development Program up to 40% of the food produced in India is wasted. About 21 million tons of wheat are wasted in India and 50% of all food across the world meets the same fate and never reaches the needy.*

Optimum moisture, temperature, with optimum input feedstock ratio of organic waste and continuous supply of air maintained in the rotary drum, accelerates the composting process, the key requirements for rapid aerobic composting. Three combinations of trials were carried out to identify the best recipe in composting, using cooked wastes, uncooked wastes separately and with the mixed combination of cooked and uncooked wastes. Out of these three combinations of trials, the maximum C/N reduction was found out in the combination of cooked and uncooked wastes along with bulking agent rice husk and cow dung.

Keywords: *Organic Waste; Food Waste; Bulking Agent; Compost; C/N Ratio;*

INTRODUCTION:

Greenhouse gas emissions and the loss of soil fertility worldwide are two important environmental issues that we are facing today as part of global climate change. As the human population continues to rise and harmful environmental practices persist, it affects the public health and also affect environment. In many developing and developed country, there are municipality having authority to collect, transport and disposal of domestic waste from cities area, but food waste is not collect properly in small towns and urban areas of large cities.

Landfills are a major source of the potent greenhouse gas, methane. The food waste we sent to landfills is the reason that landfills emit methane and carbon dioxide. Through poor soil management, soils are increasingly becoming degraded and unable to support plant life and the synthetic fertilizers used to enhance soils contribute to environmental issues. One solution among many to mitigate greenhouse gas emissions and improve soil fertility is diverting food waste from landfills and turning it into compost that we can apply to soils.

By taking such problems in mind, we provide an advance technique to solve the problems by composting the food waste by rotating drum method. The rotary drum provides agitation, aeration and mixing of waste which is for composting. (i.e. food waste, vegetable waste, dry leaves, paper waste, etc.) and giving a proper atmosphere for acceleration of composting process.

This provides the path to go for decentralization and onsite treatment of organic wastes and derive environmental benefits, like reduction in pollution of water, land, air and also the economic benefits that go to farmers with the end product. These, if propagated well, the understanding of nature together with the mandatory enforcement laws of compulsory recycling of organics, the costs of recycling can be brought down with the reduction in volume of waste.

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Sushant Gajbhiye (2019) conducted a study on 'Speed Characteristics of Starting Vehicles 'for determining the relation between speed and acceleration of vehicles. A series of tests was conducted on six and eight-cylinder passenger cars. Data was collected for three years (1935 to 1937), especially for speeds above 48.3 km/h (30 mph), equipped with three-speed manual transmissions.

Agarwal et.al., (2005): worked on municipal solid waste recycling and associated markets in Delhi, India. He found, through a number of field interviews undertaken on recyclists, recyclables dealers and municipal authorities, a complete hierarchy from recyclists to the final sellers of the recycled product was identified and delineated and the profits at each level determined. The value addition to each product at every level of the waste trade was also determined.

METHODOLOGY :

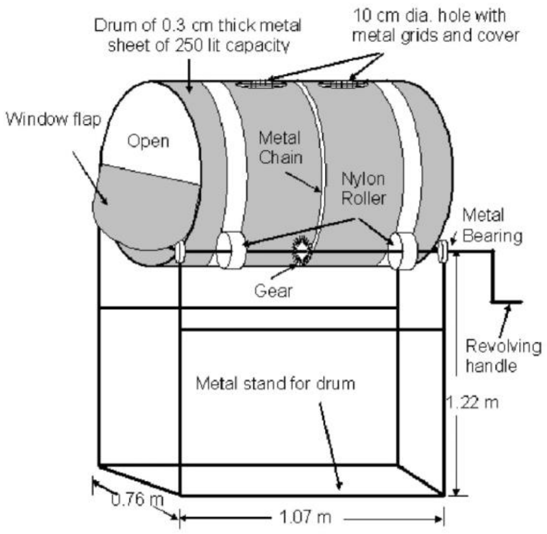
Cattle manure, mixed green vegetable waste (uncooked), food waste (cooked), grass cuttings, paper waste and sawdust were collected from the Guru Nanak Institute Of Technology campus. The collected waste mixture was shredded manually to achieve 1 cm particle size for better aeration and moisture control. The compost was prepared to create three different types of organic waste mixtures with the proportions detailed in Table 1.

Table No 1: Waste compositions:

Feedstock material	Mixture A	Mixture B	Mixture C
Cattle manure (kg)	0	20	15
Grass cuttings (kg)	20	5	0
Food waste (cooked) (kg)	15	05	20
Vegetable waste (uncooked) (kg)	15	10	10
Paper waste (kg)	0	5	0
Sawdust (kg)	0	5	5
Total weight of mixture (kg)	50	50	50
Initial C/N ratio	14.25	21.57	25.78
Initial moisture percent	60.48	63.35	66.38
Initial pH	6.36	7.48	6.28
Initial electrical conductivity (dS m−1)	3.41	3.45	4.11
Initial total organic carbon (%)	33.12	38.2	45.35
Initial total nitrogen (%)	1.36	2.34	2.21

Rotary drum composter design : In order to study the composting process, a rotary drum composter of 250 L capacity was used (Figure 1). The main unit of the composter, namely the drum was 0.92 m in length and 0.9 m in diameter, made up of a 4 mm thick metal sheet. The inner side of the drum was covered by an anti-corrosive coating. The drum was mounted on four rubber rollers attached to a metal stand and the drum was rotated manually. In order to provide the appropriate mixture of waste, 40 mm angles were welded longitudinally inside the drum. In addition to that, two adjacent holes were made on the bottom of the drum to drain off excess water. The shredded mixed organic waste was loaded into the drum by means of a plastic container and filled up to 70% of the total volume. Aerobic conditions were maintained by opening up both half side doors of the drum after four rotations had been provided manually on a daily basis, which ensured proper mixing and aeration.

Feedstock material: A mixture of cattle manure, green vegetables from small towns and peri-urban areas of large cities of India and sawdust was selected as the mixed organic waste to be used. Prior to composting, the maximum particle size in the mixed waste was restricted to 1 cm in order to provide better aeration and moisture control. An initial C/N ratio of 22 and moisture content of around 61% was brought about by mixing cattle manure, mixed green vegetables and sawdust in a 2.5 : 2 : 1 ratio, on wet mass basis



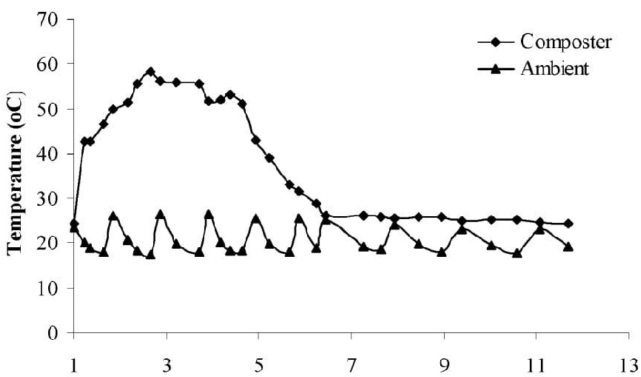
Measuring techniques : Grab samples, each about 100 g, were collected from six different locations, mostly at the mid-span and ends of the composter using a compost sampler without disturbing the adjacent materials. Finally all the grab samples were mixed together and considered to be a homogenized sample. Triplicate homogenized samples were collected and stored for a maximum of 2 days at 4°C for analysis of moisture contents (105°C for 24 h), bacterial population (1 : 10 w/v waste : water extract) including total coliforms, fecal streptococci and fecal coliforms by inoculation of culture tube media using the most probable number (MPN) method. The biodegradable organic matter was measured as biochemical oxygen demand (BOD; by the dilution method, APHA Standard Methods), Chemical oxygen demand (COD) (by the dichromate method, APHA Standard Methods).

Temperature was monitored using a digital thermometer throughout the composting period. Sub-samples were air dried immediately, ground to pass through a 0.2 mm sieve and stored for further analysis. Each sub-sample was analyzed for the following parameters: pH and electrical conductivity (EC) (1 : 10 w/v waste : water extract), total Kjeldahl nitrogen (TKN) using the Kjeldahl method, NH4+-N and NO3−-N using KCl extraction (Tiquia & Tam 2000), total organic carbon (TOC) determined by Shimadzu (TOC-VCSN) Solid Sample Module (SSM-5000A), total phosphorus (acid digest) using the stannous chloride method (APHA 1995), potassium and sodium and calcium (acid digest) using flame photometry trace elements including Cr, Ni, Fe, Cd, Pb, Zn and Cu (acid digest) were analyzed using atomic absorption spectroscopy (USEPA 1996). The loss of organic matter (expressed as a percentage) was from the initial (A1) and final (A2) ash contents according to the equation: {(A2 − A1)/[(1 − A1)× A2]}× 100. The presence of volatile fatty acids (VFAs) (water soluble) including acetic acid, formic acid, butyric acid, propionic acid was determined using a Hewlett-Packard (HP) liquid chromatograph and a UV detector column (Nova Pac 39 mm O.D.× 150 mm length).

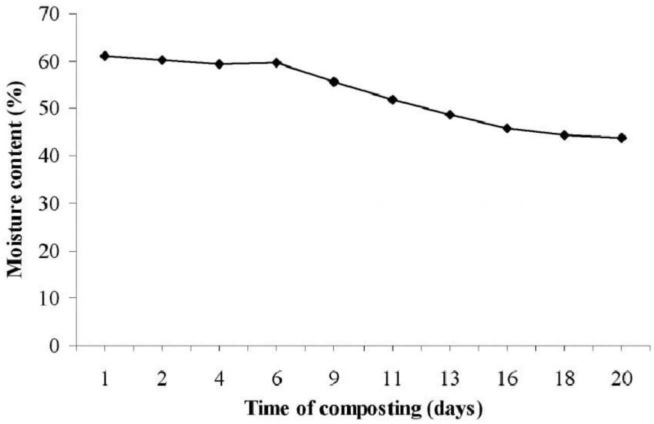
Statistical Analysis : All the results reported are the means of three replicates. Repeated measures treated with analysis of variance (ANOVA) were made using Statistical software. The objective of the statistical analysis was to determine any significant differences among the parameters analyzed for different C/N ratios during the composting process.

RESULT AND DISCUSSION :

Temperature: Temperature changes were observed at three different locations in the composter; namely at the centre and both ends. The variation in temperature of the composting material with time. The mesophilic and thermophilic cooling stages are clearly depicted. Mixture A contained a large amount of grass cuttings and reached 75°C (maximum in all three mixture) and entered into the thermophilic phase within a few hours indicating the rapid establishment of microbial activities. The longer thermophilic phase (6 days) as well as the greater increase in temperature at the beginning of composting was attributed to a larger content of easily biodegradable carbon. Afterwards a cooling period was observed up to the twelfth day. In mixture B, the initial temperature was 23.6°C, which further increased up to 65 °C and entered the thermophilic phase on the third day of composting. The thermophilic phase lasted for 5 days and a further cooling period was noticed up to the sixteenth day. However, mixture C required 6 days, a comparative longer time to reach a maximum temperature of only 55°C. This was due to a larger amount of food waste, which did not provide favorable conditions for growth and biological activity of micro-organisms.

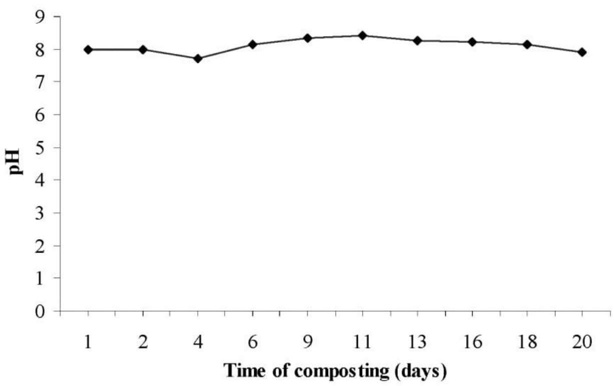


Moisture content : Moisture loss during the composting process can be viewed as an index of decomposition rate, since the heat generation which accompanies decomposition drives vaporization or moisture loss (Liao et al. 1996). However, the composting material should have just bare minimum moisture content for the survival of micro-organisms. The optimum initial moisture content should vary between 50 to 60% (CPHEEO 2000). A larger initial moisture content of 67.11% was observed in mixture A due to the large proportion of grass cuttings and food waste; this dropped to 52.71% at the end of 20 days of composting. For mixture B, moisture content at the beginning was 62.25%, which was reduced to 41.78% within 20 days (Table 2). During the initial 12 days of composting, the moisture content was found to be within an acceptable range of 50 to 60%. For mixture C, initial moisture content was 65.95%, due to the larger amount of food/vegetable waste, and it was reduced to 57.29% after 20 days. On analyzing the results by ANOVA, the moisture content varied significantly among all three organic waste mixtures ($P < 0.0001$). A much smaller difference (2–4%) in moisture contents was observed in the top and bottom portions of the composter, implying uniformity of mixture by rotation. The leachate formation was not observed during the composting period. A lower moisture loss (13%) was observed in mixture C compared to 21% loss in mixture A and 28% in mixture B due to higher rise in temperature and longer thermophilic phases. The results indicated that appropriate final moisture content was only observed in mixture B (44%) indicating lower microbial activity (Haug 1993, Gomez et al. 2006).

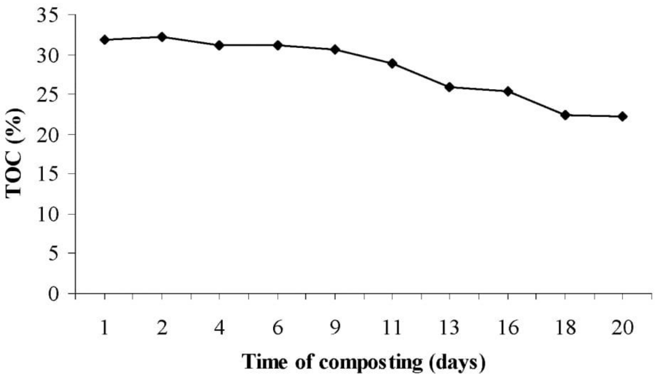


pH and EC : pH of the composting material for all mixture. Composting proceeds most efficiently at the thermophilic temperature when the pH is approximately 8 (Liao et al. 1996). Mixture A showed maximum pH value of 8.48 on the fifteenth day which increased from the initial pH of 6.62 and further steadily decreased to 8.12. Throughout mixture B, the pH level was found to be 8 or slightly more. The maximum pH value of 8.42 was observed on the 10th day, which further decreased to 7.96. The decrease in pH at the later stage of composting was caused by the volatilization of ammonical nitrogen and H+ released due to microbial nitrification process by nitrifying bacteria (Eklind & Kirchmann 2000). At the beginning of mixture C the pH was lower (6.31) than mixtur A and mixtur B, due to a larger amount of food and vegetable waste, and it increased to 7.94 showing a greater incremental change in comparison with mixture B. The increase in the pH level during composting was due to the increase in volume of ammonia released during protein degradation (Liao et al. 1996).

The variation in pH between the three organic waste mixtures varied significantly ($P = 0.001$). The values of pH followed a similar pattern to that depicted by Cabanas-Vargas et al. (2005) and Wu et al. (2000), increasing progressively over the first few days; and then decreasing slowly but steadily after that point and remaining fairly stable with values between 8 and 8.5. These results suggest that all mixtures might have come to the end of the active composting phase. The EC of mixture A shown in Table 3, increased from the beginning of composting showing a peak value on day 3 similar to that found by Huang et al. (2004), which further reduced to 4.84 dS $^{m-1}$. The higher EC observed in mixture A in comparison with the other mixtures could be due to the larger amount of grass cuttings and food waste. Mixtures B and C showed similar patterns of changes in EC, with a peak value at the beginning of composting, decreased up to 4–5 days and then a slight increase followed by a steady decrease until the end of composting. The initial peak could be due to the release of mineral salts and ammonium ions through the decomposition of organic matter (Huang et al. 2004). Mixture A showed a higher peak due to a greater release of ammonium ions throughout the composting process in comparison with mixture B and C. mixture A also showed a higher content of mineral salts in comparison with mixture B and C, leading to higher EC.



Total carbon and nitrogen The change in the TOC content during the composting period is detailed in Figure 5. The content of organic carbon decreased as the decomposition progressed. Initially, the amount of organic carbon in the material was 31.90%, which then reduced to 22.27%. Around 30% of the available carbon was utilised by micro-organisms as a source of energy.



CONCLUSION :

The composting of a combination of cattle manure, vegetable waste and sawdust (mixture B) yielded 2.23% total nitrogen and 3.57% total phosphorus after 20 days of composting in a rotary drum. However, in the case of a waste mixture of cattle manure, food waste, vegetable waste and paper waste (mixture C), compost yielded 4.42% total nitrogen and 2.52% total phosphorus after 20 days. On the other hand, treatment of a grass cuttings and vegetable waste mixture (mixture A) affected the behavior of a number of important parameters significantly during composting of mixed organic waste. During the thermophilic phase, the temperature remained above 50 °C in all mixtures satisfying the regularity requirement for the destruction of pathogens. The negligible amount of VFA concentrations observed in all composting mixtures indicated the full aerobic condition during the composting period.

Therefore, it can be supposed that rotary drum composting of organic waste mixture (cattle manure, vegetable waste and sawdust) at an initial C/N ratio of 22 (mixture B) led to a compost which reached maturity after 20 days of composting. Although the waste mixture (cattle manure, food waste, vegetable waste, paper waste and sawdust) with an initial C/N ratio of 30 (mixture C) could produce quality compost, it would require a composting period of more than 20 days. Finally the loss of nitrogen observed for the waste mixture (grass cutting and vegetable waste) at a low C/N ratio of 15 (mixture A), mean that it is not suitable for composting in rotary drum.

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