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# Vermicomposting from Gondia Municipal Solid Waste

**Mr. Fanindra Faglal Katre[1*] , Dr. Jayant Damodar Supe[2] , Mr. Raju A. Bondre[3]**

[1]*Assistant Professor Dept. of Civil Engg. Guru Nanak Institute of Technology Dahegoan Nagpur Maharashtra India*
[2]*Associate Professor Dept. of Civil Engg. Rungta College of Engineering and Technology Bhilai Chhattisgarh India*
[3]*Assistant Professor Dept. of Civil Engg Guru Nanak Institute of Technology Dahegoan Nagpur Maharashtra India*

***Abstract*** *- Growing urbanization and industrialization have led to generation of large quantities of wastes. Major portion of Municipal Solid Waste is dumped in landfill sites without any pretreatment, which further creates the organic load on the ground water, and more emissions of landfill gases. The best possible option to reduce the potential pollutants before entering the natural biological system is to pretreat it prior to its final disposal. Here, an outdoor study was under taken to pretreat the Municipal Solid Waste collected from a vegetable market on a pilot scale by windrow composting and vermicomposting. The raw waste was put to dynamic composting without any source separation and pulverization. Pretreatment indicators were developed and are used as a tool to measure the stabilization of the waste under different conditions, periodically. It was investigated that the volatile solid content of the waste reduced from 86 % to 60 % within two weeks of active windrow composting. The volatile solid content in the vermicomposted waste was also reduced by 19%. The degradation of organic matter was greatest within the first week of active composting with an average pile temperature of 55$^{0}$C. Furthermore, by adding proper amount of sludge from waste water treatment plant to the raw waste, resulted to a greater breakdown of organic residues, which ultimately resulted in a lowering of C/N ratio from 43 to 24 within one week*

***Keywords***- **Variation Temperature, pH, Carbon Content, Organic matter, Moisture content, Nitrate Content, C/N ratio, Phosphorous content and Potassium content.**

## INTRODUCTION

Vermicomposting is the conversion of biodegradable refuse into a high quality bio-fertilizer with the aid of Earthworms. Whereas, the composting is the other mode round where, the organic part of the refuse is consumed by a series of successive bacteria according to the heat of the system. Earthworms have from time immemorial played a key role in soil biology by serving as handy natural bioreactors to harness and destroy soil pathogens, thus converting organic wastes into valuable bio-fertilizers, enzymes, growth hormones and proteinaceous worm biomass. The worms do it by feeding rapaciously on all biodegradable refuse such as leaves, paper (non-aromatic), kitchen waste, vegetable refuse.

## II. LITERATURE REVIEW

2.1.1 By Ahmad and Bhargava (2005), "Vermicomposting of filter mud from sugar industries, mixed with food waste", He suggested that, Quantum disposal problem for filter mud can be fairly sorted by mixing with food waste and applying the vermicomposting on it by Eisenia Foetida red worm filter mud was fairly rich in organic nutrient, it find little use as agricultural fertilizer.

2.1.2 By Teresa Gea, et al. (2004), "Composting of de-linking sludge from the recycled paper manufacturing industry", He suggested that the composting of different type of sludge from recycled paper manufacturing industry was carried out at laboratory scale. Physio-chemical sludge (PCS) from the de-inking process and biological sludge (BS) from the waste water treatment plant ware composted and co-composted with and without addition of a bulking material. Despite its poor initial characteristics (relatively high C/N ratio, low organic content and moisture), PCS showed excellent behavior in the composting process, reaching and maintaining thermophilic temperature for more than 7days at laboratory scale, and therefore complete hygienization.

2.1.3 By Gajalakshmi, et al. (2004), Composting-Vermicomposting Of leaf litter ensuing from the tree of mango", He suggested that the ability of the earthworm to survive, grow and breed in the vermireactor fed with composed mango tree leaves and a rising trend in vermicast out put in spite of the death of few worm after four months of reactor operation indicate sustainability of this type of vermireactor.

2.1.4 By Pagam. Font & Sanchez (2005), "Emission of volatile organic compounds from composting of different solids waste", He suggested that, emission and volatile organic compound produced during composting of different organic waste (like sealed source organic fraction of MSW, Raw sludge, aerobically digested waste water and animal by-product) during the composting process on the gas was higher during beginning of the process and were no generally related to the biological activity of the process and conclusion from this study is that removal efficiency was at rate of 97% during composting and all volatile concentration were $50mg/cm^3$.

2.1.5 By Xi Zhang & Liu (2005), "Process kinetic of inoculation composting of municipal solid waste", He suggested that this method was used to improve the composting efficiency by seeding with inoculums A (a blend of bacillus azotofixams, bacillus megaterium and bacillus mucilaginous), inoculums B (a blend of effective cellulolytic strain i.e. trichoderma koningii, streptomyces cellulose, and white-rot fungi), and inoculums C (a mixture of A&B). in this study temperature, $O_2$, $CO_2$ and $H_2S$ emission and microbial concentrated were investigated to study of efficiency of inoculation composting.

2.1.6 By Ouyang et al. (2005), "Comparison of Bio-augmentation and composting for remediation of oily sludge", He suggested that A field study in china suggested that while studying of this method two bioremediation technology were performed in order to explorer better treatment process for an oily sludge to restoration in china during 2004. The Bio-remediation by augmentation of bio-remediation was compared with a conventional composting.

2.1.7 By Iyengar and Bhave (2005), "In-vessel composting of household waste", He suggested that, The method of composting has been studied using 5 different type of reactors, each simulating a different circumstance for the development of compost, one of which was designed as a self-motivated complete- mix type domestic compost reactor. A lab scale study was conducted first using the compost accelerator culture (Ttrichoderma viridae, Ttrichoderma harzianum, Trichorus spirallis, Aspergillus sp. Paecilomyces fusisporus, Chaetomium globosum ) grown on jowar (Sorghum vulgare) grains as the inoculums mixed with cow-dung slurry, and then by using the mulch/compost formed in the individual reactor as the inoculum. The reactor were loaded with raw as well as cooked vegetable waste for a period of 4 weeks and the mulch formed was allowed to maturate. The mulch was analyzed at various stages for the compost and other environmental parameters.

2.1.8 By Hete (2009), "Treatment of industrial sludge by vemicomposting", He suggested that, in this study rice mill sludge where taken with food waste which is first composted and then vermicomposted. Here use biodung method with Eisenia Foetida worms. The compost was analyzed at various stages and on environmental parameter. The compost provided good humus to build up a poor physical soil and some basic plant nutrients.

## III. MATERIALS AND METHODS

For this study the solid waste was collected from Gondia vegetable market. The waste as received was introduced in the composting unit without any source separation. At the composting site the waste collected are piled up in four bins. Before making up the pile these wastes are properly mixed using pitchforks and spade. Daily temperatures of the bins are recorded and maintained at the composting site using compost thermometer. The raw waste that we receive, although doesn't contain any hazardous materials but since it was handled manually during its composting period therefore gloves and other precautionary measures were also practiced. The initial temperature of the waste in the heap is measured and is recorded as $(30\text{-}40^0)$C the temperature shoots up to a maximum of $(32\text{-}40^0)$C during the first week and latter it decreased rapidly to about $(30\text{-}34^0)$C and then it remains constant for couple of days. This is then followed by a brief turning, which resulted in the rise of few degrees but falls back to its same old profile within few days. Three runs are studied in the same manner within a period of three weeks.

3.1.1 Important parameters for breeding:

Table 3.1: Regulated parameters during the breeding of earthworms

| **Sr. No.** | **Parameter** | **Optimum Range** | **Average measured value** |
|---|---|---|---|
| 1 | Temperature | $(10\text{-}35)^o$C | $30^0$C |
| 2 | Moisture | (60-75%) | 65%(wet basis) |
| 3 | pH | 4.5-9 | 7.5 |

3.2 GROWTH RATE DETERMINATION:

$$G = (N_1 - N_0)/ T$$

Where,

**R =** Growth rate

$N_0$ = Number of initial worms
$N_1$ = Number of worms at the end of time t
**t** = Total time of the experiment in days

## IV. CASE STUDY AND WORK

4.1 **Demography And Profile Of Gondia City**: Gondia is also known as Rice City. Area of Gondia is 5226.6 Sq. Km. It is 29th largest district in Maharashtra and 209th largest in India in terms of total area. Gondia is situated in the extreme eastern side of Maharashtra. Gondia is having the borders of Madhya Pradesh and Chattisgarh. The Gondia District is experiences great variations in high temperature with extremely hot summer and extremely cold winters and an average relative humidity of 62 percent.

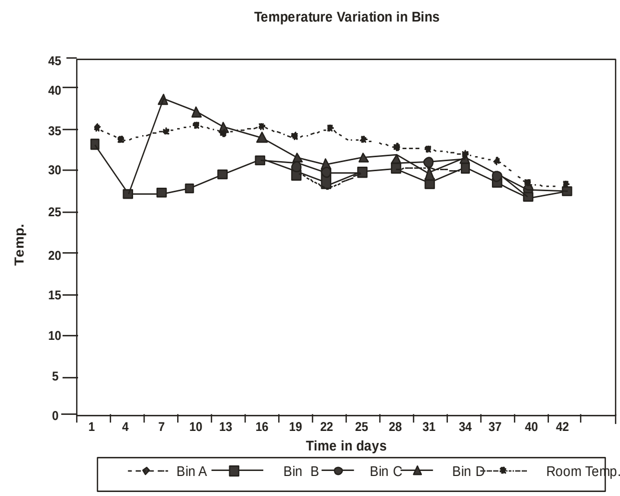
4.2 **Different Culture Media Used In Composting Process** Earthworms: Used earthworm for vermicomposting was used in the experimentation. They are quite hard and can tolerate wide fluctuation of temperature and humidity.
Leachate: Leachate from Chota Gondia landfill site was used in experimentation to assess the effect of leachate on degradation process so that it can be used for composting process at the landfill site.
Effective Microorganism (EM) solution: INORA's Very Effective Microorganism (IVEM) solution was used.
Biosanitizer: Biosanitizer in powder form from Bhawalkar Ecological Research Institute, Pune was used.
Decomposting Culture: Decomposting culture of INORA, Pune was used.

4.2.1 Experimental setup for bin-1: 0.5 kg of organic waste was spread daily in wooden box for 20 days for every process, thus total 10 kg of organic waste was added. 40 earthworms at staring of experimentations were added. Effective microorganism - 100 ml of prepared EM solution was spread on first day and on 8th day again 150ml of EM solution was added. Biosanitizer- 500 gm of Biosanitizer was spread at starting only. Leachate - 500 ml of leachate from Chota Gondia landfill site was added at starting. Decomposting culture – 200 gm of decomposting culture powder was spread at starting.
4.2.2 Experimental setup for bin-2: 0.5 kg of organic waste was spread daily in wooden box for 30 days for every process, thus total 15 kg of organic waste was added. 30 earthworms and 250 ml prepared EM solution was spread at staring. 200 ml of leachate from Chota Gondia landfill site was spread at starting.
4.2.3 Experimental setup for bin-3: 0.5 kg of organic waste was spread daily in wooden box for 30 days for every process, thus total 15 kg of organic waste was added. For all the process 7kg of culture was spread at the starting to startup the reaction.
4.2.4 Experimental setup for bin-4: In this stage 15 kg of organic waste was spread in wooden box at starting of experimentation.

1. Vermicomposting- 40 earthworms at staring of experimentations were added.
2. Effective microorganism - 100 ml of prepared EM solution was spread on first day and on 8 day again 150ml of EM solution was added.
3. Biosanitizer- 500 gm of Biosanitizer was spread at starting only.

## V. RESULT AND DISCUSSION

Table 5.1: Temperature variation in laboratory Room and Bins, as recorded is given in table No. 1




Graph 5.1 Temperature Variations in Bins

**Table 5.2:** The variation of pH in vermicompost at various stages as shown in table No. 2

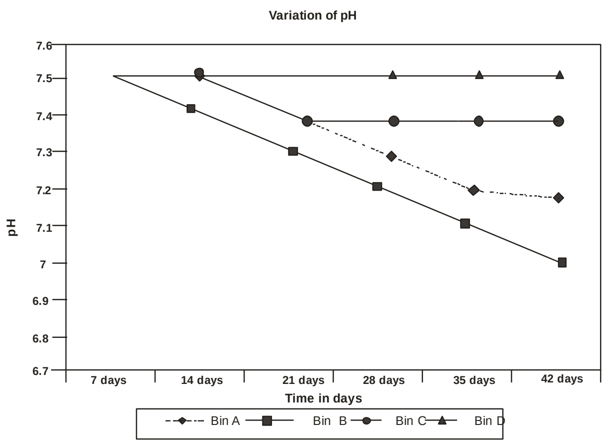
| Period | Bin A | Bin B | Bin C | Bin D |
|---|---|---|---|---|
| 7 days | 7.5 | 7.5 | 7.5 | 7.5 |
| 14 days | 7.5 | 7.4 | 7.5 | 7.5 |
| 21days | 7.4 | 7.3 | 7.4 | 7.5 |
| 28days | 7.3 | 7.2 | 7.4 | 7.5 |
| 35days | 7.2 | 7.1 | 7.4 | 7.5 |
| 42days | 7.2 | 7 | 7.4 | 7.5 |

**Table 5.3** The variation of Carbon Content of vermicompost at various stages as shown in Table No.3

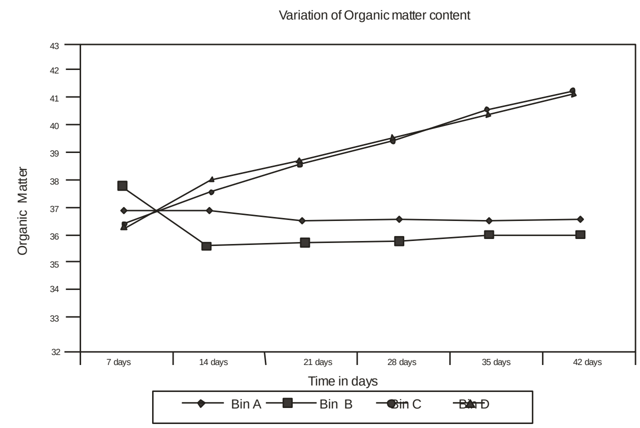
| Period | Bin A | Bin B | Bin C | Bin D |
|---|---|---|---|---|
| 7 days | 21.4 | 21.9 | 21.1 | 21 |
| 14 days | 21.4 | 20.5 | 21.8 | 22.2 |
| 21days | 21.1 | 20.6 | 22.6 | 22.75 |
| 28days | 21.2 | 20.7 | 23.1 | 23.2 |
| 35days | 21.25 | 20.8 | 23.8 | 23.6 |
| 42days | 21.29 | 20.85 | 24.10 | 23.98 |

Table 5.1: Temperature variation in laboratory Room and Bins, as recorded is given in table No. 1

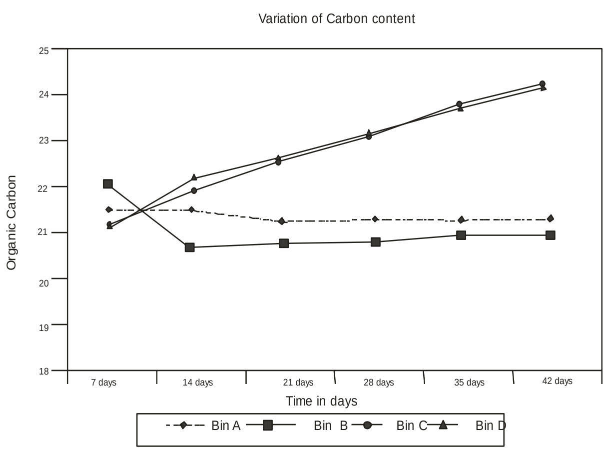
| **Time days** | | **1** | **4** | **7** | **10** | **13** | **16** | **19** | **22** | **25** | **28** | **31** | **34** | **37** | **40** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room temp.$^0$C | | 35 | 34 | 36 | 37 | 36 | 37 | 36 | 37 | 36 | 34 | 35 | 35 | 35 | 32 |
| Bins Temp $^0$C | A | 32 | 28 | 28 | 29 | 31 | 32 | 31 | 29 | 30 | 31 | 32 | 33 | 32 | 30 |
| | B | 32 | 28 | 28 | 29 | 31 | 32 | 31 | 30 | 30 | 31 | 31 | 33 | 32 | 30 |
| | C | 32 | 28 | 28 | 29 | 31 | 32 | 32 | 31 | 30 | 31 | 33 | 34 | 33 | 31 |
| | D | 32 | 28 | 40 | 39 | 37 | 35 | 33 | 32 | 32 | 32 | 32 | 34 | 33 | 30 |




Graph 5.2 Variation of pH




Graph 5.4 Variation of organic matter content



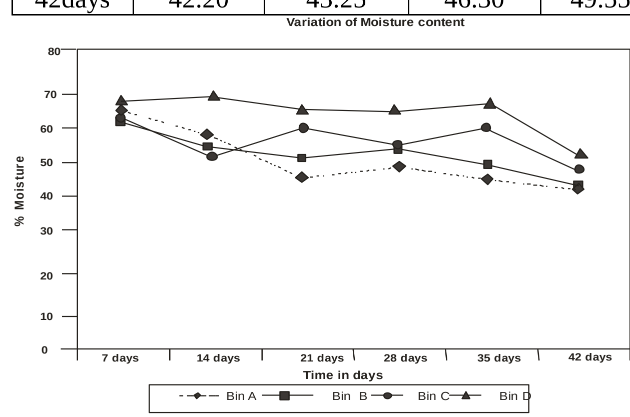

Graph 5.3 Variation of carbon content

Table 5.4: The variation of organic matter of vermicompost at various stages as shown in Table No.4

| **Period** | **Bin A** | **Bin B** | **Bin C** | **Bin D** |
|---|---|---|---|---|
| 7 days | 36.90 | 37.75 | 36.37 | 36.20 |
| 14 days | 36.90 | 35.34 | 37.58 | 38.27 |
| 21days | 36.37 | 35.51 | 38.96 | 39.22 |
| 28days | 36.55 | 35.68 | 39.82 | 40 |
| 35days | 36.63 | 35.86 | 41.03 | 40.68 |
| 42days | 36.70 | 35.95 | 41.55 | 41.34 |

**Table 5.5:** The variation of moisture content of the vermicompost at various stages as shown in Table No.5

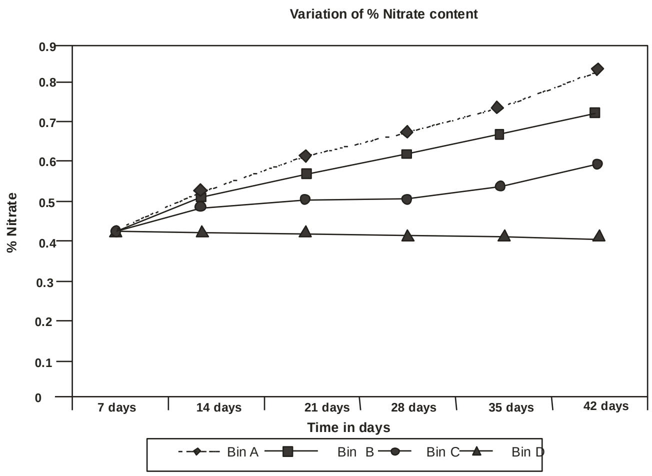
| **Period** | **Bin A** | **Bin B** | **Bin C** | **Bin D** |
|---|---|---|---|---|
| 7 days | 65.55 | 62.85 | 63.75 | 67.50 |
| 14 days | 60.08 | 56.16 | 53.76 | 70.08 |
| 21days | 45.34 | 50.29 | 58.9 | 63.15 |
| 28days | 46.65 | 51.35 | 52.35 | 62.45 |
| 35days | 43.48 | 47.92 | 56.12 | 63.84 |
| 42days | 42.20 | 43.25 | 46.30 | 49.55 |




Graph 5.5 Variation of moisture content

**Table 5.6:** The variation of Nitrate Content of vermicompost at various stages as shown in Table No. 6

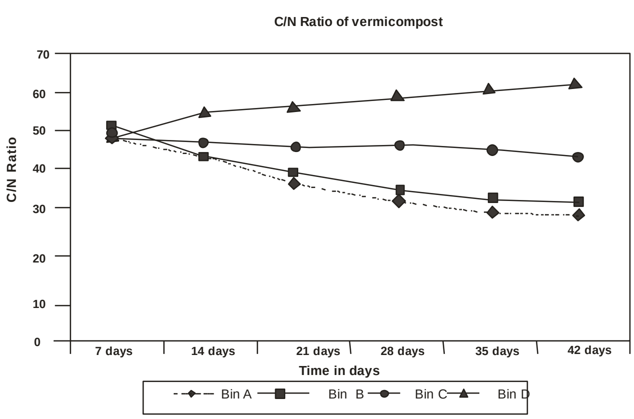
| Period | Bin A | Bin B | Bin C | Bin D |
|---|---|---|---|---|
| 7 days | o.44 | 0.43 | 0.43 | 0.43 |
| 14 days | 0.51 | 0.49 | 0.47 | 0.42 |
| 21days | 0.63 | 0.57 | 0.51 | 0.42 |
| 28days | 0.72 | 0.65 | 0.53 | 0.41 |
| 35days | 0.80 | 0.71 | 0.58 | 0.41 |
| 42days | 0.85 | 0.75 | 0.62 | 0.41 |




Graph 5.6 Variation of % nitrate content

Table 5.7: The C/N ratio of vermicompost at various stages as shown in Table No. 7

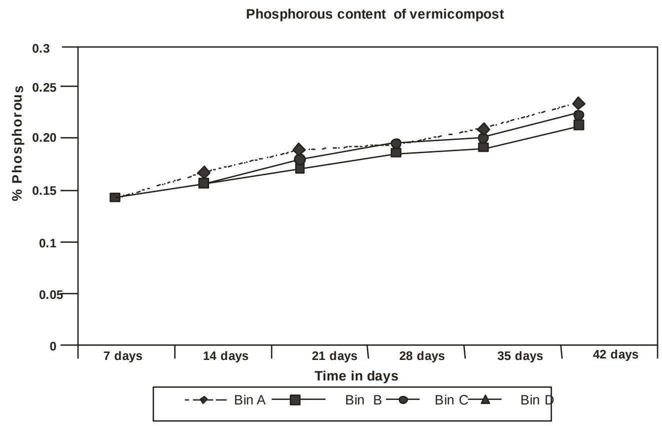
| Period | Bin A | Bin B | Bin C | Bin D |
|---|---|---|---|---|
| 7 days | 48.63 | 50.9 | 49.07 | 48.83 |
| 14 days | 41.96 | 41.83 | 46.38 | 52.85 |
| 21days | 33.49 | 36.14 | 44.31 | 54.16 |
| 28days | 29.51 | 31.84 | 43.58 | 56.58 |
| 35days | 26.55 | 29.29 | 41.03 | 57.56 |
| 42days | 25.04 | 27.8 | 38.87 | 58.48 |




Graph 5.7 C/N ratio of vermicompost

**Table 5.8:** The variation of Phosphorous content of the vermicompost at various stages as given in Table No. 8

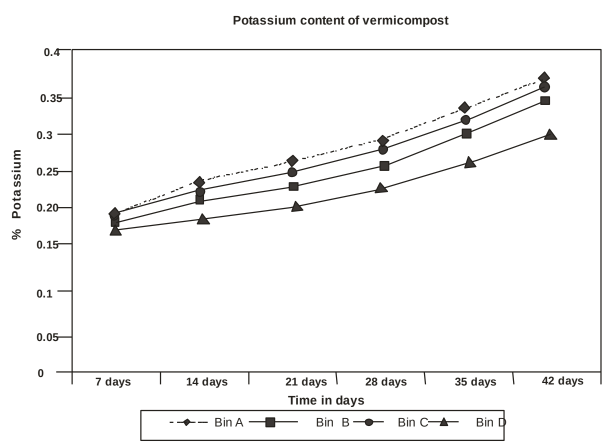
| Period | Bin A | Bin B | Bin C | Bin D |
|---|---|---|---|---|
| 7 days | 0.14 | 0.14 | 0.14 | 0.14 |
| 14 days | 0.17 | 0.16 | 0.16 | 0.16 |
| 21days | 0.20 | 0.18 | 0.19 | 0.18 |
| 28days | 0.21 | 0.20 | 0.21 | 0.20 |
| 35days | 0.23 | 0.21 | 0.22 | 0.21 |
| 42days | 0.25 | 0.23 | 0.24 | 0.23 |




Graph 5.8 Phosphorous content of vermicompost

Table 5.9: The variation of potassium content of the vermicompost at various stages as shown in Table No. 9

| Period | Bin A | Bin B | Bin C | Bin D |
|---|---|---|---|---|
| 7 days | 0.19 | 0.18 | 0.19 | 0.17 |
| 14 days | 0.23 | 0.21 | 0.22 | 0.19 |
| 21days | 0.26 | 0.24 | 0.25 | 0.21 |
| 28days | 0.29 | 0.26 | 0.25 | 0.23 |
| 35days | 0.33 | 0.30 | 0.31 | 0.26 |
| 42days | 0.35 | 0.33 | 0.34 | 0.28 |




Graph 5.9 Potassium content of vermicompost

## VI. DISCUSSION

**6.1.1 Physical Parameter:** The vermicompost formed in all the bins except 'bin B' has a musty/earthy odour, brown to brownish black colour and soil like texture after the maturation period. The compost from 'bin B' showed a light colour than other due to high percentage of recycled paper sludge is present in initial stage.

**6.1.2 C/N:** Using industrial waste in combination with bio-dung gives the C/N ratio as 30 values which is most favorable for efficient composting.

Decomposition of organic matter is brought by microorganism that uses the carbon as a source of energy and nitrogen for building cell structure, more carbon is needed. If the excess carbon is too great, decomposition decrease when the nitrogen is used up and some of organism die. The stored nitrogen is then used by other organism to form new cell material. In the process more carbon is used, thus the amount of carbon is reduced to more suitable level while nitrogen is recycled. In general a drop in the C/N was observed for vermicompost formed in all reactors.

**6.1.3 Temperature:** There is a difference of temperature between the bins and the room temperature being mostly slightly higher than the room temperature.

Heat generation result from microbial activity, so the composting process experience an initial rise in temperature followed by declining and stabilized temperature as microbial activity decreases due to lower level of available organic matter.

**6.1.4 pH:** The pH of the vermicomposting material dropped during the initial week of composting due to the formation of organic acid, i.e. amino acid and other volatile fatty acid, after this period, the pH tend to move toward neutral again when there acid have been converted to carbon dioxide by the microbial action.

**6.1.5 Potassium:** The low potassium content in the compost (0.1-0.4%), compared to the suggested 1% for compost, may be aspect to its drainage out in the form of leachate. The total potassium content was found to raise during the period of vermicomposting.

**6.1.6 Phosphorous:** Phosphorous content gradually increased during the vermicomposting process. The water solubility of phosphorous decreased with the humification thereby. Showing that phosphorous solubilised during the decomposition was subjected to further immobilization by the compost accelerator microorganism. Compost maturity test- In compost maturity test of seed germination after 72 hours in compost tea is more than 90% i.e. it indicates that, compost is well mature and ready for agricultural/horticultural use.

## VII. CONCLUSION

**7.1 CONCLUSION:**

- Using solid waste and cow dung in proportion 50:50 and 70:30 gives the optimum result with an overall reduction of 40-50% in the C/N ratio.
- Excess moisture is rejected by the worm and is disposed off in the form of lechate.
- The nutrient content of waste increased progressively with the vermicomposting period with increment being observed in the P and K values.
- There is difference of temperature between the bins and the room with room temperature being mostly slightly higher than the bins temperature.

## VII. SCOPE FOR THE FUTURE WORK

There is vast scope of further study on this topic as follows-

- With taking different material with municipal solid waste as combination like food waste, night soil, vegetable waste and other industrial waste.
- By taking other type of worm like Eudrilus eugeniae, Eisenia fetida.
- Rice industries is mostly present in this area hence it may be possible to study on combination of both industry wastes.
- By accepting method of anaerobic composting.
- By accepting method of composting first and then vermicomposting.
- By checking presence of heavy metal like Iron, Magnesium, Zinc, Copper, Boron, Aluminum and there removal.
- By checking presence of toxic material in industrial waste and there reduction or removal.

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