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A Pilot Scale Solid Waste Management Programme through Vermicomposting of Organic Waste Worship Materials from Some Religious Places of Patna Bihar

KEYWORDS: Patna, State capital of Bihar, Worship places, organic solid waste, Improper disposal, Ganga river, Vermicomposting of organic waste materials, Eiesenia faetida, Eudrilus eugeniae species of earth worms, Environmentally benign technique of waste disposal

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ABSTRACT *The increasing quantity of solid waste is rapidly exhausting the existing capacity of landfills and establishment of new sites are very difficult targets to achieve. Alternative practices to solid waste disposal can be reduction of solid waste at source of production, recycling, composting the organic waste and incineration. Patna the capital city of the State of Bihar has large number of temples, mosques, churches and gurudwaras. Devotees of different faith and religion profusely offer flowers, fruits, cotton cloths etc. while performing prayers and rituals at their religious places. After the prayers or rituals are over these worship materials, mostly organic in nature are carelessly thrown away in nearby areas – land and or water bodies. According to one estimate organic waste worship materials constitute some 5-7% of the total organic solid waste generated in the municipal area of Patna. Our present research work describes environment friendly disposal of organic components of the worship materials from some selected temples and mosques of Patna through their vermicomposting using Eisenia fetida and Eudrilus eugeniae species of earthworms. The resulting vermicompost has been analysed at regular intervals for such physicochemical parameters as pH, moisture content, total N, available P, organic C and C/N ratio. The results are encouraging for their use as organic manure. It is planned to extend this environmentally benign technique of waste disposal from all the known religious places located in the city of Patna. We feel happy that through this small endeavour we may become a part of the highly ambitious " Clean India Mission (Swascch Bharat)" of our Honourable Prime Minister.*

INTRODUCTION

A phenomenal growth in human population, fast but unplanned urbanization, shift from traditional to modern agricultural practices etc. have led to an increased generation of waste materials. The waste materials may act as a secondary host of diseases and pests, as nature alone is unable to degrade the huge quantity of wastes in a short period of time. The proper disposal of solid wastes have emerged as one of the major problems in the developing countries due to lack of limited economic resources and proper disposal techniques matching with their available resources.

Patna, the state capital city of Bihar has the pride to have many famous temples, Gurudwaras, churches and mosques. Temples include Patan Devi temple, Sheetala Maata temple, Mahaveer temple, Sri Premnidhi Rupkala Smarak Panch Mandir temple to name a few. The world famous Patna Saheb Gurudwara is one of the most highly revered seat of worship of the Shikh community. The Catholic Church, the Padri ki Haveli, the Roman Catholic Archdiocese of Patna are the famous churches whereas famous mosques include Phulwari Sharif Mosque, Pathar ki Masjid and Begu Hajjam's Mosques. At these worship places large quantity of worship items are offered to deities. The worship materials include flowers, leaves, fruits, sweets, jiggery, milk and milk products, grains etc most of which are organic biodegradable materials suitable for vermicomposting.

In the city of Patna the worship items offered by devotees of different religion and faith are disposed off in highly unscientific manner by throwing them away carelessly around nearby areas – open land and or water bodies including the river Ganga which flows through northern end of the city. At these common public places the organic wastes decay aerobically and anaerobically producing foul smell, toxic gases and solid liquid wastes causing severe health problems to the people around.

AIMS AND OBJECTIVES:

The aim of this socio-scientific work is twofold-

(i) To adopt and popularize scientifically sound and environmentally benign method of disposal of the worship materials from various worship places of Patna and
(ii) To convert these organic wastes into valuable manure and thereby recycle the plant nutrients.

It is also aimed to design experiments and ascertain optimum conditions – pH, temperature, moisture content, air (oxygen), ratio of the waste to cattle dung to be fed into the vermicomposting tank, duration of maturation of vermicompost etc, under which vermicomposting of the worship materials is the most efficient yielding manure which is high both in quality as well as in quantity.

Vermi composting is the phenomenon of compost formation by earth worms. Earth worms are well known to play an important role in the cycling of plant nutrients, turnover of organic matter and maintain the soil structure[1,2]. In this technique soil microflora also play important role. The earth worms feed on plant refuses or any organic matter and digest in their guts with the help of their own enzymes. Vermicomposting is an odourless dark brown biofertilizer obtained from the process of vermicomposting. The vermicompost obtained are also termed vermicasts as they are expelled as casts from earthworm gut. Vermicompost is excellent product high in nutrient content, have desirable aesthetics, has reduced level of contaminants,

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has plant growth harmones, higher level of soil enzymes, greater microbial population and hold more nutrients over a longer period without adversely impacting the environment[3].

The vermicomposting process is a mesophillic process and operating conditions such as temperature, pH, electrical conductivity and moisture content levels must be optimized[4].

It is known that process such as thorough mixing of material, turning upside down and watering the components enhances the decomposition process. The turning upside down ensures an adequate supply of oxygen to the microbes. At the later stages the turning upside down process fails to reheat the composting pile indicating that the compost materials have become biologically stable.

MATERIALS AND METHODS:

The worship materials containing floral wastes were collected from the two main temples namely the Mahaveer Temple located near the Patna Railway station and the Sri Premnidhi Rupkala Smarak Panch Mandir located at Daroga Rai Path, Near New Secretariate Patna.

The collected floral wastes were chopped into fine pieces of 1- 2.5 cm length and then left for few days (nearly 7-8 days) with occasional mixing (turning upside down) and by maintaining its moisture level till its temperature stabilized. It was then transferred into three plastic rectangular bins of 60 x 40 x 25 cm dimension. The vermicomposting process was carried out at the vermicomposting centre established by P.G. Department of Environmental Sciences, A.N. College Patna. The floral wastes were filled in the three bins with different proportion of cattle dung as given below.

(i) Bin A, it contained 100% floral waste : 0 % cattle dung(5 Kg floral waste)
(ii) Bin B, it contained 75% floral waste: 25% cattle dung (3.75 Kg floral waste + 1.25 Kg cattle dung)
(iii) Bin C, it contained 50% floral waste: 50 % cattle dung (2.5Kg floral waste + 2.5 Kg cattle dung)

The plastic bins filled with floral wastes in different proportions were sprinkled with water averagely every 5th day after turning it upside down. However in Bin A100% floral waste water was sprinkled after a gap of 8 days in the beginning but later on sprinkling of water was discontinued due to high content of moisture in it. The vericomposting was initiated in thermally stabilized waste by mixing together 40 species of *Eisenia fetida* and 40 species of *Eudrilus eugeniae* in each of the three experimental Bins A, B, and C[5,6].The moisture content of 65-75% at the temperature of the experiment 25^{0}C was maintained in all the bins undergoing vermicomposting. The bins were covered with wet gunny bags to prevent the invasion of lizards, rats and rodents and to check the escape of earth worms from the bins. The bio composting process was continued for 90 days, sprinkling of water was stopped five days before the completion of the composting[7,8]. At the end of 45 days, 60 days and 90 days vermicompost was collected separately from the three bins and was analysed for various physicochemical parameters including, pH, temperature, moisture content, total nitrogen, available phosphorus, available potassium, organic carbon and C: N ration[9-13]. Analysis was done as per the methods described in the "Manual for Analysis of Municipal Solid Waste" published by Central Pollution Control Board, New Delhi. Mostly AR quality chemicals of Merck make were used for analysis. All the solutions were prepared in double distilled water.

RESULT AND DISCUSSION:

(1) Vermicomposting of 100% floral waste (Bin A content) was found to be the slowest as it took about 90 days to complete. However the time reduced gradually as the proportion of cattle dung in the floral waste was increased successively. Thus the vermincomposting of the contents in Bin B was complete in 80 days while that of Bin C took about 70 days only.

100% floral waste took longer time to decompose. It might probably be due to non addition of the cattle dung which has a high mineral and nutrient content, which are favourable for microbial growth and activities[14].

(2) *Variation in the moisture content:*

The results of variation in moisture contents during composting are given in table-2 and shown on fig-1. At the outset of the composting moisture contents were recorded to be 80% in 100% floral waste (Bin A), 78% in 75% floral waste mixture (Bin B) and 74% in 50% floral waste mixture (Bin C).The moisture value fluctuated from 75-80% in (Bin A) while average moisture reduced as the proportion of cattle dung was increased in the composting mixture. It was found to be 55-70% in (Bin B) while its value reduced to 55% level in case of 50% floral waste mixture content (Bin C). It was also observed that the moisture content value irregularly fluctuated throughout the period of composting. Results of moisture content values show a significant relationship with the cattle dung proportions in the floral mixture contents. In 100% floral waste content (Bin A) the moisture level was observed to be higher because there were no absorbing substances present in the waste material content. During the microbial decomposition process water is released as a product which may be one of the reasons for the increased moisture level. However cattle dung containing components of the floral wastes (Bin B and Bin C) showed lower moisture content values. It may be attributed to the presence of cattle dung which is a good absorbent of moisture.

Table-1: Floral waste Component distributions(% & mass)

S. N.	Floral wastes % and mass in Kg	Cattle dung % and mass in Kg
1.	100 % (5 Kg)	0 % (0 Kg)
2.	75 % (3.75 Kg)	25 % (1.25 Kg)
3,	50 % (2.5 Kg)	50 % (2.5 Kg)

Table- 2: Moisture distribution in %

Moisture %	1st day of composting	10th day of composting	45th day of composting	60th day of composting	90th day of composting
Bin A	80	78	75	75	75
Bin B	78	70	64	59	55
Bin C	74	70	62	54	55

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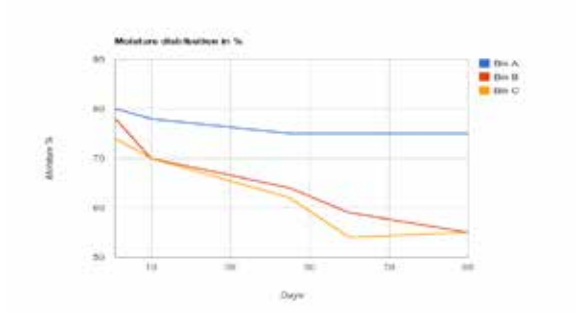

Fig- 1

(3) *Variation in Temperature:*
It was observed that the temperature was higher in 100% floral waste (Bin A) and it reduced gradually with the increase in the quantity of cattle dung in the composting mixture. At the initial stage of composting i.e. after four days from the start the temperature recorded for the 100% floral waste component was 60^{0}C, for 75% floral waste component it was 53^{0}C and for the 50% floral waste component it was 45^{0}C. After four days period, the temperature started reducing markedly, on 12th day of composting the temperature recorded showed the following figures- 37^{0}C, 32^{0}C, and 28^{0}C for 100% , 75% and 50% floral waste components respectively while on 21st day of composting contents of all the three Bins recorded almost an equal temperature of 25^{0}C (the room temperature). There was a very slight increase in temperature in the 100% floral waste component on 30th and 35th day of composting, it being 28^{0}C and 27^{0}C respectively. There was no variation of temperature in the rest of the two floral waste components and after this period, all the three components showed no variation in temperature till the completion of composting.

General rise in temperature in initial days of composting i.e. between one to four days of composting can be attributed to mineralization of organic carbon and nitrogen in the presence of adequate aeration and moisture as required by microbes responsible for decomposition and degradation of organic components.

Table-3

Temperature	At the outset of vermicomposting	On 4th day of Vermicomposting	On 12th day of Vermicomposting	On 21st day of vermicomposting	On 30th day of vermicomposting	On 35th day of vermicomposting
Bin A	25^{0}C	60^{0}C	37^{0}C	25^{0}C	28^{0}C	27^{0}C
Bin B	25^{0}C	53^{0}C	32^{0}C	25^{0}C	25^{0}C	25^{0}C
Bin C	25^{0}C	45^{0}C	28^{0}C	25^{0}C	25^{0}C	25^{0}C

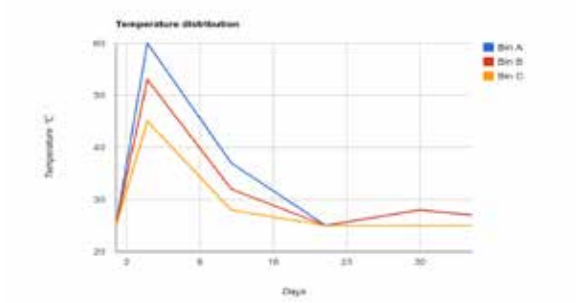

Fig-2

(4) *Variation in PH:*
pH of the 100% floral waste component in Bin A at the outset was found to be 7.21, after 45 days it slightly reduced to 6.78, after 60days it was 6.68 and finally after 90 days it recorded 6.55. In Bin B pH on first day was 7.32, after 45 days it was 7.20, after sixty days 7.10 and finally after 90 days of composting period it recorded 7.00. Similar trend was observed in Bin C, one first day pH was 7.63, on 45th day 7.59 on 60th day it was 7.40 and on the 90th day it was 7.37. The pH shift towards lower values attributes to mineralization of the nitrogen and phosphorus in to nitrites/nitrates and orthophosphates[15].The lower pH in the final vermicompost might have been due to the production of CO_2 and organic acids by microbial activity during the process of bioconversion of different substrates[16].

Table-4 Variation in pH

pH	1st Day	45th Day	60th Day	90th Day
Bin A	7.21	6.78	6.68	6.55
Bin B	7.32	7.20	7.10	7.00
Bin C	7.63	7.59	7.40	7.37

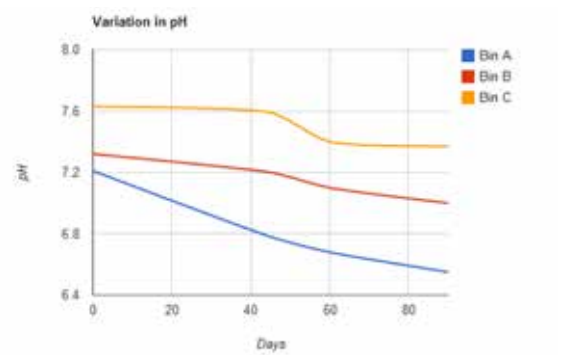

Fig- 3

(5) *Variation in Nitrogen, Phosphorus, Carbon, Potassium and C/N Values:*
Nitrogen content values in the raw floral waste before starting the composting process was recorded to be 0.81 after 45 days it was 0.85, after 60 days it was 0.87 and after completion of composting i.e. after 90 days it was .89. In Bin B after 45 days of composting the nitrogen content was observed to be 0.87, after 60 days it was 0.89 and after 90 days it was 0.91. In Bin C the nitrogen content value after 45 days was recorded to be 0.88, after 60 days it was 0.90 and finally after 90 days it was 0.92.

Similar pattern was observed for the phosphorus content. On first day of the composting phosphorus content was recorded to be 0.52% in the raw floral waste content. After 45 days of composting, it was recorded to be 0.57%, 0.62% and 0.63%, after 60 days it was 0.59%, 0.67% and 0.69%, and after 90 days of composting it was 0.61%, 0.73% and 0.76% for Bin A , Bin B and Bin C respectively.

Potassium content percentage also increased gradually with the progress of the vermicomposting. At outset of vermicomposting it was recorded to be 0.55%. After 45 days of composting, it was recorded to be 0.57%, 0.59% and 0.60%, after 60 days it was 0.58%, 0.61% and 0.62%, and after 90 days of composting it was 0.60%, 0.62% and 0.65% for Bin A , Bin B and Bin C respectively.

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As far as carbon content in different floral waste compost components is concerned, a remarkable decrease in carbon content was observed during the composting period. Carbon content in the 100% floral waste component (Bin A) at the beginning of composting was 29.52% and after 45 days 27.3%, after 60 days 25.87 and after 90 days i.e. after the completion of composting in different compost components it was recorded to be 16.32% . In Bin B after completion of 45 days the organic carbon content was recorded to be 14.26%, after 60 days 13.57% and after 90 days it was 12.65% while in Bin C after 45 days of composting period the organic carbon content decreased to 13.8%, after 60 days it recorded to be 13.10% and after 90 days it was 12.73%. C/N ratio for Bin A at the start of composting was 36.44, after 45 days 32.11, after 60 days 29.73 and after the completion it was 18.33. Similar pattern was observed in Bin B for the C/N ratio, after 45 days it was observed as 16.39, after 60 days it was 15.25 and after 90 days it was 13.90. In Bin C after 45 days of composting the C/N ratio reduced to 15.90, after 60 days it was 14.71 and after 90 days it was 13.83

Table-5 Nitrogen%

Nitrogen % in	At the outset of Vermicomposting	On 45th day of vermicomposting	On 60th day of vermicomposting	On 90th day of Vermicomposting
Bin A	0.81	0.85	0.87	0.89
Bin B	0.81	0.87	0.89	0.91
Bin C	0.81	0.88	0.90	0.92

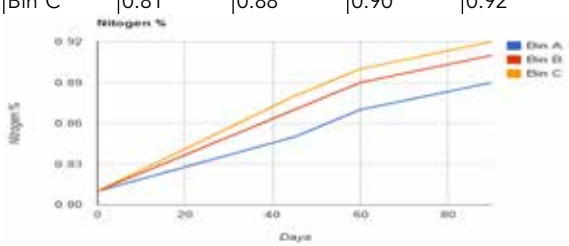

Fig- 4

Table-6 Phosphorus %

Phosphorus % in	At the outset of Vermicomposting	On 45th day of vermicomposting	On 60th day of vermicomposting	On 90th day of vermicomposting
Bin A	0.52	0.57	0.59	0.61
Bin B	0.52	0.62	0.67	0.73
Bin C	0.52	0.63	0.69	0.76

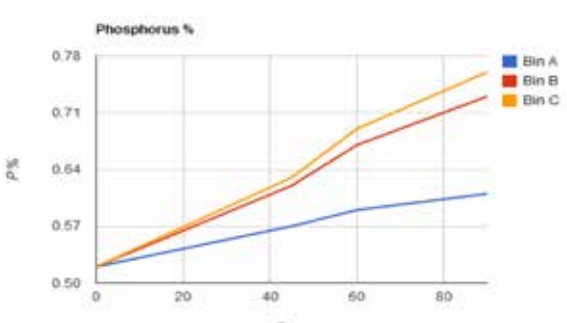

Fig-5

Table-7 Potassium %

Potassium % in	At the outset of Vermicomposting	On 45th day of vermicomposting	On 60th day of vermicomposting	On 90th day of **vermicomposting**
Bin A	0.55	0.57	0.58	0.60
Bin B	0.55	0.59	0.61	0.62
Bin C	0.55	0.60	0.62	0.65

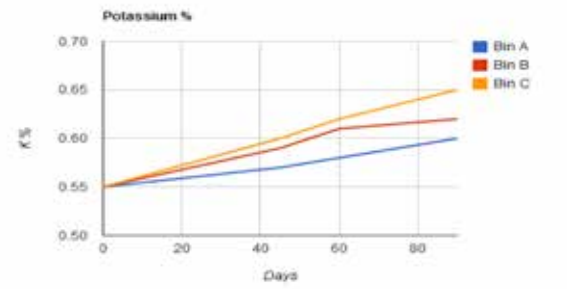

Fig-6

Table-8 Carbon %

Carbon % in	At the outset of Vermicomposting	On 45th day of vermicomposting	On 60th day of Vermicomposting	On 90th day of vermicomposting
Bin A	29.52	27.30	25.87	16.32
Bin B	29.52	14.26	13.57	12.65
Bin C	29.52	13.80	13.10	12.73

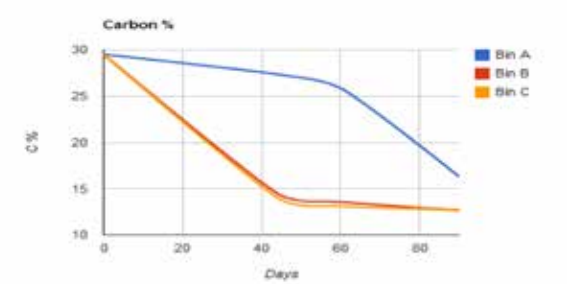

Fig-7

Table-9 C/N Ratio

C/N ratio in	At the outset of Vermicomposting	On 45th day of vermicomposting	On 60th day of Vermicomposting	On 90th day of vermicomposting
Bin A	36.44	32.11	29.73	18.33
Bin B	36.44	16.39	15.25	13.90
Bin C	36.44	15.90	14.71	13.83

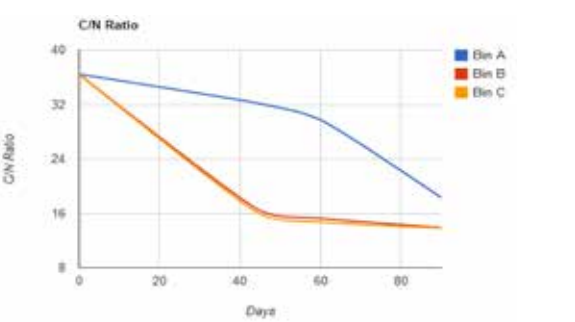

Fig-8

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Conclusion:

The organic waste worship materials mixed with cattle dung (in 1:1 ratio or so) is an excellent raw material for vermicomposting using a mixture (1:1) of Eisenia foetida and Eudrilus eugenae species of earth worms. The vermicompost so produced has good fertilizer value. An equally important aspect of the present work is that it provides an environmentally benign and sustainable method of disposal of organic wastes generated at worship places of different religions and faiths. It is our suggestion that this eco-friendly method of waste disposal from worship places should be extended for all the worship places. On our part it is planned to extend the programme to all the known religious places located in Patna, the capital city of Bihar.

Disposal of floral wastes in highly unscientific manner by throwing them away carelessly around nearby areas – open land and water bodies including the river Ganga has been a serious health hazard.

Sri Premnidhi Rupkala Smarak Panch Mandir Temple, Daroga Rai Path Patna - Our site of Vermicomposting of floral wastes of the worship places.

Our finished product (Vermicompost) is packed in polythene packets for display and sale at the Mandir Counter.

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