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Elephant dung: A promising organic source for tropical soils of Kerala

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Abstract
The study on elephant dung as a promising organic source for tropical soils of Kerala was conducted at College of Horticulture, Vellanikkara from January 2009 to May 2011. In order to study the effect of micro fauna on the *in situ* decomposition of elephant dung, a field monitoring at Padukkad was undertaken by identifying six stages of degradation of dung *viz*. more than one year old, one year old, eight months old, four months old, fresh sample constituting of body washings and fresh faecal bolus. Since the dung was rich in lignocellulose, isolation of native lignocelluloses degraders was carried out. Vermicomposting mainly focused on identification of suitable microbial degraders for pre composting and selection of the best substrate for vermicomposting. The factor without microbes was compared with *Pleurotus platypus*, combination of *Aspergillus flavus* and *Bacillus subtilis* and native microbes efficient in lignocellulose degradation. Different substrate levels included FYM and elephant dung in 1:1 and 1:8, elephant dung and banana pseudostem in 1:1 and 1:8 proportion. The compost worm used was *Eudrillus euginae*. Worm multiplication was influenced by the substrate controlled micro environment with the combination of FYM and elephant dung in the ratio 1:8 registering an eight fold increase in worm count at the time of compost harvest. Consortium of *Aspergillus flavus* and *Bacillus subtilis* have taken minimum maturity period for composting. The compost from the substrate combination of ED: FYM (8:1) pre composted with *Aspergillus flavus* and *Bacillus subtilis* recorded manurial value of 10.78% C, 1.34% N, 0.66% P, and 0.61% K^+, 0.67% Ca^{2+},0.04% Mg $^{2+}$and 0.12% Na^+ with a pH value of 7.3. The study on utilization of elephant dung for vermicomposting revealed that elephant dung and FYM in the ratio 8: 1 must be pre composted with *Aspergillus flavus* and *Bacillus subtilis* in order to get biotically enriched elephant dung suitable for tropical soils having minimum maturity period.

Keywords: elephant dung, vermicompost, *Aspergillus flavus*, *Bacillus subtilis*, nutrients, maturity period, substrate.

Introduction
Kerala is home for around 800 captive tuskers. Elephant's capacity to digest food is poor and only 40% is digested and 60 % passed out as faeces.Normally an elephant defecates 12 to 15 times per day at the rate of 5-8 balls having 1-2 kg in weight, 100 to 160 mm in diameter and 70 to 180 mm in length resulting in a dung production of 100 – 150 kg per day (Sreekumar, 2009). Dumping huge quantity of dung is a common practice in elephant conservation centres. Even though burning is the major way adopted for dung disposal, it can create atmospheric pollution as well as health problems. Also burning can result in loss of organic carbon which can otherwise nourish soil fertility especially for tropical soils. The lignocellulolytic nature of dung demands effective decomposers for rapid decomposition of dung which is a carbon rich material. Our soils of tropical nature are deficient in carbon and so additions of these materials are necessary. In this juncture the significance of study comes.

Materials and Methods
The investigation on 'Utilization of elephant dung for vermicomposting' was conducted at College of Horticulture, Vellanikkara from January 2009 to May 2011. The elephant dung was procured from Padukkad, the elephant conservation centre of Paramekkavu Devaswam Board, Thrissur, Kerala. In order to study the effect of micro fauna on the in situ decomposition of elephant dung, a field monitoring at Padukkad was undertaken by identifying six stages of degradation of dung *viz*. more than one year old (E_1), one year old (E_2), eight months old(E_3), four months old (E_4), fresh sample constituting of body washings(E_5) and fresh faecal bolus (E_6) (plate 1) Since the dung was rich in lignocellulose, isolation of native lignocelluloses degraders was carried out (Sharma, 2007) [5]. Vermicomposting of dung mainly focused on identification of suitable microbial degraders for pre composting (factor M) and selection of the best substrate for vermicomposting (factor S). The design followed was factorial CRD with the two factors, factor S and factor M. Factors M and S were at four levels with two

replications. Accordingly, 32 treatment combinations, 4x4x2 were tested. The compost worm used was *Eudrillus euginae*. The factor without microbes (M_0) was compared with *Pleurotus platypus* (M_1), combination of *Aspergillus flavus* and *Bacillus subtilis* (M_2) and native microbes efficient in lignocellulose degradation (M_3).In M_0 combination earth worms were not used. Combination of lignocellulose degraders (M_2) and native degraders (M_3) were mass multiplied in suitable medium for pre composting process. For that one milliliter of pure bacterial culture and two to three fungal hyphae were inoculated on 300 ml of nutrient broth and potato dextrose broth respectively. Bacterial culture incubated for five days and fungal culture for fifteen days for effective multiplication. For each bacteria and fungus, three liters of nutrient broth and potato dextrose broth were used for mass multiplication.10 liters of boiled cooled water was used for consortium preparation for fungus and bacteria. The pure culture of bacteria and fungus was added to clean bucket and 20 liters of boiled cooled water has been added to it and stirred well using a clean stick.

Different substrate levels included FYM and elephant dung in 1:1 and 1:8 (S_1 and S_3), elephant dung and banana pseudostem in 1:1 and 1:8 (S_2 and S_4). The filling of earthen pot with substrate was done on volume basis. The microbial inoculam *Pleurotus platypus* was given @ 2.30g/kg of substrate; M_2 and M_3 were given @ 250ml/kg of substrate and pre composting with microbial agents were continued for fifteen days. The biotic agent *Eudrillus euginae* was applied @ 60/kg of substrate after pre composting. The moisture content was maintained at 70 percent throughout the experimental period by sprinkling required quantity of water after measuring the daily variations in moisture by moisture metre. The mud pots were protected from sunlight and contents were thoroughly mixed at alternate days till the decomposition was completed. Details of treatments are given in table 1.

The data obtained was stastistically analysed by the method of analysis of variance (ANOVA) (Panse and Sukhatme, 1985) [4] and using DMRT by M STATC programme.

More than 12 months old

12 months old

Eight months old

Four months old

Body washings (Fresh samples)

Faecal bolus (Fresh sample)

Plate 1: Different stages of degradation of dung

Table 1: Different treatment combinations with notations

Treatment Combination	Notation
S_1M_0	FYM :ED* in ratio 1:1, pre composted without microbes
S_2M_0	ED: BPS* in ratio 1:1, pre composted without microbes
S_3M_0	FYM :ED in ratio 1:8, pre composted without microbes
S_4M_0	ED: BPS in ratio 1:8, pre composted without microbes
S_1M_1	FYM :ED in ratio 1:1, pre composted with *Pleurotus platypus*
S_2M_1	ED: BPS in ratio 1:1, pre composted with *Pleurotus platypus*
S_3M_1	FYM: ED in ratio 1:8. pre composted with *Pleurotus platypus*
S_4M_1	ED: BPS in ratio 1:8 pre composted with *Pleurotus platypus*
S_1M_2	FYM :ED in ratio 1:1, pre composted with *Aspergillusflavus&Bacillus subtilis*
S_2M_2	ED: BPS in ratio 1:1, pre composted with *Aspergillusflavus&Bacillus subtilis*
S_3M_2	FYM :ED in ratio 1:8, pre composted with *Aspergillusflavus&Bacillus subtilis*
S_4M_2	ED: BPS in ratio 1:8, pre composted with *Aspergillusflavus&Bacillus subtilis*
S_1M_3	FYM :ED in ratio 1:1, pre composted with native microbes
S_2M_3	ED: BPS in ratio 1:1, pre composted with native microbes
S_3M_3	FYM: ED in ratio 1:8. pre composted with native microbes
S_4M_3	ED: BPS in ratio 1:8, pre composted with native microbes

***ED:** elephant dung ***BPS:** banana pseudosterm

Results and Discussions

The results obtained from the field study under the elephant conservation centre shows that the temperature of degrading dung was always higher than atmospheric temperature indicating that natural decomposition was a continuous process. Considering the C: N ratios, the highest C: N ratio was recorded at four months old sample (E_4) followed by eight months old sample (E_3). The fresh faecal bolus (E_6) was on par with E_2 and also found that E_5 (body washings) were on par with E_1 (fig 1). At early stages of dung degradation *viz* E_3 and E_4, lignocellulolytic break down is taking place leading to reduction in C: N ratio and reducing the substrate of bacteria resulting in their lower multiplication rate during advanced stage of decomposition (E_1 and E_2).

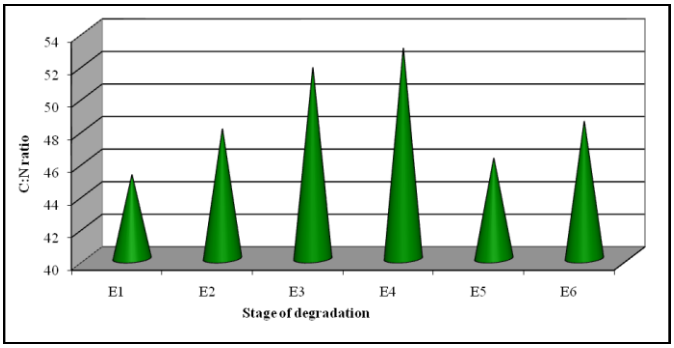

Fig 1: C: N ratio of dung at different stages of degradation

Among the treatment combinations S_3M_2 had higher microbial activity. The microbial consortium (M_2) was found to be efficient lignocellulose degrader (Girija *et al*., 2011) [2]. The substrate combination of elephant dung and FYM in 8:1 proportion had more lignocellulolytic substrate which in turn resulted in the proliferation of lignocellulose degraders At all the stages of composting, the dominance of micro flora was found to be in the order bacteria> fungi>actinomycetes.

Worm multiplication was influenced by the substrate controlled micro environment with the combination of FYM and elephant dung in the ratio 1:8 registering an eight fold increase in worm count at the time of compost harvest (Fig 2). It may be due to high amount of cellulose content in elephant dung. The substrate combination of ED: banana pseudo stem (1:8) recorded the lowest earth worm multiplication rate. It may be due to high moisture content of the substrate banana pseudo stem (BPS) used.

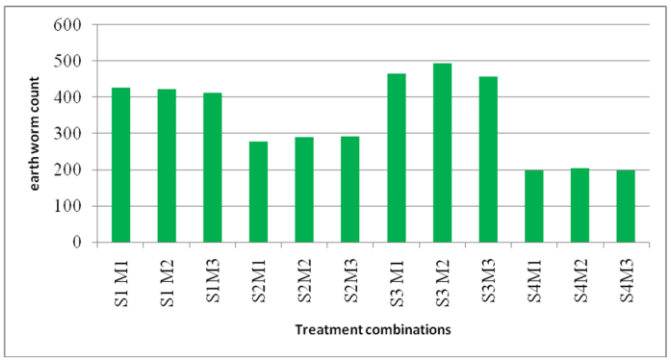

Fig 2: Earth worm count/kg of substrate at harvest stage of composting

There was no significant difference between compost combinations on the maturity days of composting. This may be due to the fact that vermicomposting with different substrates were actually started after the cessation of pre composting with different microbes for fifteen days. But coming to the substrate combination of elephant dung alone, the minimum maturity period was recorded by ED: FYM (1:1) which was on par with ED: FYM (8:1).The highest maturity period was recorded by ED: BPS (1:8) proportion (fig 3). Dung from ruminant animal is a source of lignocellulose degraders which may be the reason for lowest maturity period for substrate combination with FYM. Similar findings were given by Wahyudi, *et al*. (2010) [8]. Considering the influence of microbes, native microbes, and treatment without microbes were on par recording maximum maturity period (fig 3). Consortium of *Aspergillus flavus* and *Bacillus subtilis* have showed minimum maturity period.

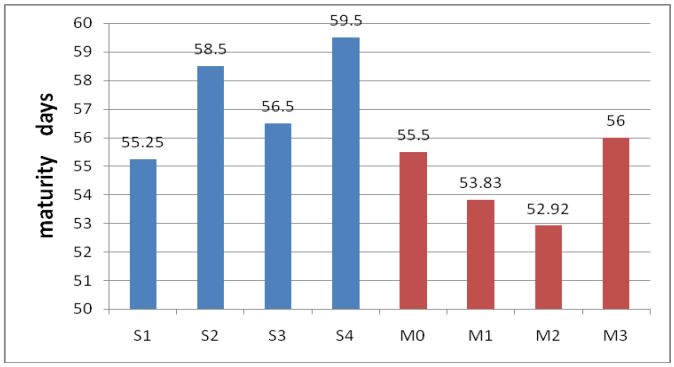

Fig 3: Comparison of maturity days among substrates and microbes

Cellulose, hemicellulose and lignin fractions of dung were accounted to be 35.8, 30.1 and 17.5 percent respectively. Details of physico chemical parameters of substrate used for compost are provided in table 2.There was a reduction of 34.4% in the organic carbon content of the elephant dung with FYM in 8:1 proportion after pre composting with effective lignocellulose consortium (plate 2) of *Aspergillus flavus* and *Bacillus subtilis.* Kaviraj and Sharma (2003) [3] also reported a 25-43% loss of organic carbon during vermicomposting of municipal or industrial waste.

Coming to the nutrient status of enriched vermi composted elephant dung the highest value for N in compost obtained for S_3M_2 and the lowest for S_4M_2 (fig 4). Though the different substrate microbial combination did not influence the nitrogen content of vermi composted elephant dung, the substrate combination of elephant dung and FYM in the ratio 8:1 registered the maximum nitrogen content in the compost. Maximum rate of earthworm multiplication has been noticed in that combination which resulted in addition of nitrogen in the form of mucous, nitrogenous excretory substance, growth stimulating hormone and enzyme from earth worm as reported by Tripathy and Bharadwaj (2004) [7].

Table 2: Physico –Chemical Parameters of substrate used for compost

Parameters	C %	N %	P %	K %	Ca %	Mg %	Na %	pH
FYM	32.3	0.51	0.43	0.53	0.18	0.07	0.19	6.1
Banana pseudostem (BPS)	38.3	0.83	0.38	1.03	0.57	0.30	0.31	7.2
Elephant dung (ED)	48.18	0.864	0.342	0.373	0.192	0.045	0.25	7.1

The P content of compost ranges from 0.45 percent in S_4M_0 to 0.90 percent in S_1 M_3 (fig 5). The highest P content was registered by FYM: ED (1:1) which was closely followed by FYM: ED (1:8). As compared to the introduced microbes the isolated native consortium augmented more phosphorous from elephant dung. So there is a clear role for native microbes in releasing/ solubilising P from different substrate combinations.

As the banana pseudostem (BPS) contained 1.03 % K^+ (table 2), the vermicompost generated from BPS always registered higher K^+ status. The highest K content was recorded in S_4M_1 with 1.04 percent (fig 6). The release of different nutrients in the compost was influenced by the original contents of the same elements in different substrates. Among the microbes *Pleurotus platypus* enriched the compost with highest potassium content. It may be due to the presence of carrier material i.e., talc which is a k source.

The calcium content ranged from 0.025 percent to 0.945 percent in various combinations (fig 7). It was strikingly noticed that in all the compost combination without earth worm has very low calcium status compared to earth worm introduced treatment. It may be attributed due to the presence of calciferous glands in earth worms. In all other combinations, there was increase in calcium status with respect to the substrate combination.

Sodium ranged from 0.09 percent in S_5M_3 to 0.25 percent in S_4M_1 and S_6M_1 (fig 8). Considering the substrate combination, FYM: banana pseudostem (1:8) and elephant dung: banana pseudostem (1:8) proportion recorded highest sodium content. In treatment combinations, those applied with consortium of *Bacillus subtilis & Aspergillus flavus* and *Pleurotus platypus* recorded the highest Na content. There was no significant difference between treatment combinations on magnesium status (Fig 9). Antagonism between calcium and magnesium and selective function of earth worm in calcium metabolism may be the reason. Similar report of antagonism was reported by Bindhu (2010) [1] during vermicomposting of spent mushroom substrate.

Aspergillus flavus and *Bacillus subtilis* released significantly higher contents of Na^+, Ca^{2+} and Mg^{2+}. The compost (plate 3) from the substrate combination of ED: FYM (8:1) pre composted with *Aspergillus flavus* and *Bacillus subtilis* on an average manurial value of 10.78% C, 1.34% N, 0.66% P, and 0.61% K^+, 0.67% Ca^{2+},0.04% $Mg^{2+}$and 0.12% Na^+ with a pH value of 7.3.

Plate 2: Effective Microbial consortium

Plate 3: Compost of S_3M_2

Conclusion

The study on utilization of elephant dung for vermicomposting revealed that elephant dung and FYM in the ratio 8: 1 must be pre composted with *Aspergillus flavus* and *Bacillus subtilis* in order to reduce the maturity period of compost. Moreover the same treatment recorded high rate of microbial activity, maximum earthworm multiplication rate and high nitrogen, phosphorous and calcium status. Even though the native microbes isolated from dung have no significant effect on lignocellulose degradation, it helps in releasing/ solubilising P from different substrate combination.

It has also been noted that in all compost combination without earth worm has very low calcium status compared to earth worm introduced treatment.

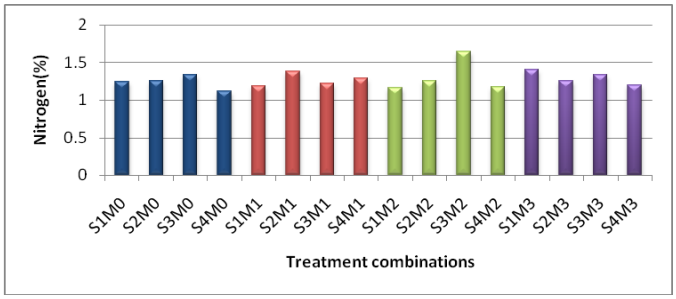

Fig 4: Nitrogen content of compost as influenced by different treatment combinations

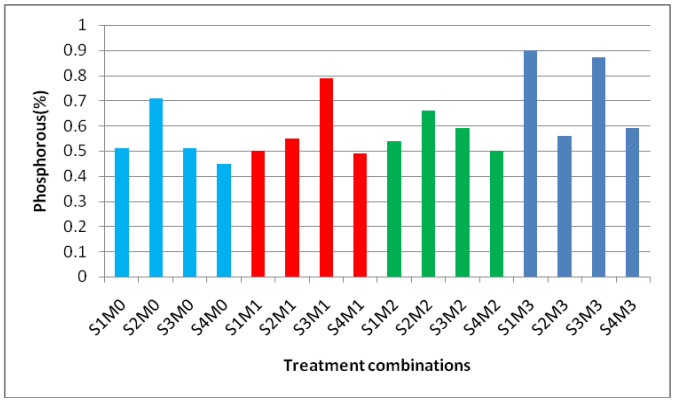

Fig 5: Phosphorous content of compost as influenced by different treatment combinations

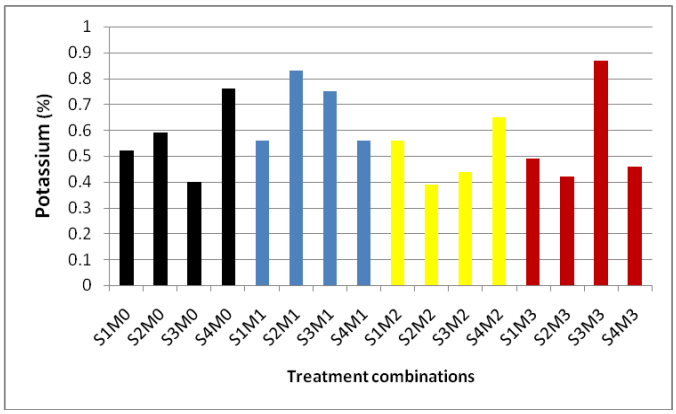

Fig 6: Potassium content of compost as influenced by different treatment combinations

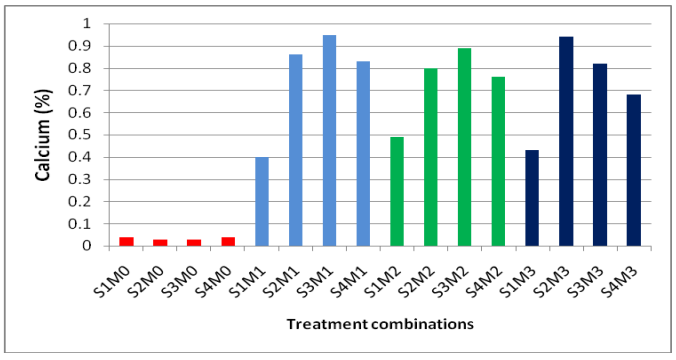

Fig 7: Calcium content of compost as influenced by different treatment combinations

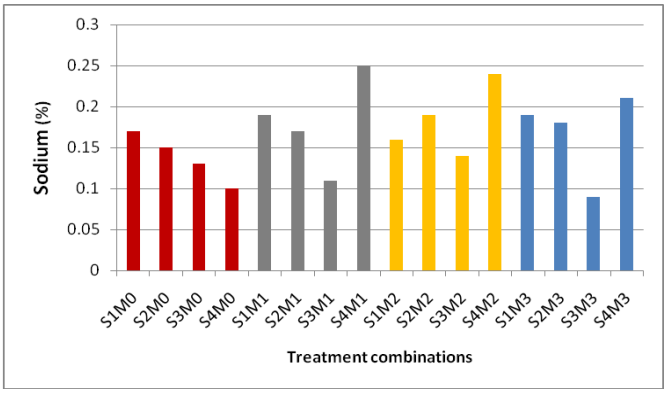

Fig 8: Sodium content of compost as influenced by different treatment combinations

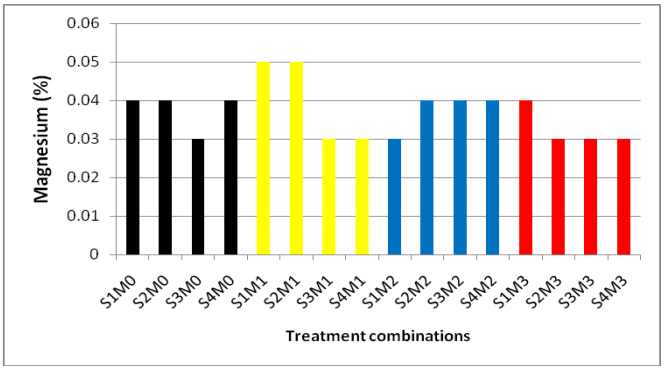

Fig 9: Magnesium content of compost as influenced by different treatment combinations

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