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Transformation of Wet Garbage of Indian Urbanites at Household Level

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Abstract:

Human activities of all sorts generate waste and waste has to be managed properly. An illusion that anyone can think of is to throw the accumulated waste away from homes to keep clean and tidy within their dwellings. The objective of house-hold management of waste is to transform the wet/organic waste/garbage into resourceful compost by providing feasible, arable environment for microbial (aerobic) and compost earthworm activities. Since several decades several methods/protocols has been laid for, yet an easiest ways and means is not yet a near-reach of a kitchen worker. The method that has been mentioned in the current research is simpler, instantaneous and a natural aerator system that the waste itself adopts, is beyond imagination and one can keep their waste in the corner of one's kitchen which is organic waste container without obnoxious odor, without fly menace and without leachate but emancipate a pleasant fruity odor/ after rain smell – a proof of healthy composting activity that will be set within 24hrs. The only another raw material (can be called as leachate absorbing raw material – LARM) that one need to outsource is coirpith/cocopeat from coir industry available in the Southern states of India and bagasse from sugarcane factories in the North-Western states of India and jute waste from Eastern parts of India. In the present study as model two sets of wet garbage generated in urban family has been taken up. Four member family and a ten member family work have been shown to prove the vermicomposting activities throughout the year, irrespective of season in a simpler, semi-scientific manner.

Keywords: Earthworm activity, Odorless, Leachate, Ligno-cellulose, Waste, Fly menace, Wet garbage.

1.0 Introduction:

The prime importance of household waste management is to know the type of waste, form of waste and categories of waste. One can bifurcate the waste as wet/organic garbage and dry/inorganic recyclable/non biodegradable waste. The current research activity deals with the wet organic garbage at household level. The study is shown to prove a simple form of safe conversion of wet garbage generated at home. Management of wet garbage can become house-hold affairs to reduce the risk and burden faced by the municipalities/corporations to certain level. As Satterthwaite (1999) clearly reports that one of the principal limits to the sustainability of towns and cities is the disposal of solid waste and waste water. Weber and Heinrich (1982) have shown the importance and mandatory options of complete and systematic practice of composting methodologies for wet/organic garbage.

Prior to the composting/vermicomposting of the house-hold garbage it is a must to quantify wet waste. Wet organic waste accounts for 70-75% of total waste generated from households that include leftover food, fresh peels of fruits and vegetables (with seeds), soiled tissue, scraps of meat and bone, used paper baggage, soiled cloth etc., all that can go in for transformation in bioremedial way by means of initial aerobic degradation and followed by vermiculture biotechnology. A beginner need to get an idea of generation of average wet garbage/day/week/month/year produced in his/her house to maintain required number of containers, required area to place the containers, required earthworm biomass for feeding activities, required quantity of coirpith/cocopeat/bagasse/jute waste or any other similar agro-industrial waste powder of ligno-cellulosic origin depending on one's place of dwelling.

Literature survey suggests that aerobic composting (Kale and Sunitha, 1993; Gautam *et al*., 2010; Theresa *et al*., 2008) is more advantages in terms of faster processes. The present research work shows the better and easiest technique for no odor problems and less or no fly menace and no leachate conditions. Aerobic composting always suggested to be carried out above the ground level for proper air circulation, to enhance aerobic microbial establishment and for easier workability. The above ground composting needs to be done by making permanent structures: like tanks or stacks or using cement well rings (Sunitha and Kale, 1995). Care is to be taken for the height or depth preferably of 1.5 to 2.5ft; however the length and breadth of the area of the tank can be according to one's interest. Workers have already shown the importance of vermicomposting in the biodegradation of organic wastes (Bhiday, 1994; Gandhi *et al*., 1997; Manna *et al*., 1997; Subler *et al*., 1998, Edwards, 2000).

In the present paper a feasible protocol has been provided for the house-hold levels that works very well under semi-scientific-systematic principles; can be easily adoptable by each and every household in such a way that the transformation of wet/organic waste/garbage becomes one's private issue. The aim of the study is to prove the simplest method of transformation of wet garbage as it is generated at home into vermicompost in a given time and space without much labor involved in it. Apart from aerobic vermicomposting, the trick is to handling of the wet garbage by using leachate absorbing raw materials (LARM) of lignocellulose base available throughout the country as wastes of cocopith, jute waste and bagasse. The objective of the study proved that using LARM material was the best option to get rid of leachate; fly menace and odor at one go. Having 3-4 recyclable plastic containers the wet garbage generated per year was transformed into vermicompost - a value added aerobic compost used for the ornamental plants and for kitchen gardening.

2.0 Materials and Methods:

The following method was laid for an orderly transformation of wet garbage produced at household level considered for 4-member and 10-member family as models. Health conscious urbanites consumed more of plant-based food thus produced wet garbage **(Fig. A)** that varied 500g-700g/day (av.600g) for a 4-member family and 600g-900g/day (750g) for a 10-member family. The Experiment was conducted for one year using 4-member family as one model and 10-member family as another model. Table 1 gives detailed aspect of wet waste generated/day/month/year.

On an average the wet garbage contained 90% moisture that formed the leachate during decomposition which was made to absorb by using Leachate Absorbing Raw Materials (LARM) cocopith, bagasse and jute waste. Table 2 provides the daily utilization of LARM that was calculated for one year from the feasibility aspect of procurement and storage. The required size of the plastic basins taken were of 1.5ft diameter (from outer rim) and with 0.75ft depth. Such container held 17Kgs of wet garbage inclusive of prescribed quantity of LARM. The required number of containers per year was calculated based on time and quantity of wet garbage with LARM taken for filling in an annual cycle and the obtained vermicompost/year are shown in Table 3. A layer of LARM was spread over at the basement of the container for initial absorption of oozed out leachate from the wet garbage. Day- to- day kitchen waste/ wet garbage collected was transferred to the container. In the night before going to bed, recommended quantity of LARM (Leachate Absorbing Raw Material), was evenly sprinkled on the surface of the waste. Average of 100g and 150g of LARM was used for a 4-member family and 10-membered family model respectively.

When the first plastic bin (A) with wet garbage and LARM completed its 60days cycle, it was ready with vermicompost and reusable earthworms. Then this container (A) was reused for the next set of wet garbage collection on day-to-day basis. Likewise the containers (B) and (C) were reused after their turn of 60^{th} day each. Thus in a very practical way the same 3 containers (A, B and C) were repeatedly used again and again (at least 4 cycles) on each completion of the 60^{th} day. In a similar fashion, for a 10-member family, only 4 containers were sufficed to carry out the transformation of wet garbage in 365days (Table 3). Compost earthworms *Eudrilus eugeniae* and *Eisenia fetida* were used together that fed the aerobically decomposed material in the containers from surface to the inner depth and voided excreta-the vermicompost. Earthworms were collected back from the container by inverting on the ground for 30mts to procure bundled up earthworms from the heaped vermicompost and were simultaneously released into the next container of aerobically decomposed material.

3.0 Results and Discussion:

The study and the research were carried out in a semi-scientific yet systematic ways based on several years of experiences in micro level as well as macro level studies under semi-laboratory conditions utilizing an array of organic wastes, agro-industrial wastes and wet organic garbage (Kale and Sunitha, 1993; Sunitha and Kale, 1995a, 1995b, 1997; Kale and Sunitha, 1994; Kale *et al*, 1993, 1994; Sunitha *et al*, 1994; Sunitha, 2001). The steps provided in the present study were the scientific data but shown in semi-scientific format, to popularize the simplicity in the transformation of household wet garbage in an annual cycle using recyclable quality of plastic containers, that were of circular type, much preferred and recommended to get more surface area for aerobic activity of the wet garbage and LARM. The study model taken up to show a classical example of 4-member and 10- member family, typical family types seen throughout the country.

Table 1: Generation of Wet Garbage in a 4-Member and 10-Member Family/day/week/year

Wet garbage generated	Wet garbage generated (average)	
	4-member family [all adults]	10-member family [extended family with two children]
Per day	600g or 0.6Kg	750g or 0.75Kg
Per week	4.2Kgs	5.25Kgs
Per month	18Kgs	22.5Kgs
Per year	219Kgs (220Kgs)	273.75Kgs (275Kgs)

The only outsourcing material was the leachate absorbing raw material (LARM), a well known array of wastes from agro-industries such as coir industry (cocopith/coirpith) **Fig. B**, cane factory (bagasse) and jute industry (jute waste). The LARM being completely ligno-cellulosic material and an organic nature obtainable readily in powder form, as processed, as bailed and as briquette that readily acted as absorbents of leachate oozed out in the wet garbage. As was well known that these materials are the most abundant in the world as plant- based, ecofriendly and outsourcing was not a difficult task. Several workers have proven the use of lignocellulosic materials for composting purposes (Kale *et al*., 1994; Berns and Caljar 1999; Fermor, 1993). Bioconversion of lignocellulosic materials helps to provide physical, chemical, biological and structural changes to the cultivable soils (Nagavallemma *et al*., 2004; Manna *et al*., 1997; Vermico, 2001; Zayonc and Sidor, 1990; Parmelee *et al*., 1998; Edward, 2000).

Tropical and temperate countries can rely on any forms of ligno-cellulosic wastes that to be formed into powder and dry form to use as LARM to increase the immediate absorption capacity of the oozed out leachate from the wet organic garbage. In the present study under several observations with permutation and combination, the ratio for the wet garbage to cocopith/bagasse/jute waste were worked out based on 3 major seasonality (rainy, winter and summer). The seasons have been taken into consideration because the wet garbage leachate will be 30% less during summer than in other seasons due to increased atmospheric temp. The required quantity of LARM per day was 100g and 150g per day for a small and for a large family respectively. For an annual cycle of conversion of wet garbage generated per year required quantity of dry LARM was 40Kgs and 60Kgs respectively.

Since LARM was a dry, odorless, inert material of ligno-cellulosic nature and devoid of nitrogenous compounds, became an advantageous that wouldn't undergo any decomposition processes upto one year. But when admixed with kitchen waste, LARM readily acted as absorbent in absorbing the leachate that oozed out from the day-to-day wet garbage. Interestingly, when day-to-day oozed out leachate got absorbed, the entire content in the plastic container became perfectly self packed aerobic organic sponge-like solid state which created a spongy network that made way for air entry, and simultaneously arrested /abated the anaerobic microbes by instantaneous means. Moreover, purifications /fermentations were not a possibility which in turn helped and kept the flies of all sorts away from the containers.

Table 2: Required Quantities of Leachate Absorbing Raw Material (LARM)/day/month/year for a 4- Member and 10- Member family

LARM calendar	LARM requirement	
	4-member family	10-member family
Per day	100g or 0.1Kg	150g or 0.15Kg
Per week	0.7Kgs	1.05Kgs
Per month	3Kgs	4.5Kgs
Per year	36.5Kgs (40Kgs)	54.75Kgs (60Kgs)

Thereby, at one go, by using LARM, the leachate (rather became an enriched solid state nutrient); odor and fly menace were solved. In this way day-to-day wet garbage was piled up and in the night LARM sprinkling evenly continued until the container got filled up, which took 24days (av. of 700g/day) for 4-member family model and 19days (av. of 900g/day) for 10-member family. Thus round the clock, 365days on regular basis the wet garbage was collected and sandwiched with a layer of LARM. The next activity of vermicomposting processes began after 20 – 24days when the contents were aerobically degraded.

The vermicompost is an aerobically degraded organic matter which has undergone chemical disintegration by the enzymatic activity in the gut of worms (Kale *et al*., 1992). Vermicompost is rich in both macronutrients (0.56%N, 1.48% P_2O_5 and 0.36% K_2O) (Shinde *et al*., 1992) and micro-nutrients besides having plant growth promoting substances humus forming microbes and nitrogen fixers (Bano *et al*., 1987). Vermicompost contains appreciable quantities of major as well as minor plant nutrients and when applied to soil, wormcast improved nutrient status of the soil (Kale *et al.*, 1994; Kale, 1998; Sunitha, 2011).

When 200g of compost earthworms of *Eudrilus eugeniae* ***(Fig. C)*** *and Eisenia fetida* were released into each of the aerobically degraded material, the total feeding and defecating activities by the earthworms took place in 16days. Due to the faster activities of earthworms the required number of containers per annum was only 3 numbers for a model of 4-member family and 4 containers per annum for a model of 10- member family. The total quantity of decomposed material inclusive of LARM for a 4-member family model was 256Kgs, which on initial decomposition reduced to 20% and on vermicomposting further reduced to 40% that provided only 102.4Kgs of granular, stabilized vermicompost (with 60% reduction).

Similarly, for 10-member family model in 19days about 17Kgs of wet waste with LARM (rec. addition/day is 150g) was taken per container. The decomposition and the time taken for conversion was similar as mentioned above because the containers used were the same measurement. However the total number of containers required per annum was 4numbers. The total quantities of decomposable wet garbage with LARM were 329Kgs which on initial decomposition and on vermicomposting provided 131.6Kgs of vermicompost **(Fig. D)** with 60% reduction. The values have been taken based on average percentage. The generation of wet garbage or kitchen waste per family may vary on day-to-day basis, but on an average week/ month / annum generation of wet garbage remains uniform more or less irrespective of family type and eating habits.

Table 3: Times and Quantity of Wet Garbage Taken for Filling, Aerobic Degradation, Vermicomposting and the Required Number of Containers in an Annual Cycle

Details	**4- member family**	**10- member family**
Required days to fill one container	24days	19Days
Quantity filled/ container	17Kgs	17Kgs
Required days for aerobic degradation	20days	24days
Required days for vermicomposting with 200g of earthworms	16days	16days
Required number of containers/year	3	4
Aerobic decomposition (after 44days)	13.6Kgs (20% reduction)	13.6Kgs (20% reduction)
Vermicompost obtained/ container	8.16Kgs (with 40% Reduction)	8.16Kgs (with 40% reduction)
Wet garbage /year (inclusive of LARM)	256Kgs (60% Reduction)	329Kgs (60% Reduction)
Quantity of vermicompost obtained/ year	102.4Kgs	131.6Kgs

Fig. A: Typical Wet Garbage of Indian Urbanite

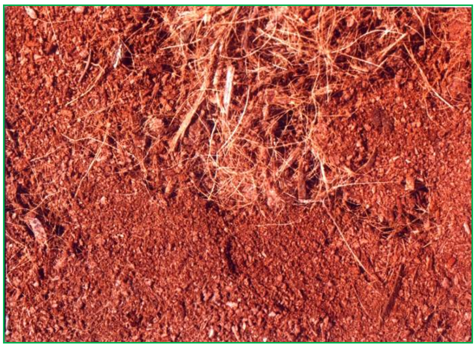

Fig. B: Cocopith [Ligno-Cellulose Waste] as LARM

Fig. C: Compost Earthworm *Eudrilus eugeniae*

Fig. D: Vermicompost - The Final Product

Table 4: Plant Nutrient Status of the Vermicompost Product of Wet Garbage

Sr.No.	Particulars	Values In %
01.	Total organic matter	31.0
02.	Total organic carbon	18.0
03.	Total nitrogen	1.78
04.	Total phosphorus	0.54
05.	Total potassium	0.60
06.	Total magnesium	2.35
07.	Total sulfur	0.65
08.	Total dissolved solids	0.90
09.	C:N ratio	15:1
10.	pH	7.30
11.	Moisture	40.0
	HCl [0.1 N] soluble constituents:	
12.	Iron	200 **ppm**
13.	Phosphorus	0.25
14.	Potassium	0.31
15.	Calcium	1.61
16.	Magnesium	0.42
17.	Sodium	0.54
18.	Available nutrients:	
19.	Phosphorus	0.069
20.	Potassium	0.056
21.	Calcium	0.91
22.	Magnesium	0.23
23.	Sulfur	0.08
24.	Sodium	0.12

4.0 Conclusion:

Instead of disposal options especially as landfills in the Indian scenario, the emphasis should be laid in using wet garbage at the source itself. Although, national and international waste management communities are well aware of the necessity to make use of wet garbage from the organic utilization and pollution abatement aspects (Fehr, 2010), a proper, feasible, simple, semi-scientific technique to convert wet garbage at home itself is still a meager option. The present study has proven to show an attractive home remedy suitable for each and every urbanite to transform wet garbage into leachate – free, non-odorous, no fly nuisance vermicompost by using LARM within 60days by keeping only 3-4 recyclable plastic containers in the home premises. Thus one's wet garbage easily becomes one's private issue to get transformed into vermicompost in reducing the burden, time and energy spent by the municipalities/ corporations at least to certain extent and an educated urbanite would be a happy dweller by safe-guarding his/her own family wet garbage.

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