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Effective Use of Cocopith for Faster Conversion of Sewage Sludge into Vermicompost

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Abstract:

Awareness of the importance and stability of soil organic matter in the barren soils has forced Indian farmers to shift back to the traditional manuring practices. Noted secondary effects of recommended chemical fertilizers and a dearth of farmyard manure [FYM] has led to depend on sewage sludge found in abundance for the cultivable lands. There are a number of constraints associated with the application of both liquid and dewatered sewage sludge on to the land – like, difficulty to spread uniformly on land, storage problems and the human pathogenic organisms' eggs. Vermicomposting of sewage sludge is a well-known fact as a bioremedial process, for better quality in terms of stabilized nutrients, keeping quality and ease in handling. Earthworm *Eudrilus eugeniae* is a well-known species used extensively in India for solid organic wastes. In the experimental studies it was observed that these worms needed more time to convert the sewage sludge without any admixes. The cause is being nitrogenous fat based, sewage sludge is an enriched feed for the worms. The time taken for gut load transit takes more time which has positive effect on the growth and survival of the worms. But under large scale production as business venture this tendancy affects in bulk production of vermicompost. For the present study knowledge on waste biosolids encouraged to use lignocelluloses base to equilibrate earthworms gut transit load in a faster rate and to encourage the use of lignocelluloses biosolids for its added advantages of improvement of physical properties of arable soils. In the current study a varied feed formulations of sewage sludge and lignocelluloses biosolids were administered to worms to study the significance in worms' feeding rate, compost recovery, worm biomass and percent hatchlings keeping in mind for the bulk conversion of sewage sludge at a faster rate. The study shows the feasible proportion of sewage sludge: cocopith for large scale production.

Keywords: Sewage sludge, vermicompost, lignocelluloses, compost earthworm.

1.0 Introduction:

As early as 1956, Gottas, laid importance for sanitary disposal along with equal importance provided to reclamation of organic wastes. Potentialities in utilizing compost earthworms for the scientific conversion of sewage sludge gained importance since three decades. Works of Mitchell et al, 1980; Neuhauser et al, 1988; Loehr et al, 1998; Neuhauser, 1998 reveals in-depth performance of earthworms for the stabilization of sewage sludge to get better manurial effects. The advancement of environmentally acceptable and economically feasible methods for the disposal of sewage sludge is one of the most needed problems to be solved by many municipalities in India. Sewage sludge is the residual material which is produced during the treatment of sewer. The Bangalore Water Supply and Sewage Board (BWSSB), Karnataka State, India, has set up 4 – 5 sewage treatment plants in an approximation of 16,000 ha. of lands. Each sewage plant has been designed to treat about 250MLD of sewerage. On an av. each plant receives about 100 – 150MLDof sewerage /day. The treated effluent is let out to the nearby freshwater bodies with about 88% reduction in BOD and about 80% of reduced SS. The semi-solid sludge that retained everyday is of about 300 – 500tons/day, that will be passed on to the nearby sand drying beds after 45 -50days of stabilization in the anaerobic digesters. The dewatered activated sewage sludge will be sold to the farmers @Rs. 6,000/lorry load [8tons] with moisture about 80%.

With the prime objective of apart from safe composting methods, the study was initiated to work out the feasibilities of using sewage sludge along with cocopith was the objective. Sewage sludge devoid of cellulose base to the maximum extent contain protein and fat substances. Worms feed in sewage sludge and get enhanced tissue growth but as observed the gut load transit will be delayed as noted in the quantity of vermicomposting in given time and space. This was assumed to the fact that sewage sludge as enriched food source suffice to maintain its physiological performances. This was a drawback during bulk conversion of sewage sludge into vermicompost. Henceforth in the present study cocopith was used in different proportion to study the feasibility of feeding, conversion, biomass and hatclings of the worms. Waste biosolid cocopith was used as modulation as an important additive in the feed of earthworms as to enhance faster gut load transit in worms and that addition of cocopith for improving the soils' physico-chemical-biological properties like water retention capacity, porosity, enhanced microbial activity, soil structure etc.

2.0 Materials and Methods:

The required quantity of semi-solid, grayish sewage sludge was obtained from BWSSB, that was mixed with cocopith in ratios [v/v] of T1 = 5 : 1; T2 = 15 : 1; T3 = 30 : 1 and T4 = 50 : 1 in sewage sludge to cocopith ratio. Thus modulated feed mixes were allowed for stabilization of 2 weeks with the maintenance of 60% moisture. Three replicates of representative treatment doses were filled to each of the plastic containers of c.30Kgs each. The feed mixes were left for further stabilization of 5 days and then 200g of preclitellate earthworms were inoculated to each of the feed mixes. Three replicates of respective feed mixes were maintained till the completion of the experimental stage, without earthworms, as control sets. Based on the feed ratios, the worms fed the complete feed mixes at different periods. As and when the feed were exhausted in the containers that particular containers were taken for the study purposes. The worms were sorted and weighed. The odorless, fluffy, granular worm castings were taken for weighing respectively. The numbers of hatchlings were taken to count by the random sampling method. Thus obtained data was analyzed statistically for test of significance following the Fisher's method of Analysis of Variance [ANOVA] as outlined by Sundar Raj et al., 1972.

3.0 Results and Discussion:

The earthworm *Eudrilus eugeniae* is well-known for organic waste degradation since several decades. The earlier workers (Graff, 1981; Bano et al., 1987; Kale and Bano, 1991) have done an in-depth study on this particular species on various feed sources, their age fecundity, percent hatchlings, growth etc. Efficiency of this species over other related organic feeders is high due to its capacity to adapt to varied range of habitat and feed habits, survival factors under semi – natural conditions, maximum growth rate in a short period of time and its high reproductive potentiality. Giraddi, 2008 used 30Kgs as feed substrate to analyse the feeding and defecation under laboratory conditions. Some of the important researchers to work on compost species of earthworms to utilize them for solid waste conversion into vermicompost (Kale and Krishnamoorthy, 1982; Reinecke and Venter, 1985, 1987; Reinecke and Viljoen, 1988 and 1990; Dayananda et al, 2008). Neuhauser et al, 1979 has provided the detailed study of life cycle of compost earthworm. In the present study, sewage sludge and cocopith in different proportion enhanced the growth and reproduction of the worms. Increased proportion of sewage sludge delayed in procurement of worm castings i.e., to say the time taken for vermicompost production increased between the treatments, viz, T1 = ten days; T2 = twenty days; T3 = thirty-six days and T4 = forty-eight days. In the treatment T1 the duration of compost conversion was very fast and took very less days due to the fact of sewage sludge : cocopith was 5:1 proportion. Similarly the time taken for conversion in the further treatments from T2 to T4 increased with increased proportion of sewage sludge and decreased proportion of cocopith. Interestingly the quantity of compost recovered did not show any significant difference as far as the different treatments were concerned. Nearly 90 – 98% of the feed mixes were converted irrespective of the treatment, which was due to the proper mixing of sewage sludge and cocopith to obtain a homogenous mixture.

Table 1: ANOVA table to show the effect of sewage sludge and cocopith [v/v] in different proportions on compost recovery, worm biomass and number of hatchlings

Species		Treatments					
	Parameters	**T1**	**T2**	**T3**	**T4**	**F**	**CD**
Eudrilus eugeniae	Percent compost recovery in Kgs	14.1	15.23	22.86	27.02	2.07	NS
	Percent worm biomass increase	24.8	291.33	315.0	346.66	39.89*	500.32
	Number of hatchlings	22.66	34.33	44.66	66.0	48.06*	9.29

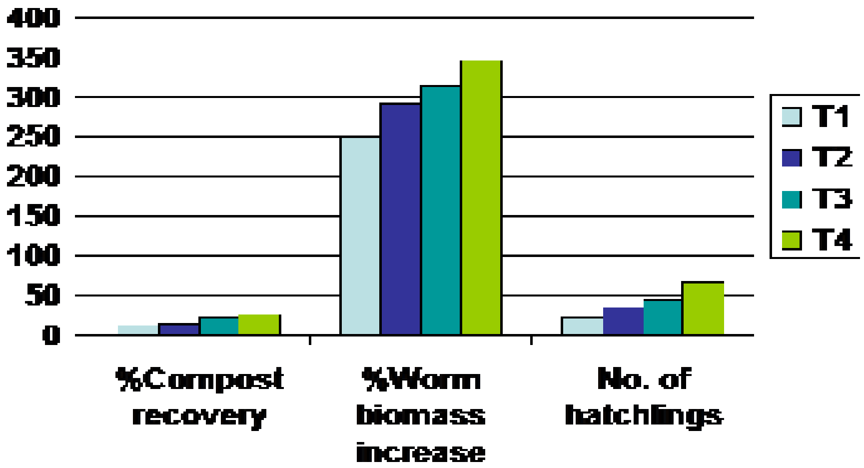


Fig. 1: Showing the treatment effect T1=5:1, T2 = 15 :1, T3 = 30 :1 and T4 = 50 :1[sewage sludge : cocopith ratio] on compost recovery, worm biomass and hatchlings

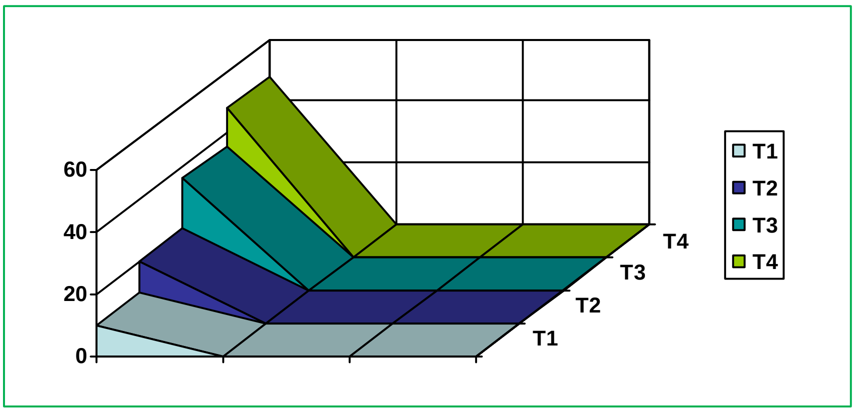


Fig. 2: Showing no. of days taken for feeding and defecation among treatments [T1=10days; T2 =20days; T3 = 36days; T4 = 48days]

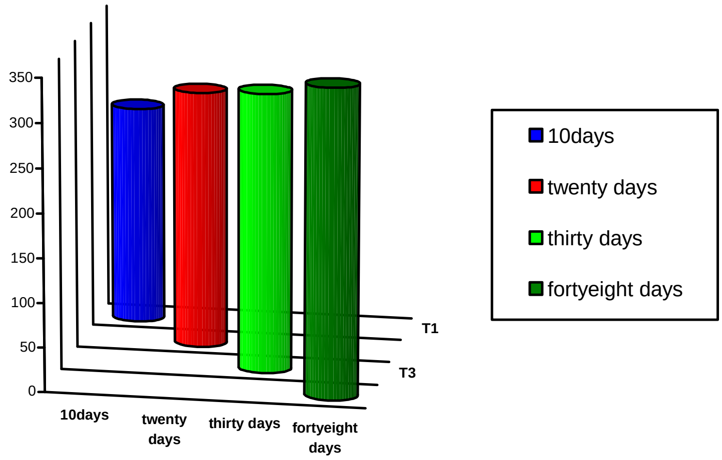
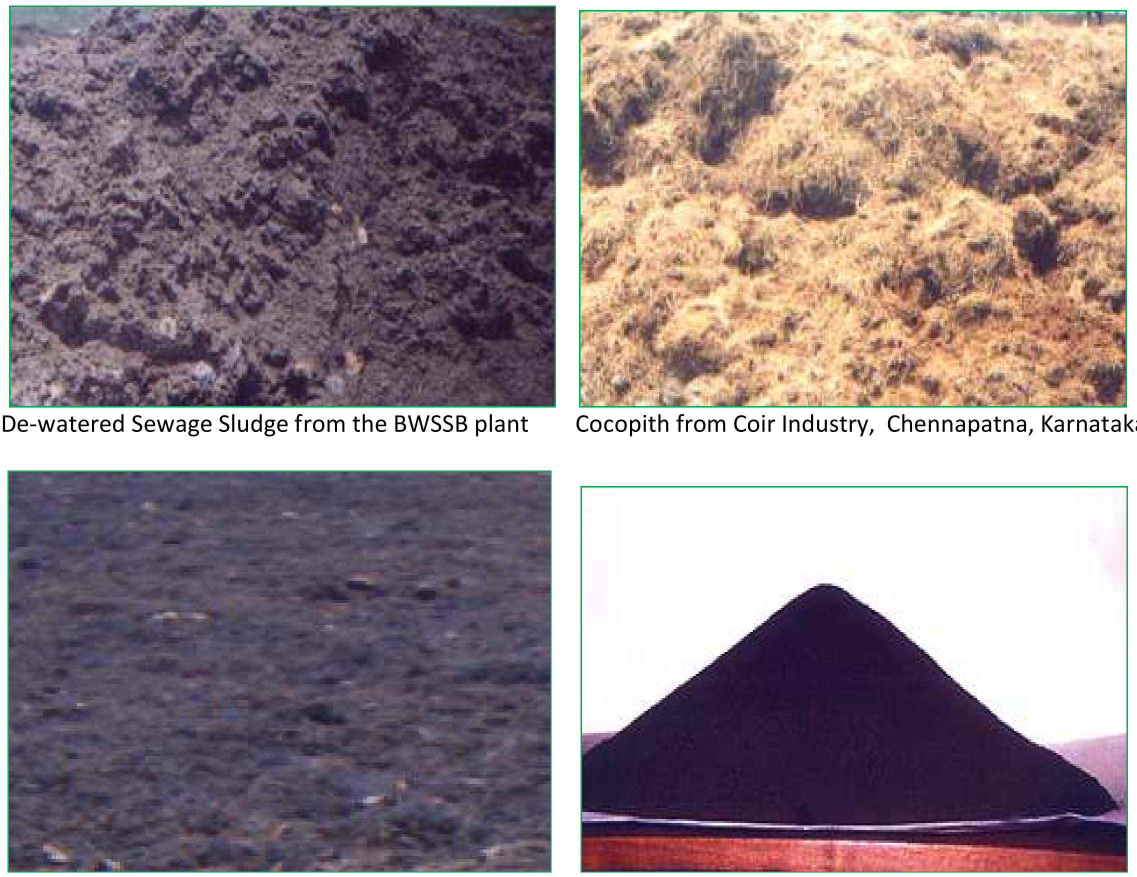


Fig.3: Effect of feedmixes [v/v] on worm biomass [% increase] based on days taken for total conversion of feed into vermicompost



De-watered Sewage Sludge from the BWSSB plant

Cocopith from Coir Industry, Chennapatna, Karnataka

Homogenous mixture

Earthworm castings after sieving in 0.5mm mesh

Fig.4: Photomicrographs of de-watered sewage sludge, coirpith, homogenous mixture of sewage sludge + coirpith and final product vermicompost

Fig.5: Combinational use of sewage sludge and cocopith under semi-natural conditions in a Pilot Scale Project in the author's Farm. To install, as an economically feasible perspective a combination of 15:1 [v/v] sewage sludge: cocopith proportion as 15loads of sewage sludge and 1load of cocopith has been used to make windrows.

Unlike other organic substrates like ruminant dung the sewage sludge is a fine suspended solids and total solids provided is taken in perfect moisture of 60%. Studies by Viqueros and Camperos (2002) have used water hyacinth (weed) as 30% and sewage sludge as 70% feed modulation and the best proportion than other and they have employed *Eisenia fetida* an equally important compost species. Gupta and Garg (2007) have done voluminous work using *Eisenia fetida* for stabilization of primary sewage sludge vermicomposting utilizing 30-40% cow dung for better performance. As the time taken for the conversion increased with increased proportion of sewage sludge, naturally that time factor enhanced the growth of the worms and the cocoon production capacity. As is observed in the Treatments T3 and T4, showed significant increase in worm growth and biomass as well as increased percent hatchlings respectively. Since sewage sludge did not have any adverse effect on the growth and reproductive potential of the worms, it can be certainly utilized for vermicompost production with an additive of biosolids of cocopith for faster conversion, increased production of vermicompost as well as worm biomass and also to facilitate the soils bio-geo-chemical properties. One can rely on a v/v of sewage sludge to cocopith in 15: 1 or 30: 1 for better options.

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