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ASSESSMENT OF VERMICOMPOSTING OF SUGAR FACTORY WASTE USING THE *EUDRILUS EUGENIAE* EARTHWORM COLLECTED FROM PETTAVAITHALAI, TIRUCHIRAPPALLI DISTRCT, TAMIL NADU

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ABSTRACT

During the processing of sugar, various types of wastes are generated which will become potential pollutants unless recycled. The traditional methods of disposal such as open dumping and land filling practices are not only expensive but environmentally unsafe. As vermicomposting can be an alternative technology for converting sugar factory wastes, the present study was attempted using *Eudrilus eugeniae* earthworm. Results of the study indicated a decrease in pH and C:N ratio while there was an increase in total nitrogen, potassium and phosphorous levels in the vermicompost. In addition, there was also a decrease in the content of heavy metals ranging from 12.5 to 50%.

KEY WORDS : Vermicomposting, *Eudrilus eugeniae* earthworm, sugar factory waste.

INTRODUCTION

The problem of efficient disposal and management of organic solid wastes has become more rigorous due to rapidly increasing population, intensive agriculture and industrialization over the last few years (Wani and Mamta Rao, 2013). The various types of environmental and disposal problems caused by the production of large quantities of organic waste all over the world requires sustainable approach in a cost-effective manner (Edwards and Bater, 1992). This has become a very important issue for maintaining a healthy environment (Senapati and Julka, 1993).

India is the second largest producer of world's sugar after Brazil and the largest consumer of the world (Rao, 2005). According to United Nations Department of Agriculture the global sugar production for 2015-16 was 172 million metric tonnes of which India produced 28.5 million tonnes (Bhat *et al.*, 2016). During the processing of sugar, various kinds of wastes are generated like press mud, bagasse, sugarcane trash, sugar-beet mud, pulp, molasses, *etc.* (Bhat *et al.*, 2014, 2015; Balakrishnan *et al.*, 2011). These wastes are potential pollutants unless recycled. The sugar mills usually store these wastes in open fields which pollutes the natural environment of that area (Bhat *et al.*, 2016). These traditional methods of disposal such as open dumping and land filling practices are not only expensive but environmentally unsafe (Slater and Frederickson, 2001).

Vermicomposting by earthworms is a bio-oxidative process which is considered as one of alternative options for converting wastes into nutrient rich vermicompost useful for plants and soil (Bhat *et al.*, 2016). It is also considered as an alternative to fertilizers and can play a major role in sustainable agriculture. Hence, vermicomposting could be an alternative technology for converting sugar industry wastes into valuable manure and so the present study was aimed at vermicomposting of sugar industry sludge using the earthworm *Eudrilus eugeniae* collected from Musiri town panchayat.

MATERIALS AND METHODS

Eudrilus eugeniae, Milk Processing Industry Sludge and Cattle Dung

Young non –clitellated *Eudrilus eugeniae* were obtained from a stock culture reared in the vermicomposting unit of the EID Parry Sugar factory, Pettavaithalai Tiruchirappali, Tamilnadu, India. Milk Processing Industry Sludge (MPIS) was obtained from Kottapattu, near Airport, Tiruchirappalli District, Tamilnadu.The sludge was collected at primary sedimentation stage. The collected sample was air dried for moisture removal. Cattle Dung (CD) was collected from a local dairy farm.

Experimental Design

In the present work, Milk Processing Industry Sludge (MPIS) was mixed with Cattle dung (CD) at different ratios on dry weight basis in two sets with earthworms Mixed Earthworm (ME) and without earthworms (MW) Plastic trays of were filled with mixtures containing different percentages of MPIS/ CD with and without earthworms in triplicates. The total weight of each tray was kept at 1 kg. The trays were covered with jute mat and were kept in a shade located in the Arignar Anna Govt. Arts College, Musiri, Tiruchirappalli District, Tamilnadu. The mixtures were turned over manually every 24 h for 14 days in order to eliminate the toxic gases. After 14 days, 20 young non-clitellated *E. eugeniae* with an average weight 56 kg were released in trays. The moisture content was maintained between 60 – 70% throughout the study period by sprinkling of water. In Mixed Earthworm (ME) sets, earthworm cocoons and hatchlings were counted manually at an interval of 15 days. At the end of the experiment (90 days) the worms, cocoons and hatchlings were removed. The final product produced from all the concentrations were sieved, air dried and physico-chemical parameters were analyzed. The initial physico-chemical parameters of Milk Processing Industry Sludge (MPIS) and Cow dung (CD) were also done (Table 1) prior to starting experiments.

Physico-Chemical Analysis

Physico-chemical analysis was done to determine the availability of total nutrient content in final Milk Processing Industry Sludge (MPIS) feed mixtures with and without earthworms. pH and Electrical conductivity (EC) were determined in a double distilled water suspension of each concentration in the ratio of 1:10 (W/V). Total Organic Carbon (TOC) was measured after igniting 0.5 g of sample in a muffle furnace at 550 ^{o}C for 60 minutes as described by Nelson and Sommers, (1982). Micro – Kjeldhal method of AOAC, (2000). Was used for measuring total Kjeldhal nitrogen (TKN) after digestion. The method described by John, (1970) was used for measuring Total Available Phosphorus (TAP), Total Potassium (TK) and Total Sodium (TNa) after digesting the samples in diacid mixture ($HCIO_4$: HNO_3 in 4:1 ratio). Heavy metals (Copper, Lead, Managanese and Chromium) were measured by Agilent 240 FS AA model Atomic Absorption Spectrophotometer in the digested samples.

RESULTS AND DISCUSSION

The details of the various physico-chemical variables that were assessed during vermicomposting of the sugar industry sludge after a period of 90 days are presented in Table 1.

As evident from the Table, from an initial pH of 8.2 after vermicomposting the pH decreased to 7.1. A review of literature reveals that Basheer and Agarwal (2013) while using earthworms to vermicompost paper-waste recorded a decrease in pH levels from 8 to 7.3 after 65 days, while Albasha *et al.* (2015) using earthworms to decompose kitchen waste recorded a decrease in pH from 7.9 to 7.1 after a period of 60 days and Suthar *et al*. (2012) and Singh *et al*. (2017) using earthworm in milk processing industry sludge also recorded decrease in pH levels. Thus, the above observations are in line with the present investigation. The decrease in pH of the vermicompost could be due to the production of metabolic compounds of aerobic digestion like CO_2, ammonia, nitrates and organic acids as suggested by Hernandez *et al*. (1997).

The total nitrogen in the present study showed an increase from 0.26 to 0.59% thus recording an increase of 0.33%. Hemalatha (2013) reported an increase of 0.72% while using vermicomposting of while Basheer and Agarwal, (2013) an increase of 0.21% and Albasha *et al*. (2015) an increase of 0.24%. The present study also reveals comparable levels except to that of Hemalatha (2013) who recorded higher increase of total nitrogen levels.

With regard to the C/N ratio, the present study recorded a decline of 71.9% after vermicomposting. Literature reveals that Basheer and Agrawal (2013) recorded a decline of 82.23% as also Albasha *et al*. (2015) a decline of 82% (Singh *et al.,* 2017). Comparing these results, the present study recorded slightly lower levels ranging between 23.8 to 97.9% using various species of earthworms. According to Bhat *et al*. (2016), the decrease in carbon to nitrogen ratio indicates decomposition of organic matter and compost maturity in final products of vermicomposting.

Table 1. Initial Physico-chemical properties of sugar production industry waste and cow dung the percentage degradation (with Earthworm and without Earthworm)

S. No.	Physico-chemical Properties	Unit	Sugar industry sludge		Vermicomposting process	
			SCP/W	Cow dung	With Earthworm	Without Earthworm
1.	pH		8.2 ± 0.86	7.8 0.66	40%	1.5%
2.	Electrical Conductivity (ms/cn)		6.2 ± 0.44	3.8 0.94	38%	6.2%
3.	Total Nitrogen	(%)	4.2 ± 0.84	4.2 0.72	48%	2.4%
4.	Total Orgaic Carbon	(%)	46.4 ± 0.72	4.2 0.68	62%	4.5%
5.	C:N ratio	(%)	44.2 ± 0.82	12.4 ± 0.64	60%	3.2%
6.	Total avilable Phosphate	(%)	2.6 ± 0.42	2.1 0.24	62%	8.4%
7.	Exchangeable Potassium	(%)	2.8 ± 0.26	1.8 0.6	72%	9.6%
8.	Total Sodium	(%)	3.9 ± 0.22	2.4 ± 0.4	74%	10.5%
9.	Chromium	(mg/L)	0.8 ± 0.32	0.6 0.28	30%	8.2%
10.	Copper	(mg/L)	0.4 ± 0.94	0.2 0.28	32%	5.2%
11.	Manganese	(mg/L)	1.6 ± 0.82	1.4 0.42	40%	2.4%
12.	Lead	(mg/L)	0.8 ± 0.24	1.8 0.42	30%	3.2%
13.	Iron	(mg/L)	2.4 ± 0.92	2.6 0.62	58%	2.6%
14.	Zinc	(mg/L)	1.9 ± 0.84	1.4 0.43	52%	5.6%

The exchangeable potassium levels showed an increase of 0.33% at the end of the vermicomposting period. Hemalatha (2013) recorded an increase of 0.61% while Basheer and Agrawal (2013) an increase of 0.27% and Albasha *et al*. (2015) an increase of 0.29% at the end of the vermicomposting period. Similarly, the phosphorous levels also showed an increase from 0.62 to 1.7% at the end of the experiment.

Literature indicates that many workers (Sangwan *et al*., 2008; Prakash and Karmegam, 2010; Kumar *et al*., 2010; Sangwan *et al*., 2010; Honarvar *et al*., 2011; Cynthia and Rajeshkumar, 2012; Singh *et al.*, 2017), while working on various vermicomposting substrates including sugar-factory wastes also suggested that with an increase in vermicomposting period, the levels of nitrogen, phosphorous, potassium and sodium increased. This observation was also noticed in the present study.

A perusal of the various heavy metals analysed on the final day of the vermicomposting period reveals that there was a decrease in the levels of heavy metals ranging from 12.5% (manganese) to 50% (copper) with chromium showing a decrease of 25% and zinc 26.31%. Niyazi and Chaurasia (2014) while studying the vermistabilization of fly ash amended with press mud reported reduction in heavy metals ranging from 35-50%. This result is in-line with the present study, eventhough it was on a lower scale.

The possible reasons for the changes in chemical composition of the vermicompost could be due to the earthworm activity like addition of mucous, nitrogenous excretory substances, growth stimulating hormones, microbe mediated transformation and enzymes available in worms as suggested by Sangwan *et al.,* (2010). The results of the present study clearly suggests that earthworms can play a major role in decomposition of sugar factory wastes.

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