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A study on sustainable utility of sugar mill effluent to vermicompost

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ABSTRACT

Rapid increase in the human population beyond the limit of the urbanization, total agriculture land is decreasing day by day which are directly affecting the crop production. Although due to the usage of various chemical fertilizers and pesticides crop production has increased many fold; but their excessive and imbalance usages causing tremendous alterations in natural's soil environment. Vermicomposting, although it has been around long enough to attract world wide attention, is any ways, still in a stage of infancy. Programs aimed to investigate the possibility of large scale vermicomposting. The vermicompost quality of the effluent treated bed is comparatively rich in N, P, K value than the control. From the present investigation it was made clear that the experimental groups Lampito mauritii have high protein content than the control samples hence they are suitable as fish bait, poultry and fish feed.

Keywords: Vermicompost, Effluent, *Lampito mauritii*, fish feed.

INTRODUCTION

In many developed countries, certain species of earthworm have been effectively used in sewage sludge management i.e., to treat the solid and product of sewage. Indeed, earthworm has been called as natures best garbage converters. To prevent waste water pollution from sugar mills, paper mills, distillery wastes food processing units earthworms are used as biofilters. Sugar mill is a large size important industry in India, besides sugar several by products are generated by the industry. Utilization or disposal of Bagasse residue, press mud and the effluent is often a problem.

The term "vermicomposting" refers to the use of earthworms for composting organic matter and the latest biotechnology which helps in giving biofertilizers in the term of vermicompost, for agricultural uses and a high quality protein (earthworm biomass) for supplementing the nutritional energy needs of animals, at a faster rate. Vermicomposts, specifically earthworm casts, are the final product of vermicomposting. It is an aerobic, bioxidation and stabilization non- thermophilic process of organic waste decomposition that depends upon earthworms to fragments, mix and promotes microbial activity [5].

With the advent of industrialization and energy based intensive agriculture, chemical pathways for raw materials conversion became predominant with extensive use of petrochemical based feedstock. The damaging long term environmental impacts and resource depletion indicate un-sustainability of the current methods.

MATERIALS AND METHODS

For the present investigation, soil samples and anecic earthworm species *Lampito mauritii* were collected from Bishop Heber College campus by hand sorting method. The soil samples were grouped in to three and maintained in separate troughs. The first trough is marked as Control and the second as Group I. The third trough is marked as Group II which is prepared as Vermibed using cow dung, straw and biodegradable wastes. All the troughs were kept ready for inoculation.

The Control, Group I, Group II cultures were left for 15 days prior to experimentation and watered on alternate days except the Group I which was treated with sugar mill effluent instead of water.

After 15 days, 25 worms of similar age groups were inoculated separately in the experimental Group I and II trays and parallel control groups. The sugar mill effluent is collected from Arignar Anna sugar mill, Thanjavur. Cultured beds were covered by an iron mesh lid to keep free from white ants and red ants and other animals such as rats, toads and other predators .The experimental troughs were arranged inside the laboratory to prevent direct sunlight .Once in a week the content in the troughs were mixed well. The pH and moisture contents of the bedding substrate were maintained throughout the experiment.

To obtain the coelomic fluid, vermiwash of the *Lampito mauritii*, 15 earthworm of same size were selected in each experimental group and washed thoroughly and for control fresh earthworms were collected from campus. They were kept in a conical flask containing 50 ml of water and kept in the mechanical agitator for 15 minutes. This fluid is collected and the earthworms are released in to the respective groups and the fluid and soil samples collected from various groups were analyzed for micronutrients such as N by Kjeldahl method, P by Stannous chloride method, and K by Flame photometry method.

For the protein and amino acid quantitative analysis, 100 mg of earthworm tissue was taken from each group and ground well in motor and pestle and then analyzed for protein by Lowry method and amino acid by Ninhydrin method.

RESULTS AND DISSCUSSION

The present investigation utilized the anecic earthworm *Lampito mauritii* and its vermicomposting potentials on the control soil, sugar mill effluent treated soil and on the vermibed prepared using straw, cow dung and biodegradable wastes (Fig.1).

The physicochemical analysis of the soil samples, vermicasts were made in the experimental groups. Besides protein and amino acid contents were also measured in the control group, group I, group II, earthworms (Table-1, 2, 3 & Fig 2 & 3).

The vermicompost quality of the effluent treated bed is comparatively rich in N, P, K value than the control (Table-2). The increased amounts of N, P, K in vermicasts indicates that there was enhanced mineralization of these elements due to microbial and enzyme activity in the gut of earthworms [1].

Histogram 1 a shows that encouraging results for N, P, K levels in the vermicasts were obtained when compared to the soil samples treated with effluent and vermibed samples. Especially the vermibed casts recorded higher level of NPK. The results of this experiment has revealed that the N, P, K contents were remarkably higher in the vermicompost collected from the bed which contained the combination of straw and the biodegradable waste as raw material.

The final physical structure of the vermicompost produced from organic wastes depends very much on part wastes they were produced. However the final product from most organic wastes is usually a finely divided peal like material with excellent structure. The nutrient content of the vermicompost differ greatly from control depending on the parent material.

Since earthworm species differ in size and behavior their characteristics have great consequences for the physical and chemical characteristics of soil [1]. The activities include ingestion of soil and organic materials and the intermixing of materials ejection of gut contents as casts and the formation of burrow systems. There is a drilosphere soil zone in the around earthworm burrows which is generally rich in nitrogen, phosphorous and humified organic matter than in the surrounding soils [2]. Kale [9] reported that the biodegradable organic wastes can be converted in to vermicompost. When earthworms feed on organic wastes it undergoes physical and chemical breakdown during processes of ingestion and digestion. About 5-10% of the ingested material absorbed into the tissue for their growth and metabolic activity and rest is excreted as casts, the cast is mixed with mucus secretion gut wall and of the microbes. These add to the structural stability of the cast which is used as vermicompost. The nutrient level depend upon nature of organic waste as food source is as follow: organic carbon 9.15 to 17% total nitrogen 0.5%-1.5% The increased amounts of N, P, K in vermicasts indicates that there was enhanced mineralization of these elements due to microbial and enzyme activity in the gut of earthworms [1]. Similarly, results with *Lampito mauritii* was reported by Ponnuraj et al., [12] using cow dung and Biogas slurry. The casting contain as much as 5 ties more nitrogen, 14 times more potassium than that of 15 cm top soil [13].There are reports that concentration of exchangeable cations such as Ca, Mg, Na, K and available P in worm casts than in the surrounding soil.

Besides microorganisms, inorganic minerals and organic matter, the cast also contains enzymes such as proteases, lipases etc, which continue to disintegrate organic matter even after they have been excreted. Sharma and Madan [13] reported that earthworm casting contain as much a 5 times more nitrate nitrogen,14 times more calcium 3 times more magnesium 11 times more potassium than that of 15 cm top soil. Vermicompost contains more carbon and phosphorous than FYM it has less K and micronutrients than FYM and both had comparable contents of nitrogen.

Vermicompost contains 1.98% N, 1.23% P and 1.59% K. This was also recorded in experiment with saw dust, city waste, sugarcane trash weed plant, press mud and slaughter house waste. The highest enhancement of 1.22% N was recorded for slaughter house waste and least with cane waste. The maximum level of P and K were recorded for press mud vermicompost and least enhancement for saw dust. Vasanthi and Kumarasamy [14] recorded the nitrogen content in vermicompost prepared from organic waste the following order *Ipomea* weed 2.99 %.> banana waste 2.83%> parthenium waste 2.99 %> sugarcane trash 2.67% neem leaves 2.61%.

Amir Khan and Fouzia Ishaq [15] reported that the vermicompost was rich in nutrients like Potassium, Nitrate, Sodium, Calcium, Magnesium, and Chloride and have the potential for improving plant growth than pit compost and garden soil.

Contents of available nitrogen, phosphorus, potassium, calcium and magnesium were more in Milli-compost and Vermi-compost as compared to ordinary compost [16].

Similarly percentage phosphorous content in vermicompost prepared from organic followed the order: *Ipomea* waste 1.37%>parthenium weed 1.30%>banana waste 1.18%>neem leaves 1.17% sugarcane trashes 1.06%.

Potassium content followed he order: *Ipomea* weed 1.46%>banana waste 1.32%> Parthenium weed 1.19%>neem leaves.

On the whole vermicompost cannot be described as being nutritionally superior to other organic manures but unique way in which it produced even right in the field and at low costs make it very attractive for practical application. The methods followed by different workers vary a great deal and steps taken are sometimes arbitrary resulting variation in product quality. Therefore there is need to standardize the method of vermicomposting for obtaining uniformly good quality products.

Earthworms are also used as protein rich source for animal feed because they have 70-80%protein on a dry mass basis. This protein is of a high quality and has good balance of essential amino acids and is especially rich is lysine. The amino acid composition of earthworm is for superior to snail and fish meat. Earthworms are used as a protein rich food source for fishery, Piggery and poultry industries. They also used as a bait for fish throughout the world.

The earthworm tissue contains about 72 % of proteins. These proteins have arginine 4 times that in blood meal and seven times in beef liver. Earthworm protein is also about 2.5 times richer in tyrosine as compared to liver protein. The earthworm has been found to act as a good poultry food [8].

The earthworms have 72% crude protein which is much higher than any other systems worm meal is much better than yeast meal and fish meal. It has biological value of 84% with net protein utilization of 79% and protein efficiency ratio of 4%. The Amino acid composition is far superior to snail, meat, and fish meal. For example arginine is 4.13% in worm meal against 3.4% in fish meal. Likewise tryptophan is 2.29% in worm meal as against 1.07% in meat meal and 0.80% in fish meal.

The essential Amino acid spectrum of earthworm tissue is very rich than the currently used sources of feed proteins. The presence of essential Amino acids in earthworm tissue is sufficient in order to fulfill the recommendations of FAO/WHO particularly in terms of lysine, methionine, cysteine and tyrosine all of which are important components of animal feed. Lawrence and Miller suggested that earthworms contained sufficient protein and considered as animal feed.

From the present investigation it was made clear that the experimental groups *Lampito mauritii* have high protein content than the control samples hence they are suitable as fish bait, poultry and fish feed. Not only protein but high content of nitrogen and fat also have been reported in this species.

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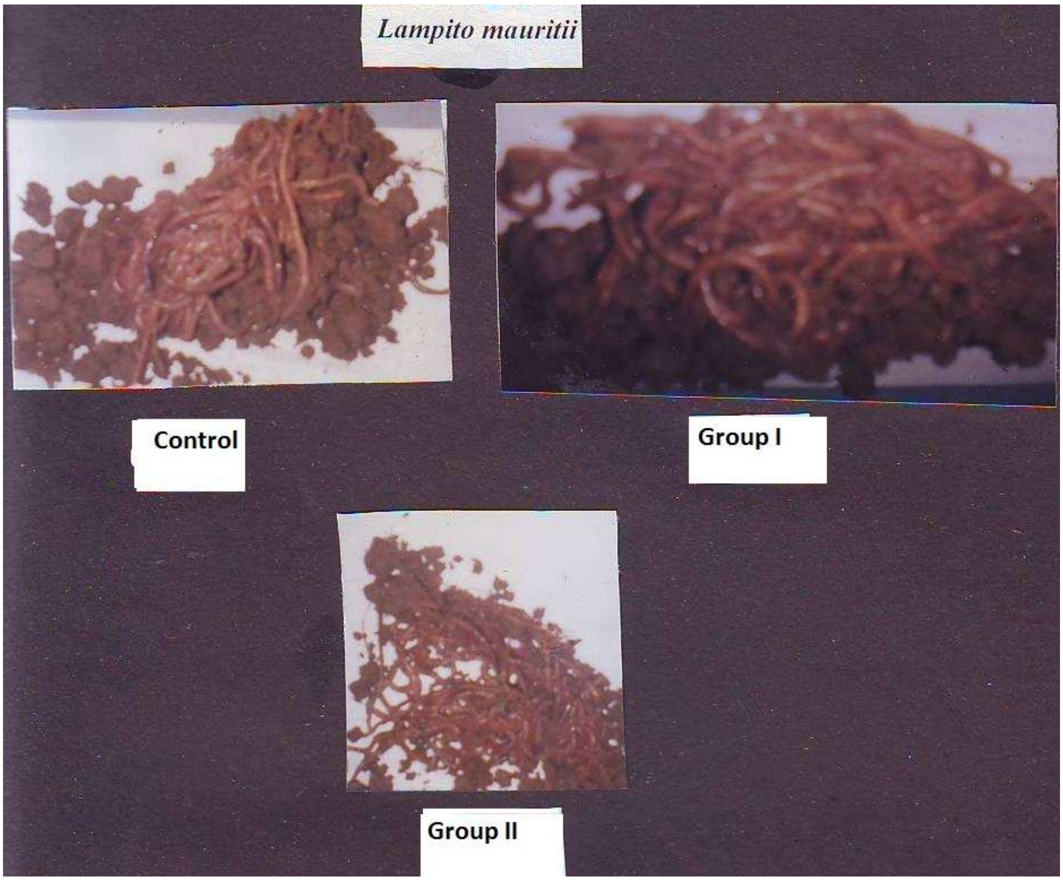
Fig -1:- Photographs showing earthworms of control freshly collected and experimental groups(treated)



Agricultural waste, horticultural waste, animal waste, silkworm litter, plant biomass (leaf litter), weeds, kitchen waste abiding, foul, acidic, spicy and spoilt food, city refuse after removing non-degradable waste material such as glass, plastic, strong rubber and metal can be vermicomposted [9].

The degradable organic matter from wastes when dumped in open undergoes either aerobic or anaerobic degradation. These un-engineered dumpsites permit fine organic matter to become mixed with percolating water to form leachate. The potential for this leachate to pollute adjoining water and soil is high. India where a lot of solid and liquid organic waste is available in different sectors with no dearth of manpower, the environmentally acceptable vermicomposting technology using earthworms can very well be adopted for converting waste into wealth. Considerable work has been carried out on vermicomposting of various organic materials and it has been established that earth-worms can hasten the composting process to a significant extent, with production of a better quality of composts as compared with those prepared through traditional methods. The viability of using earthworms as a treatment or management technique for numerous organic waste streams has been investigated by a number of workers [6, 11].

Table -1:- Physico chemical analysis of Soil samples, Vermicasts of experimental groups

Samples	Soil samples				Vermicasts			
	pH	Temperature ^{0}C	EC mmho/ cm	Alkalinity Meq/100g	pH	Temperature ^{0}C	EC mmho/cm	Alkalinity Meq/100g
Control	7.43	28	0.35	0.75	7.43	28	0.35	0.75
Group I (Effluent Treated)	7.49	29	4.32	1.75	7.13	27	0.21	0.54
Group II (Vermibed)	7.46	29	0.18	0.25	7.18	28	0.13	0.38

EC- Electrical Conductivity

Table -2:- Physico chemical analysis of Soil samples, Vermicasts, Vermiwash of control and experimental groups

Samples	Soil samples			Vermicasts			Vermiwash		
	N%	P%	K%	N%	P%	K%	N%	P%	K%
Control	0.84	2.68	3.48	0.84	2.68	3.48	0.47	0.61	0.36
Group I (Effluent Treated)	1.26	3.24	3.02	0.98	3.02	3.89	0.54	0.4	0.67
Group II (Vermibed)	1.77	2.94	3.62	1.91	3.51	4.17	0.63	0.26	0.72

N – Nitrogen, P –Phosphorous, K - Potassium

Fig. 2:- Physico chemical analysis of Soil samples, Vermicasts, Vermiwash of control and experimental groups

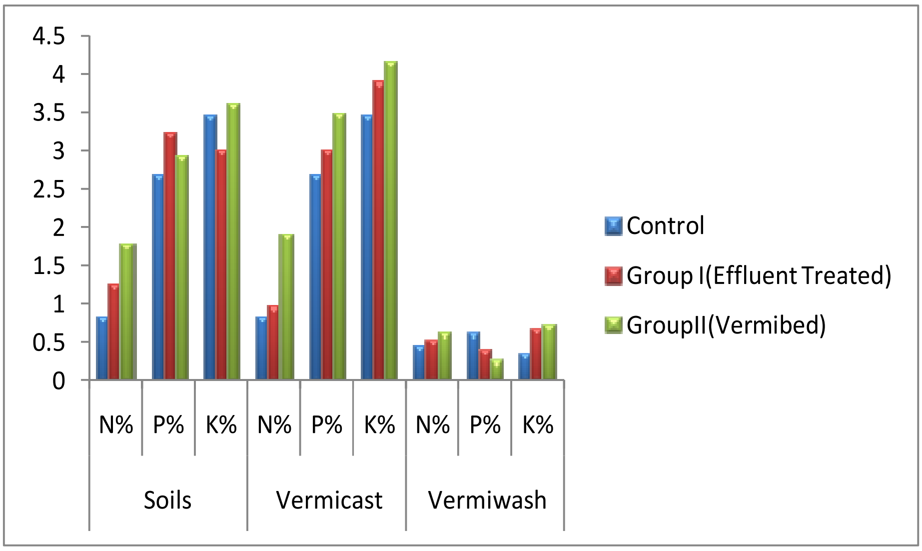
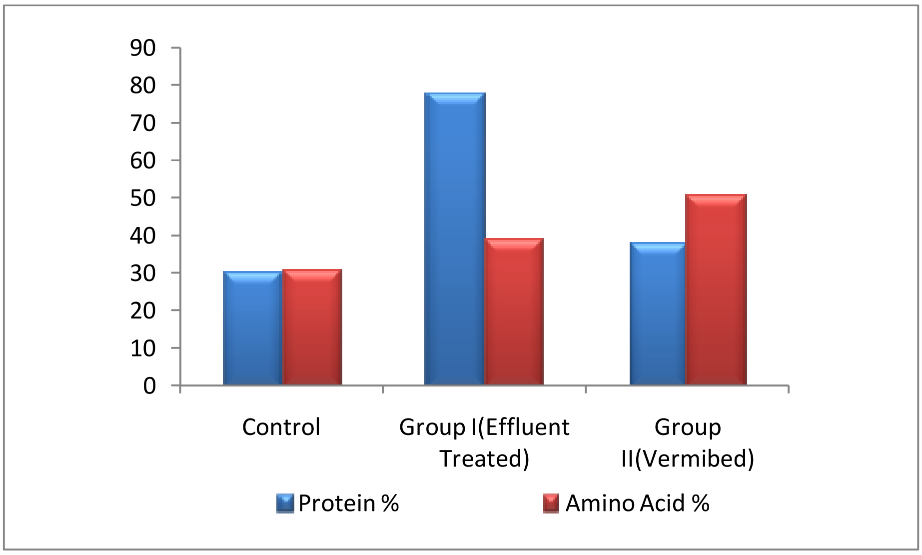


Table -3:- Estimation of Protein and Amino acid in *Lampito mauritii* of various groups

Samples	Protein (mg%)	Amino acid (mg%)
Control	Mean ± S.E	Mean ± S.E
	30.18 ± 2.85	30.76 ± 1.37
Group I (Effluent treated)	77.86±2.15*	39.13±1.61
Group II (Vermibed cultured)	38.2±1.50	51.2±1.14

Fig.3:- Total Protein and Amino acid content of *Lampito mauritii*



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