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Short Communication

Potential utilization of guar gum industrial waste in vermicompost production

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Abstract

Recycling of guar gum industrial waste through vermitechnology was studied under laboratory conditions by using composting earthworm *Perionyx excavatus* (Perrier). Three different combination of guar gum industrial waste namely guar gum industrial waste:cow dung:saw dust in 40:30:30 ratio (T_1), guar gum industrial waste:cow dung:saw dust in 60:20:20 ratio (T_2), and guar gum industrial waste: cow dung:saw dust in 75:15:10 ratio (T_3) were used for vermicomposting experiments. Chemical changes during vermicomposting were measured and comparatively T_2 showed great increase (from its initial level) for total N (25.4%), phosphorus (72.8%) and potassium (20.9%) than the other treatments. T_2 also showed higher vermicomposting coefficient (VC), higher mean biomass for *P. excavatus* (146.68 mg) and higher cocoon production (about 21.9% and 645.5% more than the T_1 and T_3, respectively). Maximum earthworm mortality during vermicomposting was recorded with T_3 treatment while zero mortality was recorded for T_2 treatment after150 days. Overall, T_2 treatment appeared to be an ideal combination for enhancing maximum biopotential of earthworms to management guar gum industrial waste as well as for earthworm biomass and cocoon production.

Keywords: Industrial waste; Vermicomposting; *Perionyx excavatus*; Cocoon; Guar gum

1. Introduction

The agriculture based industrial organic residues are candidate for transformation from expensive disposal problem to suitable vermistabilize humus for use in food production. Much attention has been paid in recent years to evolve the low input basis eco-friendly technologies for industrial waste management. Now a day's intensive research has been conducted on the potential use of earthworms in the stabilization of natural and anthropogenic wastes. Vermicomposting is an eco-biotechnological process that transfers energy-rich and complex organic substances into stabilized humus like product (Benitez et al., 2002). Earthworm aerates, shrade, grind and turn the organic material offsetting expensive specialized machinery, environmental pollution and, fossil-fuel consumptions disposal problem. There has been extensive research into using earthworm to manage the various industrial waste (Elvira et al., 1998; Benitez et al., 2002; Maboeta and van Rensburg, 2003; Garg and Kaushik, 2005).

The guar gum is obtained mainly from *Cyamposis tetragonoloba* L. Processing of the plant for producing guar gum powder produces high quantities of ligno-cellulogic waste material, which could be used for vermicomposting. The aim of this work was to use guar gum industrial waste along with some organic supplements to develop a vermicomposting process by using composting earthworm species *Perinyx excavatus* (Perrier) for under laboratory conditions.

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2. Methods

The industrial waste was collected from Rajasthan Guar gum Ltd., RICCO Industrial Area, Jodhpur, India. It was packed in gunny bags, brought to the laboratory and dried in shade for three days. Composting earthworm species *P. excavatus* were acclimatized for laboratory conditions for about 15 days and was cultured using pre-composted cow dung and when they attained sufficient size, were used for experimentation.

The guar gum industrial waste was mixed with other supplements i.e. saw dust and cow dung in different ratios and put in plastic containers (20 cm h × 28 cm diameter). Three different combination of industrial waste with other supplements were used: (i) Guar gum industrial waste + cow dung + saw dust in 40:30:30 ratio (T_1), (ii) guar gum industrial waste + cow dung + saw dust in 60:20:20 ratio (T_2), and (iii) guar gum industrial waste + cow dung + saw dust in 75:15:10 ratio (T_3). Each treatment was done in triplicate and same set-up without earthworm were also maintained, which served as control. All beddings were kept for 20 days prior to experimentation for thermal stabilization, initiation of microbial degradation and softening of waste. The moisture level of containers was maintained about 60–70%. Twenty healthy earthworms were isolated from the stock culture, pre weighed, and placed in each experimental container. To prevent evaporation of water content, mulching was done using paddy straw. All containers were incubated at a room temperature of 26.3 ± 0.4 °C. Container were placed in moist and dark place. At the start of the experiment, the guar gum industrial waste and the vermicompost produced at the each 30 days interval during the course of experiment were measured for organic C, total N, available P, exchangeable K and C-to-N ratio. Mean individual biomass, cocoon production and total mortality in different containers were also calculated at the each 30 days interval.

The vermicomposting coefficient for different chemical parameter was calculated by following formula:

$$\mathrm{VC}_x = \frac{\text{Total inrease/decrease in } x \text{ during vermicomposing (experimental)}}{\text{Total increase/decrease in } x \text{ during composing (control)}}$$

Organic carbon was determined following Walkley–Black method. Nitrogen was estimated by Microkjeldhal method. Phosphorus was detected by using tecator model 5012-autoanalyser. Potassium was determined after extracting the sample using ammonium acetate extractable method; analysed by Perkin–Elmer model 3110 double beam atomic absorption spectrophotometer.

Data were subjected for analysis of variance (ANOVA) followed by Duncan's multiple-ranged test to differentiate the significant difference between different treatments for chemical parameters, earthworm growth, cocoon production, and total mortality during experimentation. A Pearson correlation coefficient was used to evaluate the relationship between different chemical parameters and vermicomposting period.

3. Results and discussion

3.1. Chemical changes during vermicomposting

Vermicomposting process caused significant change ($p < 0.01$) in chemical structure of all vermibeds. Composting duration showed significant positive correlation with total N, phosphorus and potassium while significant negative correlation with organic C, C-to-N and C-to-P ratio (Table 1). As summarized in Table 2 organic C showed drastic decrease in all the three vermibeds after 150 days of vermicomposting. Comparatively organic C loss from vermibed was the maximum for T_1 treatment (10% of initial level), followed by the T_2 (9.63%) and T_3 (5.01%) treatments (Table 2). Nevertheless, the higher vermicomposting coefficient for organic C was recorded by T_3 treatment (Table 3). The vermicomposting process accelerates microbial degradation as well as assimilation of organic residues. Earthworm promotes suitable microclimatic conditions that consequently affect C losses from substrates through microbial respiration. Earthworm mediated microbial propagation further accelerates the degradation process of organic waste resources. Thus, composting by earthworms directly affects the organic C budget in wastes (Tripathi and Bhardwaj, 2004; Loh et al., 2005; Garg and Kaushik, 2005).

In present study, the increase in total N content was found in the order: T_1 (25.4%) > T_2 (25.2%) > T_3 (9.83 %) treatments (Table 2). Similarly, the vermicomposting coefficient for total N was recorded maximum with T_1 treatment (Table 3). Earthworm enriches the vermibed with nitrogen through excretory products; mucous and even by decaying worm tissue after death. It has been well established that vermicomposting process accelerates the mineralization of N content in organic waste resources (Tripathi and Bhardwaj, 2004; Garg and Kaushik, 2005; Kaviraj and Sharma, 2003). Greater increase for phosphorus was registered for T_2 treatment (72.8%) followed by T_1 (45.7%) and T_3 (54.8%) treatment (Table 2). According to Lee (1992) organic residues passes through the gut of earthworm results in sum of phosphorus being converted to forms that are plant available. He concluded that some release of P in forms available to plants is than mediated by phosphatages that are produced with in the earthworm and further release of P may be introduced by microorganism

Table 1
Pearson's correlation coefficient between composting period and chemical parameters

	T_1	T_2	T_3
Composting period, C	−0.982**	−0.992**	−0.829**
Composting period, N	0.947**	0.958**	0.829**
Composting period, P	0.918**	0.953**	0.949**
Composting period, K	0.983**	0.958**	0.965**
Composting period, C/N	−0.974**	−0.971**	−0.857**
Composting period, C/P	−0.966**	−0.950**	−0.954**

** $p < 0.01$.