

Role of admixtures in decomposing coir waste - their impact on chemical changes and vermicast production

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Abstract

Coir pith is a major farm waste in the coastal region of Orissa and due to slow biodegradation this agro waste poses difficulty in recycling. Therefore, the present studies were made to evaluate various admixtures with coir waste for quick degradation as well as to make them acceptable by the earthworms as feed. The studies revealed that neem leaves (30% w/w), cow dung + urea 0.5% sol. and buttermilk 10% sol., as admixtures have enhanced the partial degradation process of the coir waste. Addition of only cow dung 30% or neem leaves 30% with coir waste also showed reasonably high nitrogen content (0.71 to 0.89%) in 60 days of partial degradation of coir pith. Moreover, the acidic reaction (pH 5.83) of raw coir pith could be neutralized (pH: 7.27-7.37) with such admixtures. However, appreciable reduction in C:N ratio of the substrate was noticed when urea 0.5% and urea 0.5 + cow dung 30% were utilized as admixtures with limed coir pith. Based upon the average of two years data the

additives like neem leaves (30%), cow dung (30%) + urea (0.5%) and butter milk (10%) proved effective not only for hastening the degradation of coir pith, but also enhanced the cast production by the worms.

Introduction

Vermicompost has now been considered as a potential input for sustainable agriculture and it is gaining importance as an important component of integrated plant nutrition system (Purakayastha and Bhatnagar, 1997). A variety of biowastes have been studied by various research workers in the past for the production of vermicompost. However, limited studies have been made in composting coir pith which is a major farm waste in the coastal region of Orissa. Due to wide C:N ratio coupled with low nitrogen content, high lignin content and presence of soluble tannin related phenolic compounds (8-12%) this agro waste undergoes slow biodegradation and pose difficulty in recycling (Kadalli and Nair, 2000). Therefore, attempts were made in the present studies to evaluate

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various admixtures for quick degradation of coir waste so as to make them acceptable by the earthworms as feed. The chemical changes during the degradation process and the quantum of cast production by earthworms in response to such degraded coir waste, were also investigated.

Materials and Methods

The experiments were conducted during 2002-03 and 2003-04, at the Regional Research and Technology Transfer Station (RRTTS), OUAT, Keonjhar. The coir waste collected from local sources were first treated with 1 % lime solution so as to neutralize its pH and then 15 kg of such limed coir pith was mixed separately with admixtures like cow dung 30 % (w/w)(T₁), neem leaves 30 % (w/w)(T₂), Oyster mushroom spawn *Pleurotus sajorcaju* (1:4)(T₃), buttermilk 10 % sol. (T₄), urea 0.5 % sol. (T₅) and cow dung 30% (w/w) with urea 0.5 % (T₆), in different wooden crates. Thus, there were six treatments comprising of the different admixtures. Care was taken to keep the amended coir waste wet by sprinkling water as and when necessary until its degradation.

In order to ascertain the progress of decomposition in respect of the admixtures used, about five kilograms of each of the above treatments were taken into a polythene bag (length: 45 cm; diameter: 15 cm) separately. The height of poly bags with coir waste were measured initially and then it was kept undisturbed under laboratory conditions for a period of 60 days. The extent of initial shrinkage in height of the poly bags in response to the progress of

decomposition of coir waste was also ascertained by measuring the volume of the amended coir waste at periodical intervals of one week and such measurements were taken up to three week of decomposition. The percentage of reduction in volume during degradation was then calculated to indicate the efficacy of the admixtures in the decomposition of coir waste.

About 15 earthworms each of the species viz., *E. eugeniae*, *E. foetida*, *D. willsi* and *L. mauritii* were cultured separately in G.I. trays (60 x 25 x 10 cm) and two kilograms of partially decomposed coir pith from each test admixture was provided as food for the earthworms, separately. Adequate care was taken subsequently to keep the moisture content of the soils optimum for earthworms by sprinkling water as and when necessary. The quantum of casting generated by earthworms irrespective of species at the lapse of four months of culturing was estimated during both the years of study and the average data was used to indicate the effect of admixture in vermicast production.

The pH, organic carbon, total nitrogen and C: N ratios in coir waste during the process of partial degradation were estimated in 2002-03, to record the changes in chemical characteristics. Samples were drawn at 15, 30, 45 and 60 days after decomposition and were subjected to analysis. Analysis of the above parameters was done in the laboratory of All India Coordinated Research Project on Soil Test Crop Response Correlation (ICAR), Department of Agricultural Chemistry and Soil Science, College

of Agriculture, OUAT, Bhubaneswar. The pH of coir compost was measured in coir pith : water (1:5) suspension by means of glass electrode pH meter (Elico model) as described by Jackson (1973). The organic carbon was determined by Walkey and Black's rapid titration method, as described by Jackson (1973). Organic matter was calculated by multiplying the organic carbon value with the factor 1.724. Similarly, the total N content of coir pith amended with various treatments was determined periodically during the process of degradation by modified Kjeldahl method (Jackson 1973).

Results and Discussion

A perusal of the data in Table 1 showed a reduction in the volume from 1.77 to 15.30, 2.94 to 17.64 and 5.60 to 21.35 %, after one, two and three weeks of treatment, with respect to various admixtures, respectively. Quick degradation was noticed in coir waste mixed with neem leaves at 30% rate and a maximum of 15.30, 17.64 and 21.35 % volume of the coir waste could be reduced at one, two and three weeks after the treatment. Similarly, appreciable volume reduction of coir waste was also noticed with the addition of cow dung at 30 % + urea at 0.5 % (20.0%) and butter milk at 10 % (15.88 %) in three weeks of degradation.

However, addition of organic sources like mushroom spent material or inorganic material like urea did not exhibit distinct changes in coir degradation although such materials enhanced the degradation process to certain extent (10.20 - 12.17 % in case of oyster mushroom, *Pleurotus*



sajorcaju spawn and 7.65 - 13.50 % in case of urea 0.5 % solution). Thus, it was evidenced from the above observations that among the various materials tested as admixture with coir waste, neem leaves (at 30%) was considered as ideal for enhancing the partial degradation process and this was followed by the treatments with cow dung + urea 0.5% and buttermilk 10%.

While estimating the organic carbon (OC) and nitrogen content as well as the C:N ratio at 15, 30, 45 and 60 days after degrading coir pith it was found that OC in coir pith varied from 42.4 to 44.5, 36.7 to 44.0, 30.5 to 43.7 and 27.1 to 42.1 % at 15, 30, 45 and 60 days after degradation, respectively (Table 2). In general the reduction of organic carbon content was not discernible

days of composting was therefore considered as appreciable.

The nitrogen content in coir pith during the process of partial degradation with different admixtures ranged from 0.50 to 0.61, 0.50 to 0.68, 0.56 to 0.94 and 0.58 to 1.02 % at 15, 30, 45 and 60 days of decomposition, respectively. The nitrogen content tended to increase from 45 days onwards in partially degraded coir pith. Its value at 45 days of degradation remained comparatively high in case of urea (0.94 %) and urea + cow dung (0.84 %) treatment (Table 2). Maximum nitrogen content of 1.02 % was noticed at 60 days of decomposition when urea 0.5 and cow dung 30 % was added to coir waste. Addition of only cow dung 30 % by weight of coir waste, or urea 0.5 % or neem leaves 30% by weight of coir waste also showed reasonably high nitrogen content (0.71 to 0.89 %) at 60 days of degradation of coir pith. However, comparatively low nitrogen content values were recorded with admixtures like mushroom spawn (0.58%) and butter milk (0.61 %). A high value of nitrogen content in nitrogen amended treatments was quite obvious as addition of fertilizer nitrogen in the form of urea might have released nitrogen through mineralization during the process of decomposition. Since, the nitrogen content was found to be dependant on the degree of decomposition, addition of urea + cowdung, or only urea or cowdung or neem leaves with coir waste seemed to have enhanced the degradation process besides fortifying such materials with nitrogen.

Table 1. Effect of admixture on the partial degradation of limed coir pith

Admixture	% degradation (in terms of volume reduction) weeks after treatment		
	1	2	3
Coir pith (without treatment)	1.77	7.06	7.14
Coir pith + cowdung (CD) 30 %	2.94	2.94	5.60
Coir pith + neem leaves 30 %	15.30	17.64	21.35
Coir pith + <i>P. sajorcaju</i> (1:4)	10.20	11.50	12.17
Coir pith + butter milk 10 %	13.53	14.71	15.88
Coir pith + Urea 0.5 %	7.65	10.20	13.50
Coir pith + CD 30 % + Urea 0.5 %	14.50	17.50	20.00

(Coir pith indicated at SI No 1 to 7 was amended with lime 1 % solution)

Earlier, Patil *et al.* (1999) have observed that composting of coir pith was possible by amending the coir waste with organic waste sources like mushroom spent material or cowdung. The biocontrol agent *Trichoderma hazarianum* used for the control of fungal disease in certain field crops was also reported to be effective degrader of coir pith. In Orissa, Das *et al.* (2003) have reported successful composting of coir pith by using cow dung, lime and urea as amendments and by inoculating fungal culture *P. sajorcaju* and vermiculture *Eisenia foetida*. Therefore, the efficacy of neem leaves cowdung + urea and butter milk, as evidenced from the present investigations, seem to have merit and were considered as the first report as no published literatures are available in respect of the above findings.

at 60 days of degradation, with respect to the admixtures tested, but the treatment with urea and oyster mushroom fungi spawn *P. sajorcaju* showed comparatively low organic carbon content of 27.1 and 33.0 % as against 33.0 to 42.1 % observed in respect of other test admixtures, respectively. Das *et al.* (2003) have also observed higher organic matter content (40.53-41.33 %) at 60 days of decomposition of coir pith with various combinations of *P. Sajorcaju*, vermiculture (*E. foetida*) and nitrogen (urea). However, the above authors have found the lowest value of organic carbon in coir pith treated either with cow dung + lime + nitrogen + mushroom + vermiculture (26.32 %) or cow dung + nitrogen + vermiculture (27.08 %). Low value of 27.1 % in coir pith treated with urea 0.5 % as observed in the present investigations at 60

Similarly, the C:N ratio of the substrate which was wider initially was narrowed down with the progress of decomposition and it ranged from 70.7:1 to 98.9:1 at 15 days after decomposition. Subsequently, the C:N ratio at 30, 45 and 60 days after decomposition were estimated in the order of 54.3:1 to 88.0:1, 32.4:1 to 76.6:1 and 30.4:1 to 66.4:1 with respect to various treatments, respectively (Table 2). The narrowest C: N ratio was observed in case of urea (30.4:1) and urea + cow dung (32.3:1) treatment at 60 days after degradation indicating their superiority as admixtures with the limed coir pith. Das *et al.* (2003) have observed narrowest C: N ratio of 25.5:1 when vermiculture *E.foetida* and oyster mushroom Fungi *P. sajorcaju* were inoculated with cow dung nitrogen and lime amended coir pith. In the present investigations, addition of urea 0.5 % with limed coir pith brought down the C: N ratio conspicuously from 71.8:1 at 15 days of decomposition to 30.4:1 at 60 days of decomposition. Similarly, urea 0.5% + cow dung 30 % also showed perceptible reduction in C: N ratio from 70.7:1 to 32.3:1 for the corresponding periods of decomposition. Thus, from the point of degradation and nitrogen content,

these treatments were considered as most effective for preliminary degradation of coir waste for its use as worm feed.

As the earthworms are very sensitive to hydrogen ion concentration and the fact that soil pH may influence the worms that go into diapauses (Talashilkar *et al.* 2003), the chemical changes as indicated through pH of the substrate i.e., coir pith before and after partial degradation with various admixtures and that of vermicastings were therefore, measured. The observations as indicated in Table 3 have showed that the coir pith as such without any degradation was acidic in reaction with pH 5.83. But, when such substrate was subjected to degradation with various admixtures changes in pH was observed to range from 5.58 to 7.37 with respect to various admixtures tested with limed coir pith. Addition of either cow dung or neem leaves both at 30 % by weight of the substrate have helped to achieve neutral to alkaline conditions (pH: 7.27-7.37), while the rest of admixtures have shown acidic reaction (5.58-6.44) after partial degradation of coir pith. Talashilkar *et al.* (2003) have indicated that most earthworm species preferred soils with a pH of about 7. Das *et al.*

(2003) have observed highest pH value of 7.27 at 60 days of decomposition of coir pith amended with cow dung, nitrogen and lime and simultaneously inoculated with both fungal species (*P. sajorcaju*) and vermiculture (*E. foetida*).

However, low pH of 5.58-5.64 as observed in the present studies in treatment where nitrogen(urea) or cow dung + nitrogen (urea) was added with limed coir pith without inoculating with worms, was in agreement with the findings of Das *et al.* (2003). Instances of worms species other than the ones utilized in the present studies, have been reported thriving well in soils with pH ranging from 4.5 to 4.7 (Talashilkar *et al.*, 2003). A drop in pH in treatments with nitrogen (5.58) and with cowdung + nitrogen (5.64) from the initial value of 5.83 seemed to be due to the formation of organic acids during the process of decomposition. Despite of wider variation in pH values of the partially degraded coir pith the resultant castings produced by the worms showed almost close to neutral reaction (pH 6.75-6.95) with respect to various admixtures tested.

The cast production by test worm species was discernible when the worms achieved optimum

Table 2. Changes in chemical composition during the decomposition process of coir pith

Tr.No.	Admixture	Composition after days of decomposition,											
		15			30			45			60		
		OC (%)	Nitrogen (%)	C:N ratio	OC (%)	Nitrogen (%)	C:N ratio	OC (%)	Nitrogen (%)	C:N ratio	OC (%)	Nitrogen (%)	C:N ratio
1	Lime 1 % + CD 30 %	44.5	0.45	98.9	44.0	0.50	88.0	43.7	0.62	70.5	42.1	0.79	53.3
2	Lime 1 % + NL 30 %	43.8	0.50	87.6	43.6	0.53	82.3	42.9	0.56	76.6	40.2	0.71	56.6
3	Lime 1 % + PS	42.5	0.60	70.8	36.7	0.65	56.5	33.6	0.68	49.4	33.0	0.58	56.9
4	Lime 1 % + BM 10 %	44.2	0.53	83.4	43.0	0.58	74.1	40.5	0.71	57.0	40.5	0.61	66.4
5	Lime 1 % + Urea 0.5 %	43.8	0.61	71.8	36.9	0.68	54.3	30.5	0.94	32.4	27.1	0.89	30.4
6	Lime 1 % + Urea 05 % + CD 30 %	42.4	0.60	70.7	37.6	0.68	55.3	34.49	0.84	41.0	33.0	1.02	32.3

CD : Cow dung dry; NL - Neem leaves; P.S.: *P. Sajorcaju*; BM : Butter milk; OC : Organic Carbon

population at the lapse of 120 days of their culturing in trays under laboratory conditions and it continued for up to 180 days (i.e. from the date of release). Although, no documented reports on the period of maturation of compost in case of coir pith were available Jadhav (1995) had indicated that without earthworms the humification of cow dung and farm waste took 120 and 135 days and with inoculation of earthworms the period of maturation of such waste was reduced by 30 days.

Table 3. pH before and after decomposition of coir pith and earthworm castings, as influenced by amendments

Amendment	pH		
	Coir pith before decomposition	Partially degraded coir pith	Castings
Lime 1 % + CD 30 %	5.83	7.37	6.95
Lime 1 % + NL 30 %	5.83	7.27	6.80
Lime 1 % + PS	5.83	6.26	6.82
Lime 1 % + BM 10 %	5.83	6.44	6.75
Lime 1 % + Urea 0.5 %	5.83	5.58	6.87
Lime 1 % + Urea 0.5 % + CD 30 %	5.83	5.64	6.95

(CD: Cow dung dry, NL – Neam leaves, P.S.: *P. Sajarcaju*, BM : Butter milk)

The cumulative weight of worm castings collected during February and March in both the years of study (i.e., 2002-03 and 2003-04) in respect of the treatments as well as earthworm species showed distinct

variation statistically. In 2002-03, the quantum of cast production irrespective of earth worm species ranged from 55.7 to 95.6 g/tray with respect to the admixtures. The maximum cast production was noticed with admixture like neem leaves (95.6 g/tray) and this was followed by the treatment with butter milk (80.7 g/tray)(Table 4). Similarly, during 2003-04, the addition of neem leaves at 30 % rate with lime coir pith proved to be most effective in enhancing the cast production by the worms (108.7 g/

tray) within 180 days of inoculating the worms. Use of butter milk (10 %) also found to be the next better additive in terms of cast production (90.3 g/tray). However, addition of mushroom spawn of *P.*

sajarcaju with coir pith showed no distinct effects in enhancing cast production by the worms in general during 2002-03 (56.0 g/tray) and 2003-04 (64.1 g/tray).

The average of two years data also indicated the superiority of admixtures like neem leaves and butter milk in cast production by the worms. Irrespective of worm species utilized, the cast production in respect of the above two treatments have been recorded as 102.2 and 85.9 g/tray, respectively which were substantially high as compared to castings produced in case of other test admixtures (57.0-77.6g/tray).

Variation in the quantum of castings as observed in the present studies were also possibly due to the variation in the population density of worms present in different trays, pH of the substrate and the type of admixtures used with the substrate. However, in terms of cast production the admixtures in the descending order of their effectiveness were observed to be neem leaves 30 % > butter milk 10 % > cow dung 30 % (Table 4).

Conclusively, it is suggested that for hastening the degradation of coir pith addition of neem leaves (30 %), or cow dung (30 %) + urea (0.5 %) or butter milk (10 %) was effective and these additives also helped to generate appreciable cast production by the worms.

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Table 4. Cast production by earthworms in response to admixtures used in degrading coir waste

Admixtures	Quantum of castings produced (g/tray) irrespective of worm species, during		
	2002-03	2003-04	Average over years
Lime 1 % + CD 30 %	73.7	81.4	77.6
Lime 1 % + NL 30 %	95.6	108.7	102.2
Lime 1 % + PS	56.0	64.1	60.0
Lime 1 % + BM 10 %	80.7	90.3	85.9
Lime 1 % + Urea 0.5 %	67.4	71.1	69.3
Lime 1 % + Urea 0.5 % + CD 30 %	55.7	58.2	57.0
SE (m) +	5.6	7.2	5.9
CD (P=0.05)	16.1	20.5	16.9

(CD: Cow dung dry, NL – Neam leaves, P.S.: *P. Sajarcaju*, BM : Butter milk)

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VEG AND NON-VEG DISHES WITH COCONUT

PRAWN SOUP

Ingredients:

Shelled prawns, cut into tiny piece	- 500 gm
Vinegar	- 2 tbsp
Chicken stock	- 500 ml
Ginger juice	- one tbsp
Lemon juice	- 2 tbsp
Lemon rind	- 2 tsp
Orange rind	- one
Thick coconut milk	- 500 ml
Fish sauce	- 2 tsp
Salt	- half tsp
Chopped fresh coriander	- 2 tbsp

Method : Put shelled prawns in vinegar and wash. Boil chicken stock and ginger juice for a minute. Plunge the prawns and bring it to boil. Do not over cook. Cook till the prawns turn pink or they turn tough. Stir fish sauce, salt, lemon juice, coconut milk, lemon and orange rind. Remove from heat. Stir fresh fish sauce, salt, lemon juice, coconut milk, lemon and orange rind. Remove from heat, stir the fresh coriander and serve hot.

STUFFED MIXED VEGETABLES

Ingredients:

Grated coconut	- one tbsp
Roasted peanuts	- one tbsp
Roasted cumin	- one tbsp
Parsely	- one tsp
A dash of nutmeg	- (just grate the nut)
Salt and pepper	- to taste
Cabbage or palak leaves	- as required

Method: Mix all the ingredients together except cabbage or palak leaves and stuff boiled vegetables. Roll the blanched cabbage leaves or spinach leaves with the stuffing. Heat on non-stick pan.

BRINJAL WITH MASALA PASTE

Ingredients:

Brinjal	- half kilo
Roasted dry coconut	- 2 tsp grated
Dry roast sesame seeds	- one tsp

Dry roast peanuts	- one tsp
Dry roast cuminseeds	- half tsp
Roasted mustard seeds	- half tsp
Oil	- half tsp
Curry leaves	- 2 sprigs
Lemon juice or Tamarind pulp	- one tsp
Salt	- half tsp
Ginger juice	- one tsp

Method: Mix all the ingredients with salt, lemon juice or tamarind pulp and ginger juice. Boil brinjal, curry leaves and masala paste mixture, add the brinjals and mix with the masalas thoroughly.

BOILED MUTTON CHOPS

Ingredients:

Mutton chops cut into 2 ribs-	6
Green papaya paste	- one tsp
To marinate:	
Garlic paste	- one tsp
Salt	- One tsp
Ginger paste	- One tsp
Green chilli paste	- 2-4
Dried fenugreek leaves	
Pepper corns	- 8-10
Large onions, diced	- 2
Cinnamon	- one inch piece
curd	- 50 gm
To cook the mutton chops:	
Coconut, grated	- Half of one
Chicken stock	- 2 cup
Lemon juice	- one tsp
Coriander leaves	- a few
Raisins, stir fried	- a few

Method: Grated coconut should be added with chicken stock, squeeze and extract the milk. To this, mix 2 cups of chicken stock, boil the marinated chicken. Mutton chops should be pressure cooked for one minute. Mix one tsp lemon juice and serve in individual bowls with gravy. Garnish with chopped coriander leaves and stir fried raisin on top.

-Indu Narayan