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BIO SOFTENING OF ARECANUT WASTE ARECA HUSK, LEAF AND LEAF SHEATH FOR VALUE ADDED COMPOST

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ABSTRACT

One of the most versatile and remunerative techniques for handling biodegradable solid wastes is composting. The areca nut waste Composing was carried out using 8 kg of raw materials in a composting pit of 0.5m width, 0.50 m length and 1 m height. The areca nut waste substrates arranged layer by layer and inoculated with the microbial inoculums of ligno cellulolytic organism at the rate of 5 kg per ton of substrate. Arecanut waste inoculated *Phanerochaete chrysosporium, Pleurotous sajarcaju* without added any nutrients showed the decrease in percentage organic carbon and slightly increase in total nitrogen content. The C:N ratios in these treatments were decreased to a greater extent when compared to the control and other treatments. The initial C:N of untreated areca husk waste was 110-120, whereas C:N of the husk inoculated with different microorganisms was found to decrease significantly and it ranged from 29.94 to 77.94 in different treatments. The initial C:N of untreated areca leaf waste was 82-84 where as C:N of the Areca leaf inoculated with different microorganisms was found to decrease significantly and it ranged from 22.24 to 60.58 in different treatments. The initial C:N of untreated areca leaf sheath was 96-98 whereas C:N of the Areca leaf sheath inoculated with different microorganisms was found to decrease significantly and it ranged from 22.42 to 60.53 in different treatments.

KEYWORDS: Composting, Lignin, Organic Matter, Inoculums, Arecanut Waste, Biodegradation

INTRODUCTION

Arecanut (*Areca catechu* L.), being a highly profitable commercial plantation crop. In view of this it is important to understand the package of practices to be followed in an arecanut garden and adopt the same for maximizing the returns. On an average, 5.5-6 tones of organic wastes/ha/year will be available in arecanut garden. Direct recycling of these waste do not meet the crop demand immediately.

India is the largest producer of arecanut and at the same time largest consumer also. The major states cultivating this crop are Karnataka (40%), Kerala (25%), Assam (20%), Tamil Nadu, Meghalaya and west Bengal [1]. Among the palm trees, coconut and arecanut palm are mainly exploited for economic purposes. The fiber characteristics can vary somewhat with the environmental conditions under which the plant grow, the chemical composition is of mainly of cellulose, hemicelluloses, lignin, waxes, water soluble substances along with other organic materials [2].

Arecanut is cultivated in an area about 1.53 lakh ha in Karnataka and it leaves behind enormous quantity of arecanut husk, leaf sheath, arecanut leaf. Thus, the disposal of arecanut waste is becoming a problem especially in the intensive arecanut growing areas. At present majority of arecanut waste is disposed of by burning which resulted into a loss of potential source of organic matter and valuable plant nutrients. The value of arecanut waste as organic material for compost making or incorporation in the field has not been fully realized in our country. In nature, much cellulose is protected from decomposition by the impregnation of lignin. Lignin is a heterogenous, three-dimensional polymer of oxyphenylpropanoid units. It impregnates the xylem (i.e. woody) tissue of plants and adds rigidity to these structural cells. Most of the fungi do not have lignin degrading ability. Many wood-rotting fungi, however, are capable of breaking down lignocelluloses. A large number of fungi have potent cellulolytic enzyme systems. They include species of *Trichoderma, Pleurotous, Phanerochaetae, Chaetomium, Penicillium, Fusarium, Pythium, Mortierella,* and *Agaricus.* These represent most of the major groups of fungi.

A perusal of literature indicated that considerable information is available on the waste generated by coconut plantations and microorganisms degrading these waste. Among the microorganisms fungi play an important role in the mineralization of the wastes. *Phanerochaete chreposporium* and *pleurotus sajor-caju* are the two mainly cellullolytic species that degrade the coconut coir pith [3]. Compost can provide valuable nutrients and organic matter to soil, depending upon the feedstock (raw materials used) and upon compost management. A chemical analysis of a representative sample of compost will indicate its total nitrogen, available nitrogen, phosphorus, and potassium. Most of the composts contain relatively low concentrations of one or more nutrients and are not necessarily considered good "fertilizers"; however, as soil amendments, they are good sources of organic matter [4].

Literature on lingo cellulolytic fungal species degrading arecanut waste is not available or scanty. The organisms that degrade coconut waste could be employed for degrading arecanut waste also. However, arecanut waste predominantly composed of cellulose and varying proportions of hemicellulose, lignin, pectin and protopectin. The fibers adjoining the inner layers are irregularly lignified group of cells called hard fibers and the portions of the middle layer below the outermost layer of soft fibers in Areca husk [5] [6]. Because of this reason arecanut wastes might require a combination of fungal species for collective degradation of lignocellulose.

The two important lingoceuylotic fugal species *phanerochaete chrysosporium* and *pleurotous sajorcaju* are capable of degrading the arecanut waste materials. The above species have been employed for degradation by many workers. However their use in arecanut waste is not documented. An attempt was made to employ these lignocellulysic fungal species to determine the degradation ability of different kinds of arecanutr wastes by composting methods with inoculation of lingoceuylotic fungal organisms and amendment of nitrogen and phosphorus in combination with fungal species was also studied.

One of our main objectives was to find out the possibilities of utilizing the profitability in crop production programme. Lignin degradation may be a co-operative effort of different microorganisms. Therefore, an experiment was conducted using different lignolytic and cellulolytic microorganisms. In general the C:N ratio of arecanut waste was found to be very high. Arecanut waste inoculated with different microorganisms along with N and P addition was found to be decrease significantly

METHODS AND MATERIALS

An experiment was conducted to study the microbial decomposition of arecanut waste using lignocellulosic microorganisms. The experiment was conducted in the field located near the Krishi Vigyan Kendra, Navile, Shimoga.

Physico-Chemical Properties

pH

Arecanut waste was mixed with distilled water at 1:10 ratio and its pH was determined by a glass electrode using a digital pH meter (“Systronics” model 335).

Electrical Conductivity

The EC of arecanut waste was determined by using conductivity bridge (Digital conductivity bridge “Systronics” model 304), by mixing with distilled water at 1:10 ratio.

Organic Carbon

The organic carbon in the arecanut waste samples were estimated by taking known quantities of dried sample in a pre-weighed silica crucible. The samples were kept in a muffle furnace at a temperature of 600^0C for 2 hours. The crucible were later directly transferred to desiccators, cooled and immediately weighed to a constant weight (ash weight). The total per cent of organic matter was calculated by taking the difference of dry weight and ash weight of the sample. Then organic carbon was calculated by dividing the per cent organic matter by the factor 1.724 [7].

Total Nitrogen

Nitrogen in the sample was estimated by following the micro Kjeldahl method as outlined by Jackson (1973). Dried samples (0.5 g) were digested using 10 ml of concentrated sulphuric acid in presence of 0.3 g of catalytic mixture containing potassium sulphate, copper sulphate and selenium powder in the ratio 50:10:1 in the micro Kjeldahl digestion unit. The digested samples were diluted with distilled water and distilled after the addition of sufficient of 40 per cent NaOH to make the sample alkaline in the micro Kjeldahl distillation unit. The ammonia evolved was trapped in two per cent boric acid mixed indicator solution and titrated against 0.05 N sulphuric acid. The nitrogen content was calculated from the volume of acid consumed.

$$\%N = \frac{\text{Titer value x N of } H_2SO_4 \text{ x 0.014 x dilution factor}}{\text{Weight of the plant sample (g)}}$$

C:N Ratio

C:N ratio was calculated by dividing per cent of organic carbon by per cent total nitrogen.

Preparation of Microbial Inoculum for Bio-Composting

The two lingo-cellulolytic fungi selected cultures were grown separately in potato dextrose broth for seven days till a population of 30 x 10^8 CFU per ml was attained. The populations of organism were determined by using the serial dilution technique with pour plate method. The fungal culture *Planerochaete chrysosporium* and Pleurotus *sajarcaju* were collected from Department of Agricultural Microbiology, UAS, GKVK, Bangalore. These cultures were mixed in lignite or Jowar powder based carrier to get a fungal culture. This inoculum was used at the rate of 5 kg per ton of arecanut waste in both pot culture and scale up studies in biocomposting.

Scale Up Studies on Bio-Composting

The Areca husk, Area leaf and Areca leaf sheath were collected from the Arecanut garden of Areca Research station Navile, Shimoga. The leaf and leaf sheath was chapped to 10-15 cm length by using chopper cutting machine and Areca husk is used as it is without chapping. The microorganisms used for study were lingocellulytic fungal species *Phanerochaete chrysosporium* and *Pleurotous sajarcaju.* In laboratory trail conducted by using pot, the *Phanerochaete chrysosporium* and *Pleurotous sajarcaju* proved to be efficient in degrading lingocellulosic material among various fungus tested [8]. Hence these two culture were used in this investigation.

The pits of size 0.5 x 0.5 x 1 cubic meters were prepared to which the Arecanut wastes, i.e Areca leaf, Areca leaf sheath and Areca husk were transformed separately at the rate of 8 kg per pit. There were totally there composing experiment were conducted separately for Areca leaf, Areca leaf sheath and Areca husk. *P. chrysosporium* and *P. Sajarcaju* was inoculated to these Arecanut wastes layer wise @ 5 kg per ton of Arecanut waste. Favorable moisture was maintained by adding the water at the periodical intervals. Comparable control pits without the inoculums were maintained.

The arecanut waste in the pits was turned at 30, 60, 90, 120 and 150 days after filling. Simultaneously the samples were drawn to analyze the carbon to nitrogen ratio. Altogether there were ten treatments for all the three experiment with three replications each. Following are the treatment details.

Table 1: Treatments for the Experiment are as Follows

T_1	Arecanut waste without MI & CA
T_2	Arecanut waste +Fresh cowdung
T_3	Arecanut waste + *P. sajarcaju*
T_4	Arecanut waste + *P. sajarcaju* + 1% Nitrogen (Urea) + 1% P (Rock phosphate)
T_5	Arecanut waste + *Phanerochate chrysosporium*
T_6	Arecanut waste+ *P. chrysosporium* + 1% Nitrogen+ 1% P.
T_7	Arecanut waste +P. *sajarcaju* + *P. chrysosporium*
T_8	Arecanut waste + *P. sajarcaju* + *P. chrysosporium* + cowdung
T_9	Arecanut waste + *P. sajarcaju* + *P. chrysosporium* + 1% N_2 + 1% P.
T_{10}	Arecanut waste + *P. sajarcaju* + *P. chrysosporium* + 1% N_2 + 1% P.+ Fresh cowdung

MI = Microbial Inoculants
CA = Chemical Amendments

RESULTS AND DISCUSSIONS

It is observed from the data that arecanut waste inoculated with the two lignolytic microorganisms namely *Phanerochaete chrysosporium, Pleurotous sajarcaju* and treatments without added any nutrients showed the decrease in percentage organic carbon and slightly increase in total nitrogen content. The C:N ratios in these treatments were decreased to a greater extent when compared to the control and other treatments. In the present study it is found that arecanut waste contained higher C:N ratio. It is well known that when a material containing higher nitrogen and inoculated with decomposition organisms, results in a rapid decomposition leading to reduction in C:N ratio. Several workers have suggested that addition of materials rich in nitrogen to the ones containing a C:N ratio above 30:1 resulted in a rapid decomposition with a decrease in C:N ratio [9][10][11]. In the present study the C:N ratio of arecanut waste is above 80:1 and has been amended with decomposition organisms and supplemented nitrogen. This could be the reason for such similar results. The results of changes of in total N (%) content of compost materials during bio-composting of arecanut wastes are presented in table. The results indicated that there were significant differences among the treatments and increase in N-content at different intervals throughout the period of the decomposition.

In general, there was an increase in total N content as the waste residues reduced in its weight. At the final stage of composting the highest total N content was observed in the treatment. The data on changes in OC (%) content of compost materials at different periods of composting of arecanut waste are presented in table. In general OC content of treatments decreased with increase in the period of decomposition.

The results on changes in C:N ratio during bio-composting of arecanut wastes at different intervals are presented in table. Significant decrease in C:N ratio of different arecanut waste was observable with the period of decomposition in all the treatments

Table 2: Physico-Chemical Properties of Arecanut Waste

Sl. No.	Property	Areca Leaf	Leaf Sheath	Areca Husk
1.	pH	6.1 -6.50	6 -6.50	6.2 – 6.50
2.	EC	1.53 – 1.75	1.6 – 1.78	1.68 – 1.88
3.	Organic carbon (%)	55 – 58	60 – 63	62 – 65
4.	Nitrogen (%)	0.70	0.65	0.60
5.	C:N Ration	82 – 84	96 - 98	110 – 120
6.	Lignin (%)	36.20%	38.68	43 -44%
7.	Cellulose (%)	37.50%	26.40	41 – 42%
8.	Hemicellulose (%)	14-15%	16 – 17%	17 – 18%

The physic chemical properties of arecanut waste were determined before conducting the experiment and results were shown in Table No. 2. In general the pH of all arecanut waste in ranging from 6.1 to 6.50, EC is ranging from 1.53 to 1.88. The organic carbon to nitrogen ratios of arecanut waste ranges from 82:1 to 120:1 which shows higher the C:N ratio when compared to the all other agricultural wastes.

Table 3: Influence of Microbial Inoculants on Carbon and Nitrogen Ratio (C:N) in Arecanut Husk at Periodical Intervals

Treatments	C:N Ratio					
	30d	60d	90d	120d	150d	180d
T1	107.26	103.63	99.21	91.02	86.54	77.94
T2	111.64	109.48	98.77	88.46	85.38	76.09
T3	74.66	69.26	62.50	51.56	44.51	33.53
T4	**67.63**	**64.33**	**57.91**	**50.31**	**42.47**	**29.94**
T5	71.20	67.81	62.04	51.51	46.08	35.59
T6	73.72	69.94	62.65	50.00	45.73	34.23
T7	71.75	65.51	59.57	52.11	41.76	31.98
T8	73.92	67.67	61.36	51.56	42.28	34.04
T9	75.68	68.33	59.09	49.38	48.46	34.63
T10	75.95	70.33	63.96	52.88	45.19	36.96
F-test	NS	*	*	*	*	*
S.Em. at P=0.5	-	3.25	4.56	3.86	4.25	3.65
C.D. at P=0.5	-	11.25	14.25	12.56	13.89	12.03

NS= not significant. *= significant, d= days

Areca Husk Waste

The data on changes in C/N ratio of arecanut husk waste inoculated with lignolytic microorganism is given in table 3. The C/N ratio of arecanut husk found to be very high. The initial C/N of untreated arecanut waste was 110-120, whereas C/N of the husk inoculated with different microorganisms was found to days of decomposition, the % reduction in C/N from their corresponding initial values in the treatments inoculated with *Phanerochaete chrysosporium,* *Pleurotous sajarcaju* showed significant reduction in C/N. carbon:nitrogen (C:N) ratio of between 20:1 and 30:1 is generally considered appropriate for agricultural wastes. Higher C:N ratios slow material decomposition, because low nitrogen limits microbial activity. Lower C:N ratios may contain excessive nitrogen that may be volatilized as ammonia, thereby producing odors and wasting nitrogen [12].

Table 4: Influence of Microbial Inoculants on Carbon and Nitrogen Ratio (C:N) in Arecanut Leaf at Periodical Intervals

Treatments	C:N Ratio					
	30d	60d	90d	120d	150d	180d
T1	90.07	81.34	76.03	67.21	60.58	60.58
T2	83.80	72.95	68.67	62.18	49.38	48.17
T3	65.63	60.80	55.72	47.97	25.00	23.20
T4	58.33	53.37	48.04	40.69	22.95	22.24
T5	58.15	51.84	45.15	40.91	25.25	24.52
T6	63.82	54.14	48.06	44.84	30.48	29.23
T7	56.25	47.02	45.05	39.39	24.28	23.38
T8	71.20	63.27	56.25	48.53	34.94	34.17
T9	67.80	62.20	57.94	50.29	31.56	30.87
T10	67.59	62.35	60.59	54.26	31.74	30.10
F-test	NS	*	*	*	*	*
S.Em.at P=0.5	-	4.07	3.65	2.93	3.64	2.92
C.D. at P=0.5	-	12.025	12.27	9.54	10.56	8.75

NS= not significant, *= significant, d= days

Areca Leaf Waste

The data on changes in C/N ratio of arecanut leaf waste inoculated with lignolytic microorganism is given in table 4. The C/N ratio of arecanut leaf was found to be very high. The initial C/N of untreated arecanut waste was 82-84 where as C/N of the Areca leaf inoculated with different microorganisms was found to decrease significantly and it ranged from 22.24 to 60.58 in different treatments. At the end of 150 days of decomposition, the percentage reduction in C/N from their corresponding initial values in the treatments inoculated with *Phanerochaete chrysosporium, Pleurotous sajarcaju* showed significant reduction in C/N.

Table 5: Influence of Microbial Inoculants on Carbon and Nitrogen Ratio (C:N) in Arecanut Leaf Sheath at Periodical Intervals

Treatments	C:N Ratio					
	30d	60d	90d	120d	150d	180d
T1	89.71	81.43	74.65	0.67	60.14	60.53
T2	80.56	74.32	68.33	66.00	61.86	56.17
T3	57.18	53.69	50.00	47.53	37.11	24.23
T4	60.54	55.36	48.85	44.38	30.38	22.42
T5	60.06	54.83	43.61	36.83	29.38	24.31
T6	62.15	56.90	52.22	38.98	30.10	23.25
T7	63.55	58.13	54.12	42.33	32.42	25.21
T8	70.37	59.34	55.29	45.93	39.61	31.45
T9	70.25	63.21	58.13	46.59	40.49	29.68
T10	64.41	57.47	53.37	43.61	39.67	29.25
F-test	NS	*	*	*	*	*
S.Em.at P=0.5	-	4.59	5.73	4.32	5.02	3.21
C.D. at P=0.5	-	12.96	16.96	11.65	17.02	9.65

NS= not significant,*= significant, d= days

Areca Leaf Sheath Waste

The data on changes in C/N ratio of arecanut leaf sheath waste inoculated with lignolytic microorganism is given in table 5. The C/N ratio of arecanut husk was found to be very high. The initial C/N of untreated arecanut waste was 96-98 where as C/N of the Areca leaf sheath inoculated with different microorganisms was found to decrease significantly and it ranged from 22.42 to 60.53 in different treatments. At the end of 150 days of decomposition, the r percentage reduction in C/N from their corresponding initial values in the treatments inoculated with *Phanerochaete chrysosporium, Pleurotous sajarcaju* showed significant reduction in C/N.

CONCLUSIONS

The C:N ratio of the substrate is an important factor in composting. The materials with wider C:N ratio are degraded rates slowly by microorganisms, as microbes grow and multiply slowly for want of nitrogen. The study has thus come out with a technology to bioconvert the arecanut waste into a valuable compost. It is also observed the native fungal isolates to be better than the standard culture in the decomposition of paddy straw and sugarcane trash [13]. The arecanut waste generated in arecanut gardens is otherwise inefficiently used as a fuel. The nutrient quality of the bio-compost was also improved through microbial inoculants.

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