International Journal of Applied and Advanced Scientific Research (IJAASR)
Impact Factor: 5.255, ISSN (Online): 2456 - 3080
(www.dvpublication.com) Volume 2, Issue 2, 2017

UTILIZATION OF FUNGAL SPECIES ISOLATED FROM SOIL FOR COIR PITH COMPOSTING

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Cite This Article: A. Kanagarathinam & Dr. K. Shanthi, "Utilization of Fungal Species Isolated From Soil for Coir Pith Composting", International Journal of Applied and Advanced Scientific Research, Volume 2, Issue 2, Page Number 202-210, 2017

Abstract:

Coir pith, a ligno-cellulosic material formed during the extraction of coir fiber from coconut husks, accumulates as a waste material from coir processing factories causing environment and disposal problems. Naturally coir pith is rich in potash but low in nitrogen and phosphorous. Also it has very high amount of lignin and C: N ratio which makes composting process difficult and slow. Hence an attempt was made to isolate and identify the fungal species from soil collected from sewage treatment plant of PSG college of Arts and Science, Coimbatore. This study was also carried out to assess the coir pith composting efficiency of fungal species. The results of the study revealed that three fungal species were isolated and identified as *Aspergillus flavus*, *Aspergillus tubingensis* and *Aspergillus parasiticus* by its spore and molecular characteristics. Among these three fungal species *Aspergillus flavus* and *Aspergillus tubingensis* were used for the coir pith composting along with Panchagavya as natural additives. The compost quality was better in the combination of coir pith with *Aspergillus tubingensis* than *Aspergillus flavus* combination.

Key Words: Coir Pith, Panchagavya, Aspergillus Flavus, Aspergillus Tubingensis & Aspergillus Parasiticus

1. Introduction:

Coir is a hard fiber obtained from coconut palms, which grows abundantly in tropical countries. In India, coir manufacturing is a traditional industry, which has taken deep roots in the economic structure of the rural areas in the coastal states, especially in Kerala state (Kadalli et al., 2000). Indian coir enters the world market in the form of raw fiber, spun yarn and woven mats, matting, rugs and carpets, coir rope, etc. (Ramalingam et al., 2005). Bright golden colored yarns are considered the best and obtained from the retted coconut husks. The thicker and coarser variety is known as the bristle fiber and is used in the manufacture of brushes and brooms (Ladwani Kiran et al., 2012).

Coir fiber is multicellular in nature, and the length ranges from 10 to 35 cm and diameter from 0.1 to 0.3 mm being thickest in the middle of their length (Kanmani et al., 2009). Coir is light, elastic, water resistant, and resistant to mechanical wear. It is a natural cellulosic fiber and contains apart from cellulose, lignin and other substances, which serve as building materials for the cell structure (Table 1) (Pramanik et al., 2007). The percentages of the constituents- cellulose, lignin, and hemicelluloses (Fuangworawong, 2008) vary largely, depending upon the age of the nut from which the coir is derived (Kumar, 2010). Morphological studies of coir fibers show a framework of organized aggregates of cellulose molecules called microfibrils embedded in a matrix of non-cellulosic polysaccharides and lignin. The middle lamella and primary cell wall undergo the greatest lignification and the secondary wall the least (Ghosh et al., 2007).

Table 1: Chemical composition of coir fiber (17)

Lignin (%)	45.4
Cellulose (%)	43.44
Pectin and related compounds (%)	03.0
Hemicellulose (%)	0.25
Ash (%)	2.22

Lignin is the main constituent of coir responsible for the stiffness of the fiber and protects cellulose from degradation, as lignin itself is extremely resistant to chemical and biological degradations (Reghuvaran and Ravindranath, 2012). Fungi that selectively remove lignin without loss of appreciable amounts of cellulose are extremely attractive for use in biological pulping processes, to improve the digestibility of highly lignified plant residues for cattle (Vijaya et al., 2008). Certain pure cultures of bacteria are also able to decompose lignin and to assimilate lignin degradation products as a carbon sources (Parasuraman et al., 2002).

The lignin degradation system of fungi involves several extracellular enzyme activities like H_2O_2 requiring lignin peroxide (LiP) (Prabhu and Thomas, 2001), manganese peroxide (MnP), laccase and H_2O_2 generating enzymes like glucose oxidase, glyoxal oxidase, pyranose oxidase (Prabhu and Thomas, 2002), veratryl alcohol oxidase, etc., and at least two of them are produced by most of the fungi (Petric and Selimbasic, 2008). Lignin removal can also be achieved by initial adsorption onto the fungal cells and accumulation within the fungal cells (Kanmani et al., 2009). The fungal mycelium accumulates and decolorizes the lignin molecules. The fungal hyphae can directly metabolize and degrade aromatic and aliphatic molecules (Kumar, 2010).

Research and development efforts have been underway to find new and novel uses for this eco-friendly fiber. Chemical production of whiter coir fiber by removal of lignin with sodium hydroxide and subsequent bleaching of the dark fiber with acid produces a weak thin fiber having reduced strength and the treatment adversely affect the spinning properties. Biological treatment to produce partially de-lignified, fiber will be a better, mild, alternative to this problem. The present paper deals with the development of a fungal system for the compost.

2. Methodology:

2.1 Sample Collection:

The coir pith was collected from Coir industries, Pollachi, Tamil Nadu, India. It was sun dried and sieved to remove long fibers, stored in gunny bags and used within one month after procurement.

2.2 Test Organism and Their Maintenance:

Three fungal cultures *viz. Aspergillus flavus, Aspergillus parasiticus and Aspergillus tubingensis* are the test cultures used for the study.

2.3 Composting Process:

The coir pith was subjected to decomposition by various ways and means to achieve the good quality compost. A study of composting was carried out in plastic tub during which the moisture content was maintained at 50-60 % and kept for 60 days in shade place. To accelerate the decomposition process turning was manually done every week during composting.

2.4 Treatment Details:

T_1- Raw coir pith alone (1/2 kg) control
T_2- Coir pith (1/2 kg) + *Aspergillus flavus* (6 g)
T_3- Coir pith (1/2 kg) + *Aspergillus tubingensis* (6 g)
T_4- Coir pith (1/2 kg) + panchagavya (5 %)
T_5- Coir pith (1/2 kg) + *Aspergillus flavus* (6 g) + panchagavya (5 %)
T_6- Coir pith (1/2 kg) + *Aspergillus tubingensis* (6 g) + panchagavya (5 %)

2.5 Analysis of Physico-Chemical and Biological Characteristics of Coir Pith Compost:

After the composting period is over they were subjected to physico-chemical analysis as per the following standard method, the details are given in Table 1.

Table 2: Analysis of Physico-Chemical Properties

Parameters	Method
Physical Properties	
Moisture (%)	Oven Dry Method
pH	pH meter
Electrical conductivity	Conductivity Meter
Salinity (ds/cm)	Salinometer
Bulk density (g/cc)	Specific Gravity Bottle Method
Chemical Properties	
Lignin (%)	Acid Detergent Fiber Method
Nitrogen (%)	Kjedahl Apparatus
Phosphorous (%)	Vanadomolybdic Colorimetric Method
Potassium	Flame Photometer
Calcium	EDTA Titrimetric Method

3. Result and Discussion:

Composting is the most suitable technique for transforming organic waste into usable agricultural amendments (Vargas et al., 2007). Although the waste composition is very diverse, lignocellulose is the most abundant component which is responsible for limiting degradation (Dixon and Langer, 2006). The physico-chemical characteristics of coir pith compost were analyzed and the results were discussed below.

3.1 Physical Properties of Coir Pith:

The physical properties of the compost were analyzed and the results were given in Table 3. The values of control coir pith prior to composting and after composting were almost similar in various properties. Hence, it needed biological treatments for the effective decomposition. The pH of the control was acidic in nature where as the composted coir pith showed the increased pH was slightly acidic to neutral. The pH was moderately increased in all the treatments over the control. The coir pith composted with fungus *Aspergillus tubingensis* (T_3) showed the superior results of pH (6.92) and EC (1.7) where as higher values of BD (0.88) and salinity (0.10) obtained in coir pith composted with *Aspergillus tubingensis* + panchagavya (T_6). The pH value was found increasing towards the maturation of the compost. The trend was increasing from slightly acidic to neutral. The conductivity values were found to be minimum with the treatments. This is due to the presence of free ammonium ions. From the experiments, it is clear that there was variation in moisture content in coir pith during the decomposition. The moisture content during composting is kept high and constant for facilitating decomposition. The moisture content in raw coir pith was found to be low when comparing to other treatments.

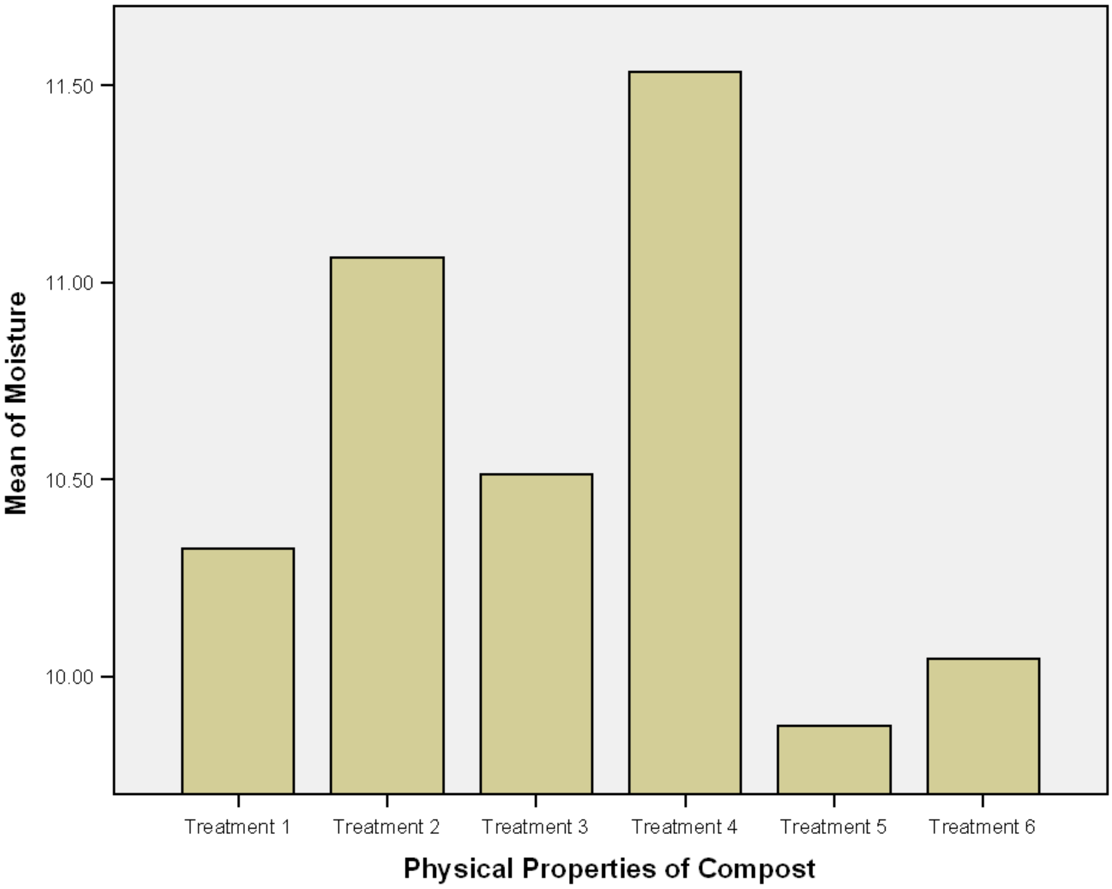
The highest moisture was recorded in T_4 over the other treatment and control. The higher moisture content shows increased levels of biodegradation.

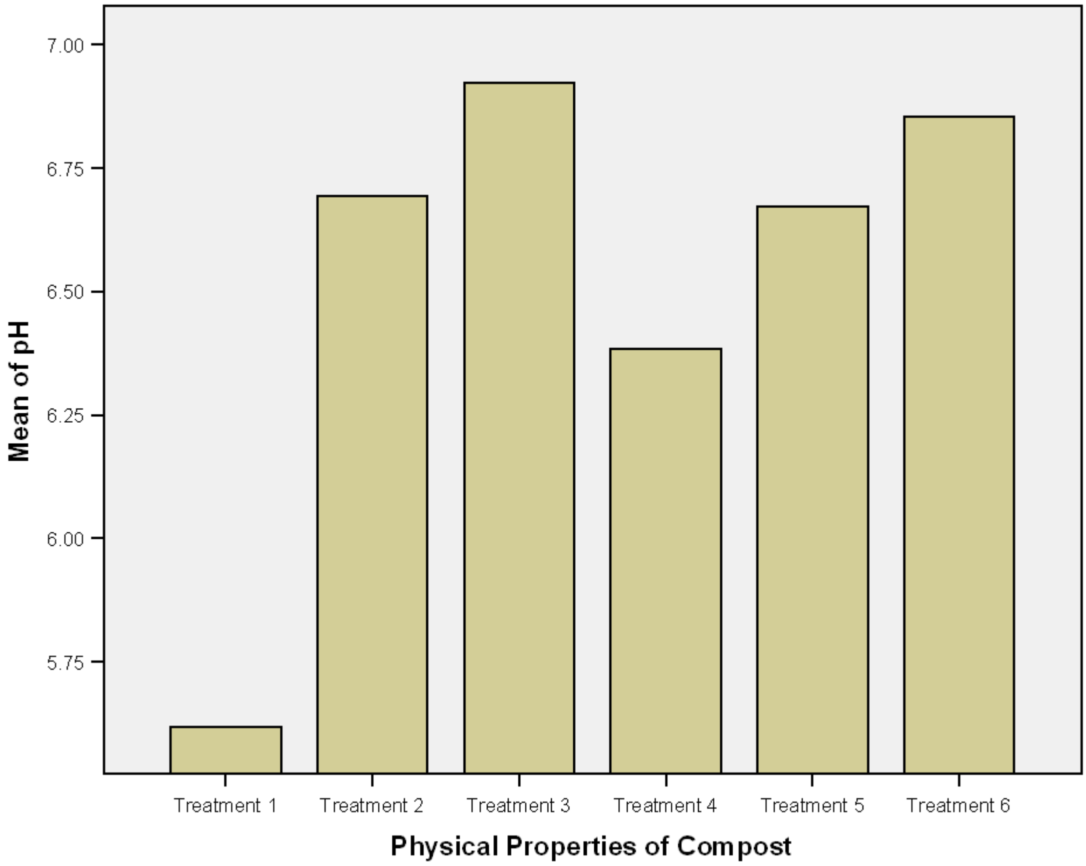
According to Richard (2006) bulk density and particle density is one of the factors determining the successful functioning of a growing medium, also observed that the bulk density and particle density decreased when the composting period is increased. The highest bulk density was recorded in T_6 over the other treatments and control. Generally, during decomposition the bulk density is decreasing. Here, the decreasing of bulk density increases with the increase in decomposition period and also depends on the nature of enriching substance addition. In the control, due to the absence of degrading microbes along with organic supplement, its breaking activity was found to be very low whereas due to the fungus inoculated treatments, the heavier particle are broken down into smaller particle. The biodegraded coir pith contains maximum values of moisture (11.5%) in Treatment 4, PH(6.92) in Treatment 3, E-C(1.7milliohms/cm) in Treatment 3, salinity (0.27ds/cm) in Treatment 3, BD(0.98g/cc) in Treatment 4. All the values are statistically significant at 0.01%. Influence of biodegraded coir pith on Physical properties are statistically significant $P<0.01$.

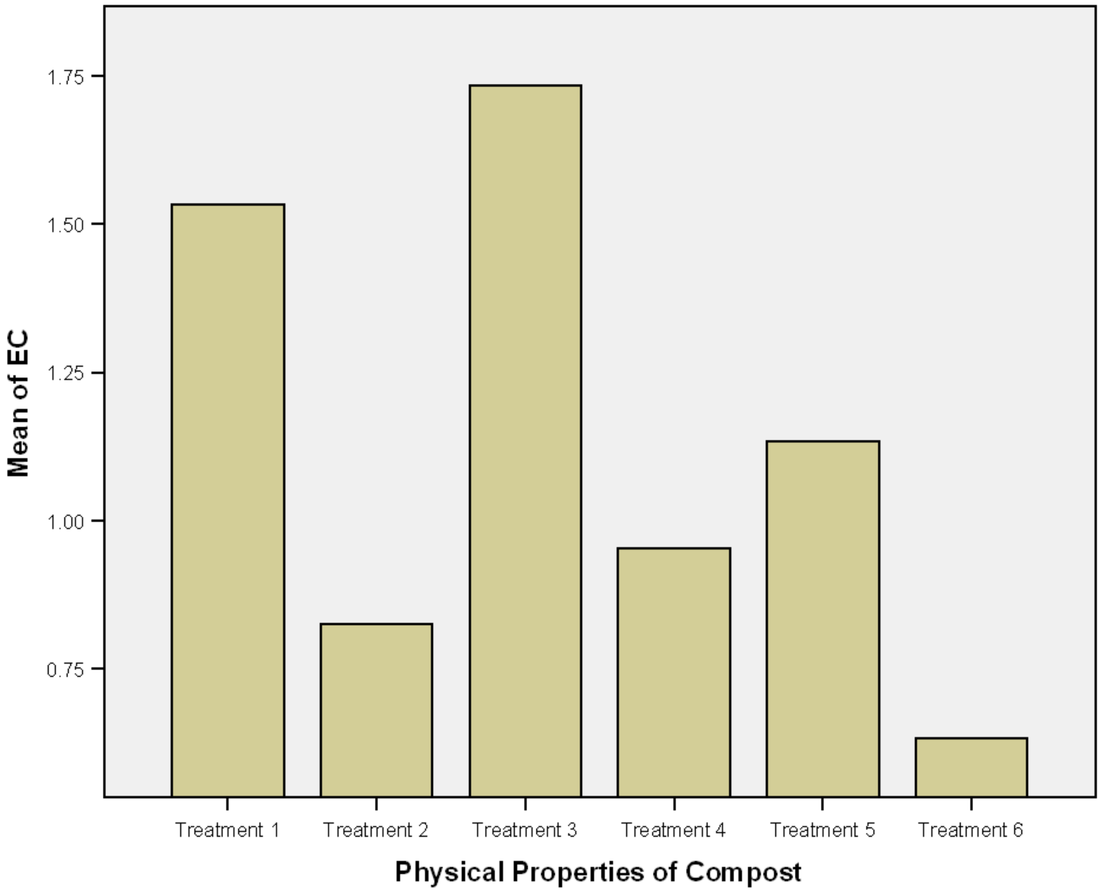
Table 3: Physical properties of biodegraded coir pith

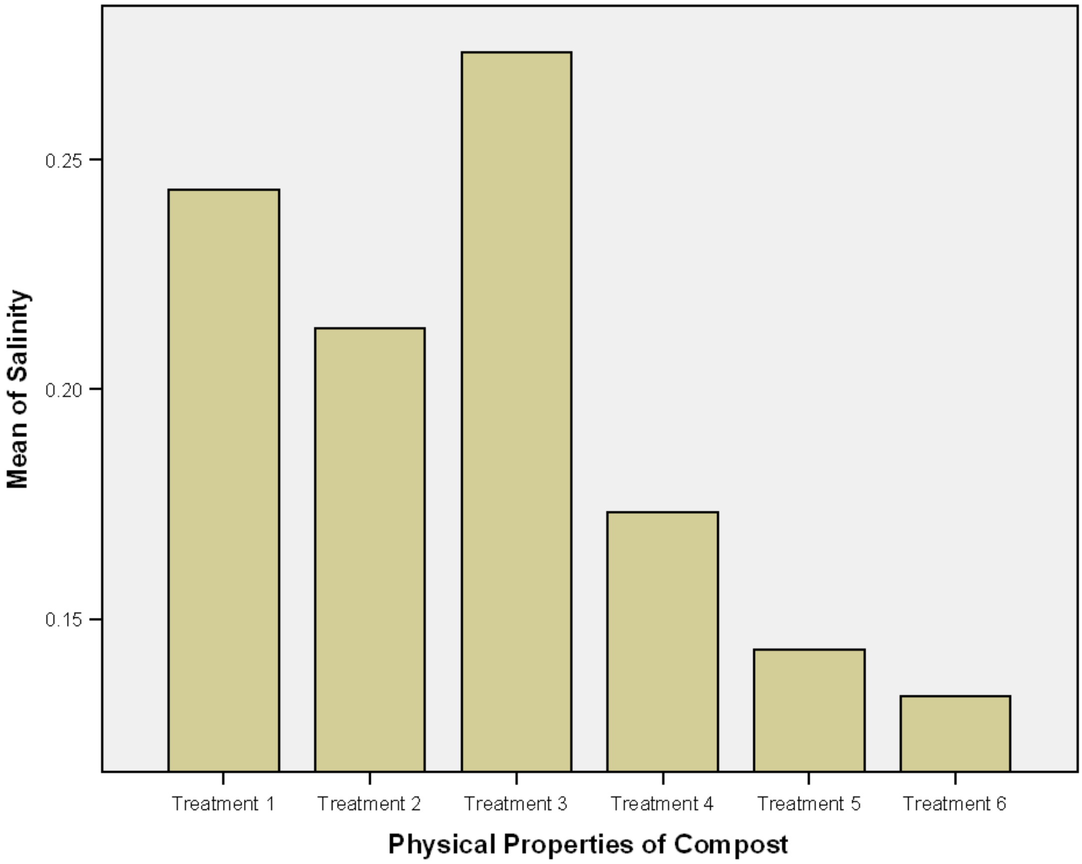
Treatments	**Physical properties of compost**				
	Moisture (%)	**pH**	**EC (milliohms/cm)**	**Salinity (ds/cm)**	**BD (g/cc)**
Treatment 1	10.32	5.62	1.5	0.24	0.92
Treatment 2	11.06	6.69	0.93	0.21	0.89
Treatment 3	10.51	6.92	1.7	0.27	0.91
Treatment 4	11.50	6.38	0.95	0.17	0.98
Treatment 5	9.87	6.67	1.1	0.14	0.91
Treatment 6	10.04	6.85	0.6	0.10	0.88

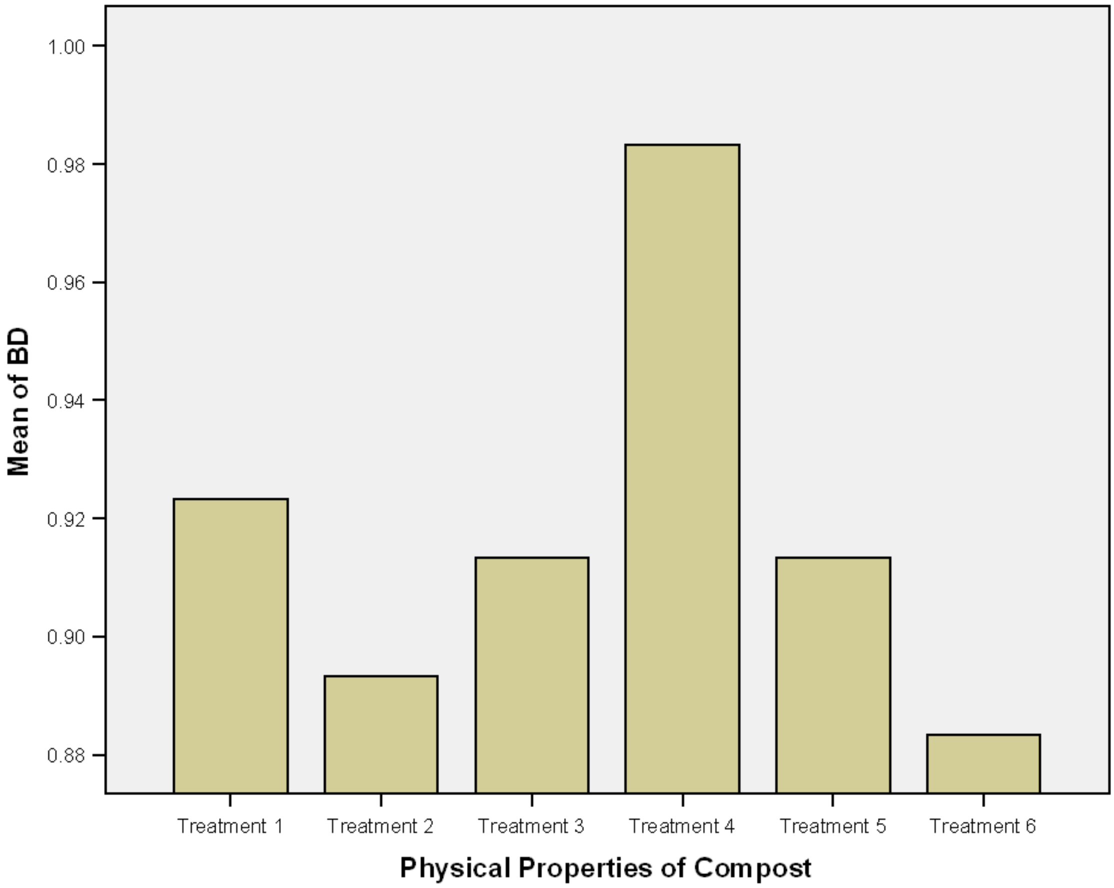
Means Plots:




7.00
6.75
6.50
6.25
6.00
5.75
Mean of pH
Treatment 1
Treatment 2
Treatment 3
Treatment 4
Treatment 5
Treatment 6
Physical Properties of Compost


1.75
1.50
1.25
1.00
0.75
Mean of EC
Treatment 1
Treatment 2
Treatment 3
Treatment 4
Treatment 5
Treatment 6
Physical Properties of Compost


Mean of Salinity
0.25
0.20
0.15
Treatment 1
Treatment 2
Treatment 3
Treatment 4
Treatment 5
Treatment 6
Physical Properties of Compost


Mean of BD
1.00
0.98
0.96
0.94
0.92
0.90
0.88
Treatment 1
Treatment 2
Treatment 3
Treatment 4
Treatment 5
Treatment 6
Physical Properties of Compost

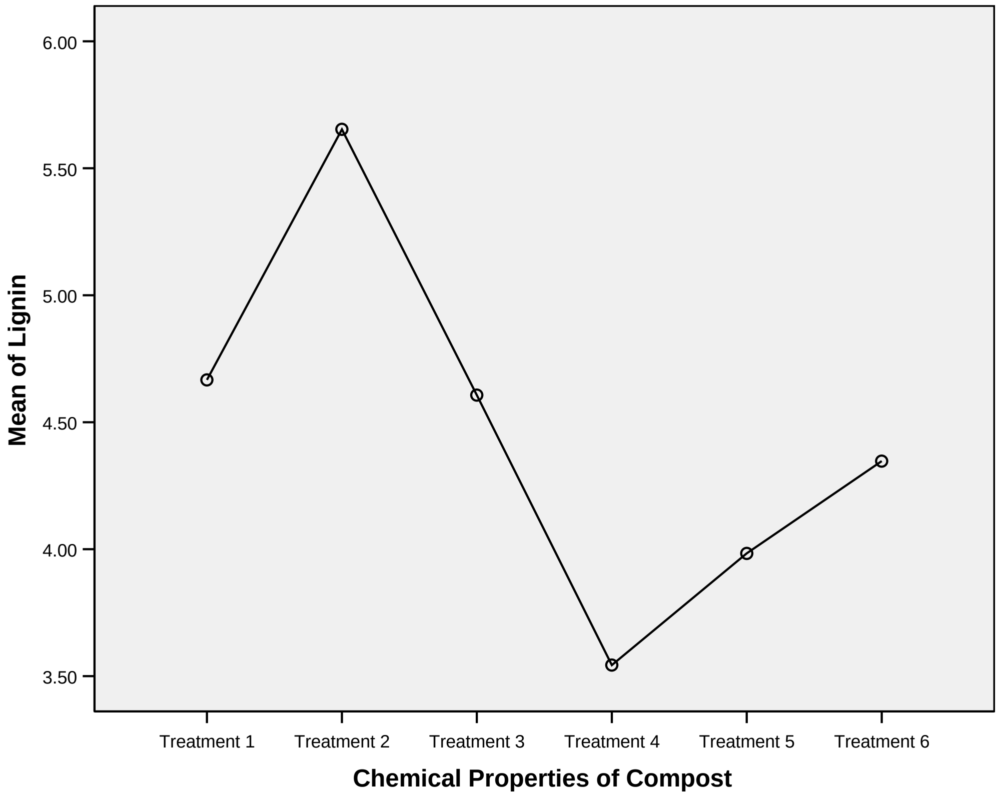
3.2 Chemical Properties of Coir Pith:

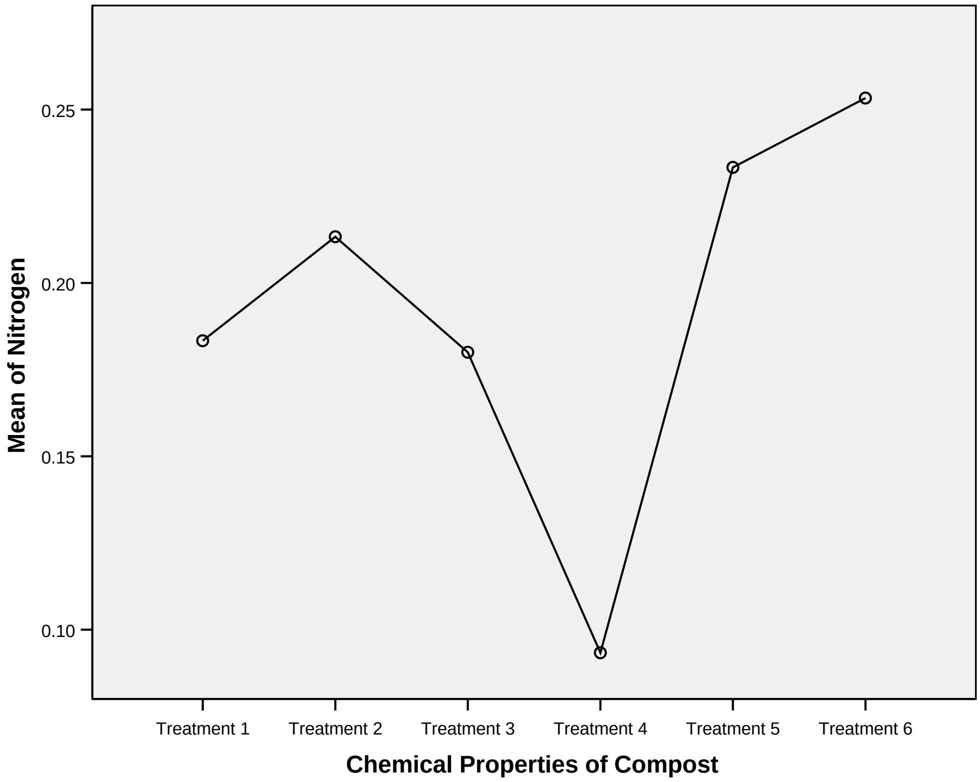
The chemical properties of the compost were analyzed and the results were given in Table 4. The maximum values of various macro nutrients like nitrogen, phosphorous, potassium and calcium were found in all the treatments. The amounts of lignin content present in the coir pith were gradually reduced during composting. However, T_6 treatment showed superior values than other treatments. Similarly, T5 composted coir pith also showed much reduction in their values. The Biodegraded coir pith contains maximum values of lignin (5.65%) in Treatment 2, Nitrogen (0.25%) in Treatment6, Phosphorus (0.11%) in Treatment4, Potassium (1.01) in Treatment6 and calcium (0.57) in Treatment1. All the values are statistically significant at 0.01%. Influence of biodegraded coir pith on chemical properties are statistically significant $P<0.01$. From this observation, the fungi *Aspergillus tubingensis* and *Aspergillus flavus* enriched with panchagavya was identified as the potential lingo-cellulosic degrader of coir pith. This is due to various degrading enzymes secreted by both of the *Aspergillus sp*. In the present study, we have utilized panchagavya which is enriching the nitrogenous status of the coir pith. Kadalli and Suseela Nair (2000) enriched the coir pith using the organic additives like panchagavya which enhanced the nutrients content of compost. Similarly in our study organic supplements were used and obtained same results. The coir waste is found to be rich in nutrients. Actually this forms the main reason for selecting the enormously available nutrient rich waste for decomposition.

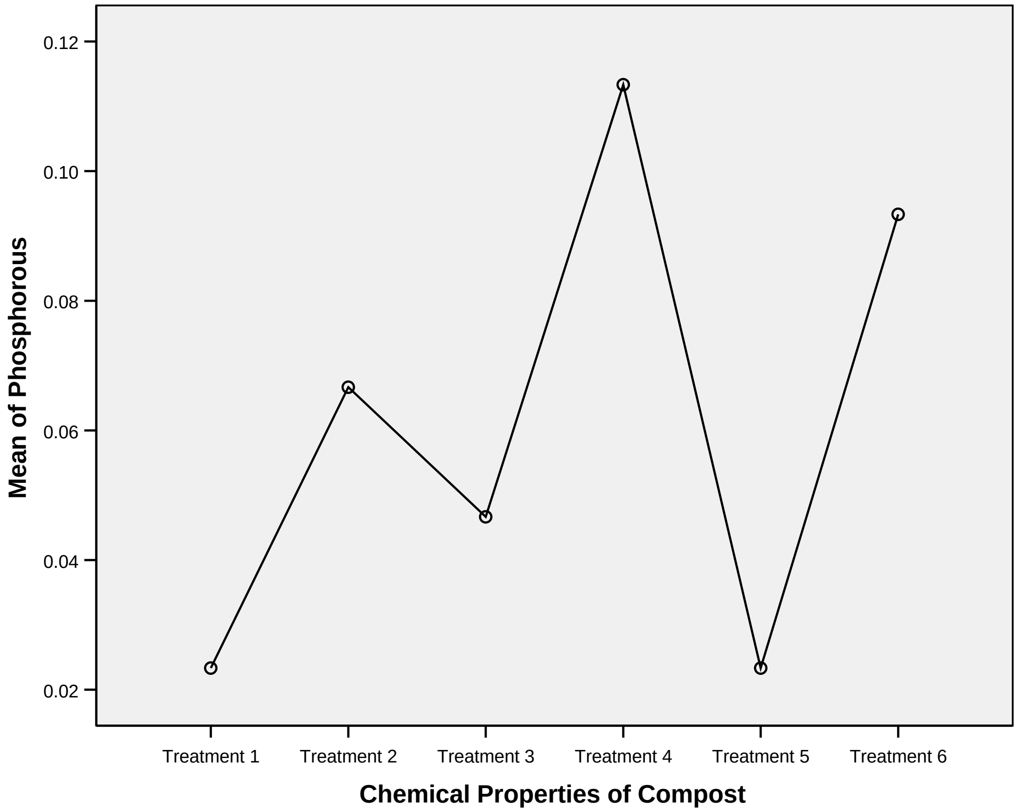
Table 4: Chemical properties of biodegraded coir pith

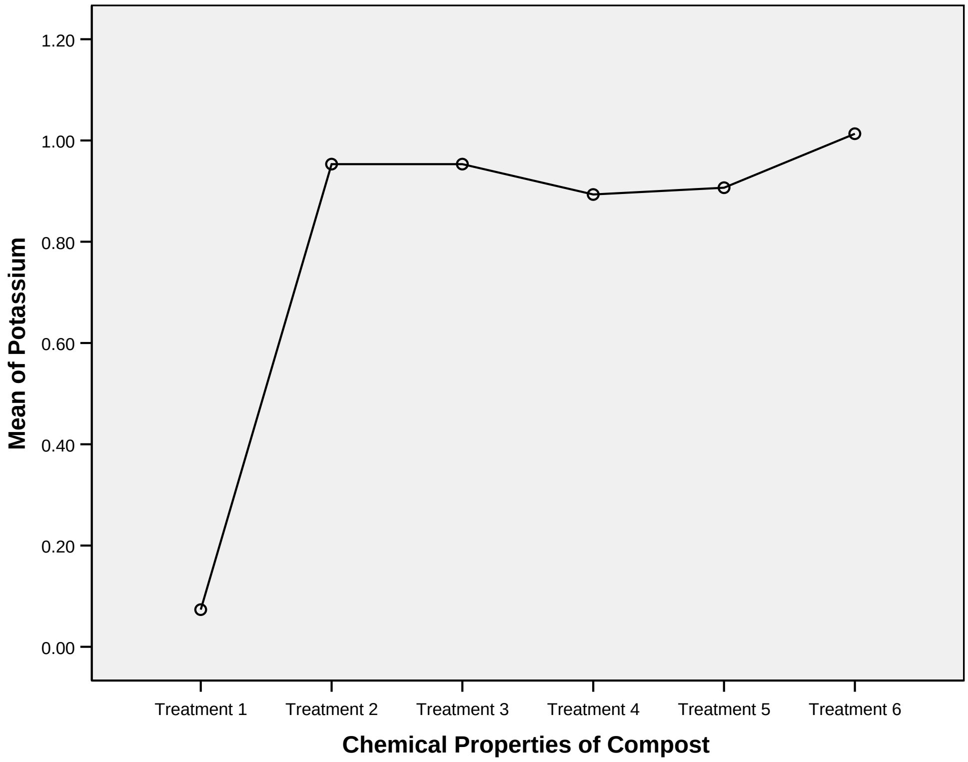
Treatments	Chemical Properties of Compost				
	Lignin (%)	**Nitrogen (%)**	**Phosphorous (%)**	**Potassium (%)**	**Calcium (%)**
Treatment 1	4.70	0.18	0.02	0.07	0.57
Treatment 2	5.65	0.21	0.07	0.95	0.45
Treatment 3	4.61	0.15	0.05	0.95	0.45
Treatment 4	3.54	0.09	0.11	0.89	0.26
Treatment 5	3.98	0.20	0.02	0.91	0.49
Treatment 6	4.35	0.25	0.09	1.01	0.53

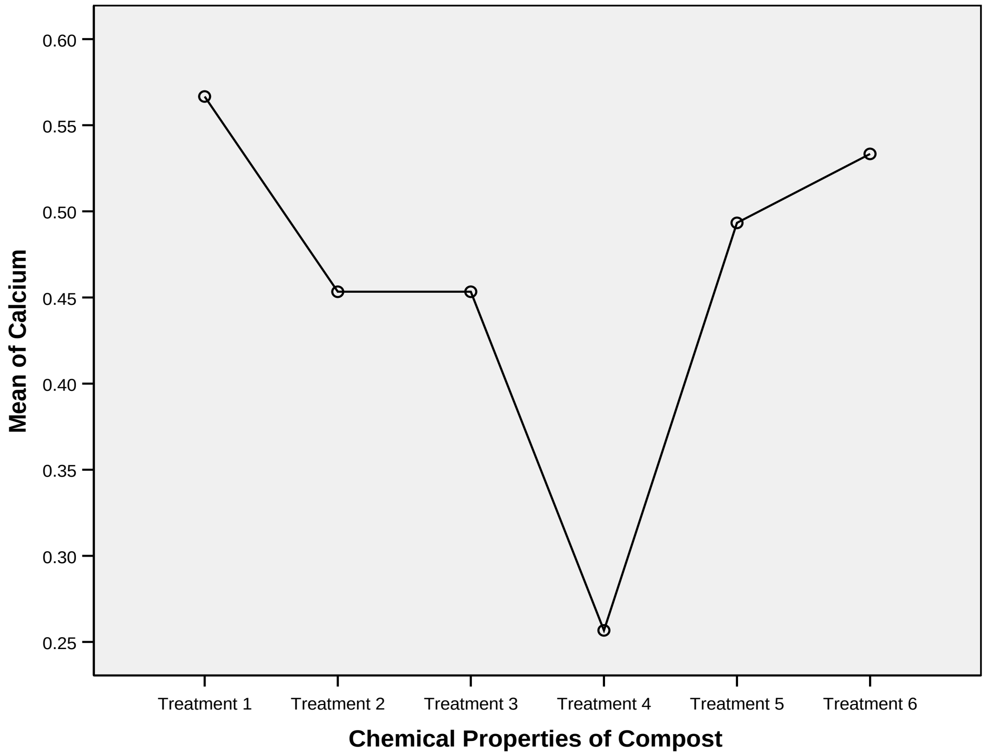
Means Plots:




Mean of Nitrogen
0.25
0.20
0.15
0.10
Treatment 1
Treatment 2
Treatment 3
Treatment 4
Treatment 5
Treatment 6
Chemical Properties of Compost


Mean of Phosphorous
0.12
0.10
0.08
0.06
0.04
0.02
Treatment 1
Treatment 2
Treatment 3
Treatment 4
Treatment 5
Treatment 6
Chemical Properties of Compost





4. Conclusion:

The results indicated that the biodegraded coir pith was statistically significantly P<0.01. The resistance of the lignocellulose constituents in coir pith to biodegradation results in the accumulation of the same as huge hillock in coir fiber production units. This causes problems of disposal and management of the coir pith. Lignin degrading fungi *Aspergillus* has been proved to degrade coir pith and convert it into organic manure in this study on the application of lignin degrading fungus species of *Aspergillus tubingensis* and *Aspergillus flavus* on the coir pith. From the study it could be conclude that the fungal species could degrade the lignin in coir pith or enhances its nutrient status. *Aspergillus tubingensis* was observed to be more efficient in lignin degradation as compared to others. The study could emphasize the fact that lignin degrading fungus species could be used for finding a solution to the problem of accumulation of the biological waste 'coir pith' and also convert it into a value added eco-friendly fertilizer for different type of plants.

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