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Research Paper

Biodegraded Coir Pith and Polythene Strips as Manure-A Field Study on Cultivation of Medicinal Plants

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ABSTRACT
Polythene usage is shooting up day by day.Polythene is dumped in to the environment as a waste posing severe ecological problem.The present study is a part of environment friendly initiatives to tackle the grave waste material.Indigenous microorganisms are not able to handle the synthetic waste and hence through bio augmentation, an active Actinomycete strain were used to biodegrade plastic strip through Co composting of Coir pith and Cow dung, thereby converting both synthetic waste and agro waste in to useful manure which is further utilised for cultivating medicinal plants.

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I. INTRODUCTION

Plastic materials over the past decades are causing severe threat to the life on our planet.The man made material is very popular wing to the ease of usability and as an inexpensive material.Among the plastics, Low density polythene(LDPE) is an inseparable commodity used for manufacturing plastic bags which end up as a waste in the environment.

In order to regulate the balance of our ecosystem and to sustain the environment for forth coming generations we should come up with eco friendly approaches to mediate the environmental problems.Through bioaugmentation microorganisms are introduced in a waste filled area where indigenous microorganisms have less role to play.Efforts are made through this paper to find the best possible solution for plastic waste problem.

The organism used for bioaugmentation is an Actinomycete, a Gram positive organism having diverse and wide range of habitat.The process of bioremediation is amended with coir pith, an agro waste causing wide solid pollution and cow dung.Coir pith is used as a carrier material for Actinomycetes and cow dung used to nullify high C:N ratio in coir pith.After the treatment ,the end product manure is utilised for cultivation of medicinal plants which shows the quality manure produced.The ecological importance of this work is that an agro waste and synthetic waste is simultaneously biodegraded and the manure utilised for further cultivation posing no threat from the waste.

II. MATERIALS AND METHODS

1 Cent land was selected for the study.The area was demarcated well so that it is separated from the rest of the area.1 cent land was again divided in to seven equal heaps and each heap again demarcated in to 3 equal portions.

Active Strain
An active strain of Actinomycete(DSR2) was isolated from dump yard soil of Calicut Corporation,Kerala.

Coir pith
Coir pith was collected from a coir industry dump yard in Calicut District.

Cow dung
Cow dung collected from nearby areas of the study.

Insertion of LDPE sheets in fields

LDPE sheets were inserted in to each seven heaps.Heaps were made in a dimension of 30x20x10 cm.Each heap had 3 subdivided portions corresponding to 30th ,60th and 90th day respectively. Composition of each heap was different and each heap was named from alphabet A-G

Composition of Heap
Heap A -LDPE strip+ Coir pith+ Cow dung+ Active strain.
Heap B -LDPE strip+ Coir pith +Cow dung +No Active strain.
Heap C -LDPE strip+ Coir pith+ Active strain.
Heap D -LDPE strip+ Coir pith+ No Active strain.
Heap E - LDPE strip+ Cow dung+ Active strain.
Heap F - LDPE strip+ Cow dung +No Active strain.
Heap G (Control) - LDPE strip only.

Coir pith was mixed with Cow dung at a ratio of 2:1.
Coir pith was mixed with Cow dung to balance the C: N ratio which will otherwise affect the action of microorganisms (Leishipem et al., 2013; Goluekn, 1991; Eiland et al.,2001; Bernal et al.,1998).

Biodegradation of LDPE sheet-Weight loss method
Prior to the insertion of the strip in to the heaps, the weight of the strips was recorded. After every 30 days up to 3 months, the LDPE strips from the corresponding soil heap were taken out and washed in Ethanol, air dried and weighed. The weight loss was then calculated and compared (Usha et al.,2011).
Weight loss % = (Initial weight-Final weight/Initial weight) x100

Determination of variation in pH value of Heap Soil.
The variation in pH value of soil at every 30 days of study was recorded by using a soil pH meter (Lutron Soil pH meter) and compared with its respective initial pH Value. A study of pH value was adopted to check the metabolic efficiency of the organisms in degrading plastics(Cosgrove et al., 2007)

Biodegraded Coir pith and biodegraded polythene strip for the cultivation of medicinal plants-Estimation of Physical Properties of growth (Reghuvaran et al.,2010)

1Kg of soil associated with compost heap together with degraded polythene strip after 90 days were taken out from all the seven heaps (A-G) and were put in small pots. All together 14 pots were taken for planting two sets of plants and each set in 7 pots having soil from different heaps and labelled accordingly. Medicinal plants such as *Phyllanthus niruri* and *Piper longum* were collected from Horticultural Division, Kerala Agriculture Farm, Ambalavayal, Kerala. Plants were selected with at most care to have the same size. Plants were then planted in all the pots containing soil with manure and degraded polythene sheets and left in half shaded area. After 30days, measurements were made of shoot and root length of plants

(SOIL HEAP ARRANGEMENTS)

III. RESULTS

The initial weight of the LDPE strips and pH of the soil near the soil heaps were recorded before insertion of LDPE sheet into the soil. The strips of LDPE sheets were taken out from all the seven heaps at an equal interval of 30 days up to 90days. pH of the soil was recorded at every 30 days interval. The LDPE sheets withdrawn from heaps were further tested for weight loss and the results recorded at each interval.

From (**Table1**), the following results were very evident, maximum percentage of degradation of LDPE sheet (11.6%) after 90days was in heap A, containing coir pith, cow dung and Active strain.A low percentage (1.6%) of degradation was seen in two heaps, Heap D containing coir pith without Active strain and HEAP F containing only cow dung without Active strain. Heap G control with no added Active strain, coir pith and cow dung reported the lowest(1.2%)degradation among them. Heap B, containing coir pith, cow dung and No active strain, recorded a result of 4% degradation. Heap C, containing coir pith and Active Strain gave a result of 5.6% of degradation. Heap E, containing cow dung and Active strain the percentage of degradation was 2%. The percentage of degradation of the LDPE strips in various heaps indicated that Biodegradation had taken place inside the heaps and is further accelerated in the presence of augmented strainDSR2, coir pith and cow dung as an organic matter.

In(**Table 2)** Heap A showed a significant variation in pH from initial 7.7 to 6.3 indicating the viability of microorganisms and the possibility of the usage of LDPE sheets as their sole source of carbon. In Heap B a slight variation of pH from the initial 7.7 to 7.3 was seen. In Heap C a variation in pH from 6.8 to 6.0 was reported. Heap D variation was narrow from 6.8 to 6.5. In Heap E a slight variation in pH was seen from7.7 to 7.3. In Heap F the variation was very small, from 7.7 to 7.5 over a period of 90 days. In Heap G pH Variation was negligible from 6.8 to 6.6 in a period of 3 months.

Table 1:- Weight loss and Percentage of Degradation

INITIAL WT-25mg	30th DAY	PERCENTAGE	60th DAY	PERCENTAGE	90th DAY	PERCENTAGE
HEAP A	24.1	3.6	23.4	6.4	22.1	11.6
HEAP B	24.8	0.8	24.3	2.8	24	4
HEAP C	24.6	1.6	24	4	23.6	5.6
HEAP D	24.9	0.4	24.8	0.8	24.6	1.6
HEAP E	24.9	0.4	24.7	1.2	24.5	2
HEAP F	25	0	24.9	0.4	24.6	1.6
HEAP G	24.9	0.4	24.8	0.8	24.7	1.2

Table:-2 pH Variation

HEAPS	INITIAL pH	30th DAY	60th DAY	90th DAY
A	7.7	7.5	6.8	6.3
B	7.7	7.5	7.3	7.3

C	6.8	6.6	6.2	6.0
D	6.8	6.7	6.5	6.5
E	7.7	7.6	7.4	7.3
F	7.7	7.6	7.6	7.5
G	6.8	6.7	6.7	6.6

After 30 days growing in pots filled with soil, degraded polythene strips and manure the measurement of shoot and root length of plant,the physical property of growth were taken to compare the quality of manure from each heap.The measurement was taken using measuring tape.

The pot containing soil from Heap A gave the best results.In *Phyllanthus niruri*,the shoot length increased by 23 cm and root length increased by 7 cm.In *Piper longum*, shoot length increased by 26cm and root length by 9cm.In HeapB, the shoot and root length of P*hyllanthus niruri* increased by 21cm and 5 cm respectively and in case of Piper longum it was 24 cm and 7 cm respectively.In Heap C,the shoot and root length of *Phyllanthus niruri* increased by 18cm and 5 cm respectively and in the case of *Piper longum* it was 20cm and 7cm respectively. In Heap D,we could see a very slow growth of shoot of *Phyllanthus niruri* with only 7cm and

root by 2 cm, *Piper longum* it was 6cm and 3cm respectively.In Heap E, the shoot and root length of *Phyllanthus niruri* incresed by 17cm and 4 cm respectively and in case of *Piper longum* it was 16cm and 5 cm respectively. In Heap F, the shoot and root length of *Phyllanthus niruri i*ncreased by 11cm and 3 cm respectively and incase of *Piper longum* it was 15cm and 6cm respectively.InHeap G, the lowest growth reported with shoot and root length of *Phyllanthus niruri* 5cm and 2 cm respectively and with *Piper longum* it was 4cm and 2 cm respectively **(Table 3**)

(TABLE 3) Root and shoot length of Medicinal plants grown in different heap soils

S.No	HEAP	*Phyllanthus niruri*		*Piper longum*	
	SOIL	SHOOT LENGTH (cm)	ROOT LENGTH (cm)	SHOOT LENGTH (cm)	ROOT LENGTH (cm)
1	A	23	7	26	9
2	B	21	5	24	7
3	C	18	5	20	7
4	D	7	2	6	3
5	E	17	4	16	5
6	F	11	3	15	6
7	G	5	2	4	2

Phyllanthus niruri

Piper longum

IV. DISCUSSION

The DSR2 strain of Actinomycetes isolated from plastic waste dump yard was used for the study. Bio-augmentation of soil was done by DSR2 strain amended with coir pith and cow dung. From the research works of Orhan Y *et al,* and Tokiwa Y *et al,* it was seen that plastic undergoes degradation and microorganisms could use plastic as a source of food. Vijaya and Reddy have also researched and found that microorganisms have the capability to degrade LDPE sheets. The microorganisms have the capacity to colonize the surface of polythene sheets forming biofilms thereby reducing the weight of LDPE strips, leading to the usage of sheets as a source of carbon. Dey U *et al* showed that reduction in pH was the result of viable cells in the heap confirming the usage of LDPE as a source of carbon and resulting in the production of monomers.

The present work is a co- composting work done by mixing soil with coir pith, agro waste and cow dung together with plastic strip. Cow dung used to accelerate the degradation activities inside the heap. George *et al* in a previous study has shown that co- composting coir pith with solid poultry manure rich in nitrogen content to convert organic waste coir pith in to rich organic manure. The viability of Actinomycetes may diminish if the compost mix contains too much Carbon in relation to Nitrogen. To balance the situation in the heap, Cow dung high in Nitrogen content is added, which is shown to solve the problem.

Bio-augmentation with DSR2 strain was carried out as it was impossible for the indigenous strains to carry out the degradative work. Indigenous microorganisms were less efficient in degrading the LDPE sheets in the field . The percentages of degradation were 0.4%, 0.8% and 1.2%, the maximum being 1.2% in 90 days (Table7, HEAP G).The bio- augmentation work gave degradation percentages of 3.6%, 6.4% and 11.6 %(Table1, HEAP A). The maximum degradation of 11.6% was seen in soil augmented with DSR2 strain and amended with Coir pith and Cow dung.

In the present study, the simultaneous biodegradation of two waste materials, an agro waste and a synthetic waste is undertaken using bio-augmentation technique with help of Actinomycete DSR2. It was also very evident that in the three heaps A, B and C, the coir pith was converted into good manure by the action of micro-organism and the simultaneous degradation of plastic sheets.

Pot culture experiments were carried out to study the quality of manure produced after the degradation experiment with Heaps A-G. Plants grown in pots where soil taken from Heap A,B,C gave good result when compared to other heaps.The root and shoot length increased considerably well due to the quality of manure produced.In a similar study carried out by Reghuvaran et al (2010) on efficiency of biodegraded coir pith for cultivation reported that biodegraded coir pith is an excellent manure providing NPK enrichment to the plants. It was also evident that the presence of degraded polythene sheets had no restrictions on the growth of the plant.

V. CONCLUSION

Bioremediation certainly is a helping hand to nature. Microorganisms having specific capacity to adapt and combat waste could be isolated more from the soil and marine environment and used for bio augmentation on waste filled areas.

The present study is a nature based solution for two wastes, an agrowaste, Coir pith and a synthetic waste, Polyethylene with more emphasis given to the degradation of polythene waste. Organic manure is a product of the study which is shown to be utilized as manure for growing medicinal plants.

DSR2 is a very promising Actinobacteria which should be utilized and exploited more for the clean up our planet for our future generations. This work also aims in propagating eco friendly approaches in treating hazardous and complex waste materials.

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