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A study to measure the cellulose and plant detritus conversion efficiency by termites

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ABSTRACT

Termites constitute a group of social insect and live together in well organized and integrated communities with highly developed social system. The present study deals with the conversion efficiency of termites. Termites can digest a frightening amount of wood in a very short time. During the present study wooden blocks were placed in such a manner that half of the blocks were buried in the soil and rest of the half were above the soil (grave yard method). It is observed that the rate of conversion efficiency of termites of wood to soil decreases with time but it is still too high. In two months on an average termite causes 11.94 per cent conversion (damage) to wood, 14.23 per cent damage in 3 months and 20.75 per cent damage in 6 months. This damage may increase with environmental conditions and by cleaning the wood periodically.

Key words: Cellulose, plant detritus, conversion efficiency, termites.

INTRODUCTION

Termites stabilise the soil with saliva which is sticky as it is issued for the digestion of the cellulose and it binds the grains of soil. Termites move in the soil and mix organic compounds and minerals resulting organo-mineral complexes with medium to long persistence. They are major determinants of soil structure, conserve soil fertility and are described as ecosystem architects (Myles, 1988, Sands 1988, Jones, 1990). Termites digest wood with the help of a large and complex community of intestinal microorganisms. The termite is a remarkable machine. Termites can digest a frightening amount of wood in a very short time, as anyone who has had termites in their house is painfully aware. Instead of using harsh chemicals or excess heat to do so, termites employ an array of specialized microbes in their hindguts to break down the cell walls of plant material and catalyze the digestion process (Falk Warnecke et*. al.,* 2007). Since termites are major converters of lignocellulosic matter to animal biomass, it would seem that they have potential for improving human utilization of lignocellulosic residues and wastes. Examples of such materials include scrap lumber and sawdust from saw mills; agricultural residues such as straw, bean pods, and sugar cane pulp; and animal dung from dairies and feed lots. Termites might be cultivated on such wastes and then harvested as feed for aquaculture or poultry production. The chemical energy in lignocellulosic wastes is usually dissipated to carbon dioxide by microbial degradation (Choe and Crespi, 1997; Abe *et al*., 2000). By feeding such waste materials to termites, vast amounts of biochemical energy could be channeled into food production. Because termites have symbiosis with nitrogen fixing bacteria, they possess the rare metabolic machinery needed to convert plant cell wall matter into animal biomass. The substantial flow of plant biomass through termite intestines represents a significant pathway in the terrestrial carbon cycle that humankind has yet to productively tap into. Termites could be important organisms for humans to learn how to cultivate. The promise of large-scale termiticulture, however, will require much more research on termite physiology, nutrition, and respiration before many technical obstacles are overcome (Uys, 2002).

Methodology

The present study was conducted by collecting of eight different plant species viz. Safeda (Eucalyptus sp.), Dhrek (Melia sp.), Shisham (Dalbergia sisoo), Kikar (Acacia indica), Sal (Shorea robusta) Mango (Mangifera indica), Neem (Azadirachta indica) and Jamoya (Prunus padus). Wooden blocks of almost 4×4×2.5 inch of each plant species were oven dried at 70°C for 15 days and weighed to record the initial weight of these blocks. These blocks were placed at different sites selected for the present study after conducting survey in the adjoining areas of Naraingarh subdivision of District Ambala (Haryana). Wooden blocks were placed in such a manner that half of the blocks were buried in the soil and rest of the half were above the soil (grave yard method).

Total three experiments were conducted. One experiment was set up in Jan. 2007 and other two in July and August 2007 respectively. The wooden blocks kept in Jan. were observed after 6 months while those kept in July were observed after three months and those kept in August were observed after 2 months.

Regular visits were given to the experiment to observe the infestation of wood by termites. After the specific time duration wooden blocks were collected, washed and oven dried and weighed on electrical balance to measure the final weight. Total weight loss and per cent weight loss were calculated. Conversion efficiency was also measured by placing the jute bag at one of the selected site in Nov. 2006 after weighing. Daily visit was made to observe appearance of termites. The decomposition time of the jute bag by the termites was observed.

RESULTS AND DISCUSSION

On the basis of identification, it was found that the experimental woods and jute bags were infested by termites. The experiments were set up in November 2006 in which a jute bag was placed in the termite dominated area and observed that termite appear on this bag after 2 days. Experiment was visited once in a week at different times. It was observed that jute bag weighing 780 gm was totally destroyed by termite up to the end of April 2007 i.e. about 6 months. So termites have good conversion efficiency. From the tables 1, 2, 3 it was observed that as the time (duration) of exposure to termites' increases, per cent damage (loss)/month to the wood decreases.

In case of *Eucalyptus* sp. when wood was placed for 2 months, per cent loss per month was 2.63 (Table 1), when it was placed for 3 months per cent loss per month was 2.30 (Table 2) when it was placed for 6 months, per cent loss per month was 2.04 (Table 3).

Table 1: Per cent weight loss of different woods due to attack by termites (after 2 months)

S. No.	Wood Species	Initial Weight (g)	Final Weight (g)	Total Weight loss	Per cent wt. loss	Per cent loss/month
1	Safeda (*Eucalyptus* sp.)	190.00	180.00	10.00	5.26	2.63
2	Dhrek (*Melia azadarach*)	150.00	131.00	19.00	12.67	6.33
3	Shisham (*Dalbergia sisoo*)	196.00	185.00	11.00	5.61	2.81
4	Kikar (*Acacia indica*)	240.00	215.00	25.00	10.42	5.21
5	Sal (*Shorea robusta*)	270.00	254.00	16.00	5.93	2.96
6	Mango (*Mangifera indica*)	210.00	155.00	55.00	26.19	13.10
7	Neem (*Azadirachta indica*)	220.00	170.00	50.00	22.73	11.36
8	Jamoya (*Prunus padus*)	165.00	155.00	10.00	6.06	3.03
	Total	1641.00	1445.00	196.00	11.94	5.97

In case of Melia azedarach when wood was placed for 2 months, per cent loss per month was 6.33, table 1. When wood was placed for 3 months, per cent loss per month was 5.56 (Table 2) and when placed for 6 months, per cent loss per month was 3.76 (Table 3).

In case of *Dalbergia sisoo* when wood was placed for 2 months, per cent loss per month was 2.81 (Table 1), when it was placed for 3 months per cent loss for month was 2.22 (Table 2) and when placed for 6 months per cent loss per month was 2.00 (Table 3).

In case of *Acacia indica* when wood was placed for 2 month, per cent loss per month was 5.21 (Table 1), when it was placed for 3 months, per cent loss per month was 4.17 (Table 2), when placed for 6 months, per cent loss per month was 3.52 (Table 3).

In case of *Shorea robusta* when wood was placed for 2 months per cent loss per month was 2.96 (Table 1), when it was placed for 3 months per cent loss per month was 2.47 (Table 2), when wood was placed for 6 months per cent loss per month was 2.08 (Table 3).

In case of *Mangifera indica*. when wood was placed for 2 months per cent loss was 13.10 (Table 1), when it was placed for 3 months, per cent loss per month was 10.16 (Table 2), when it was placed for 6 months per cent loss per month was 6.38 (Table 3).

In case of *Azadirachta indica*. when wood was placed for 2 months per cent loss per month was 11.36 (Table1) when it was placed for 3 months per cent loss per month was 8.79 (Table 2) and when placed for 6 months per cent loss per month was 5.46 (Table 3).

In case of *Prunus padus* when wood was placed for 2 months per cent loss per month was 3.03 (Table1) when it was placed for 3 months per cent loss per month was 2.79 (Table 2) and when placed for 6 months per cent loss per month was 2.45 (Table 3).

When the total loss per cent of all the woods was calculated in the table 1, 2, and 3 same trends was observed i.e. loss per cent per month for table 1 (Duration 2 month) was 5.97, for table 2 (duration 3 month) was 4.74% and for table 3 (duration 6 month) was 3.46%. The loss per cent may increase if the waste material and soil deposition at the damage site is removed periodically manually which is the matter of further investigation.

It is also revealed from the table 1, 2, and 3 that although the rate of conversion efficiency of termites of wood to soil decreases with time but it is still too high. In two months on an average termite causes 11.94% conversion (damage) to wood, 14.23% damage in 3 months and 20.75% damage

Table 2: Per cent weight loss of different woods due to attack by termites (after 3 months)

S. No.	Wood Species	Initial Weight (g)	Final Weight (g)	Total Weight loss	Per cent wt. loss	Per cent loss/month
1	Safeda (*Eucalyptus* sp.)	174.00	162.00	12.00	6.90	2.30
2	Dhrek (*Melia azadarach*)	150.00	125.00	25.00	16.67	5.56
3	Shisham (*Dalbergia sisoo*)	255.00	238.00	17.00	6.67	2.22
4	Kikar (*Acacia indica*)	240.00	210.00	30.00	12.50	4.17
5	Sal (*Shorea robusta*)	270.00	250.00	20.00	7.41	2.47
6	Mango (*Mangifera indica*)	210.00	146.00	64.00	30.48	10.16
7	Neem (*Azadirachta indica*)	220.00	162.00	58.00	26.36	8.79
8	Jamoya (*Prunus padus*)	167.00	153.00	14.00	8.38	2.79
	Total	1686.00	1446.00	240.00	14.23	4.74

in 6 months. This damage may increase with environmental conditions and by cleaning the wood periodically.

From the above observations it appears that as the wood is exposed to termites for longer period, rate of damage (Conversion) to wood decreases. This may be due to the fact that as the duration increases wood surface got covered with soil and waste material, produced by termites which hinder the movement and foraging of termites. Initially whole of the surface of wood was available to termites, therefore more damage is caused, however as time increases it gets covered by wastes produced by termites mixed with soil which is perhaps carried by termites to upper surface for gallery formation.

According to Ramos and Rojas 2000; the feeding preferences of the Formosan subterranean termite, Coptotermes formosanus Shiraki were tested in three separate experiments on 28 different wood species. Preference was determined by consumption rates. Importance of termites has been discussed by several workers for their useful role in biodegradation, recycling of soil nutrients and improvement in the quality of soil (Lee and Wood, 1971; Golley, 1983; Mishra, 1986; Singh *et al.,* 1987a, b; Coventry *et al.;* 1988; Abbade and Lepage, 1989; Jones, 1990).

Termites are important components of forests ecosystems, where they break down dead cellulose into its basic elements for use by plants and animals. Termite galleries improve soil structure, and assist water entry and storage in soil; surface runoff and subsequent soil erosion are thereby reduced by the galleries. The plant tissues upon which termites feed contain very little protein and therefore little nitrogen (Holt and Lepage, 2000; Peter and King, 2006).

In India practically very little information is available with regard to the changes brought about by termites in soil. Sen-Sarma (1974) has discussed the problem to some extent and suggested that humus feeding termites are active in the top soil which is, therefore, depleted of organic matter and thus can be a serious economic problem in areas deficient in humus. Roonwal (1976) has discussed the adaptation of termites of various soil types of Rajasthan. Shrikhande and Pathak (1948) gave an account of the effect of earthworms and insects in relation to soil fertility. Pathak and Lehri (1959) observed that the soil of termiteria built by Odontotermes sp. had a higher per cent of lime, magnesium and phosphorous. Agarwal (1975) has observed almost similar levels of organic content in the mound soil and the adjacent subsoil, which indicates utilization of subsoil in mound construction. Almost no information about the conversion efficiency of termites is available in the past although, some workers have mentioned that the conversion efficiency has direct correlation with the number of termites present at a particular site. The loss per cent may increase if the waste material

Table 3: Per cent weight loss of different woods due to attack by termites (after 6 months)

S. No.	Wood Species	Initial Weight (g)	Final Weight (g)	Total Weight loss	Per cent wt. loss	Per cent loss/month
1	Safeda (*Eucalyptus* sp.)	196.00	172.00	24.00	12.24	2.04
2	Dhrek (*Melia azadarach*)	155.00	120.00	35.00	22.58	3.76
3	Shisham (*Dalbergia sisoo*)	250.00	220.00	30.00	12.00	2.00
4	Kikar (*Acacia indica*)	237.00	187.00	50.00	21.10	3.52
5	Sal (*Shorea robusta*)	280.00	245.00	35.00	12.50	2.08
6	Mango (*Mangifera indica*)	235.00	145.00	90.00	38.30	6.38
7	Neem (*Azadirachta indica*)	226.00	152.00	74.00	32.74	5.46
8	Jamoya (*Prunus padus*)	170.00	145.00	25.00	14.71	2.45
	Total	1749.00	1386.00	363.00	20.75	3.46

and soil deposition at the damage site is removed periodically manually which is the matter of further investigation. Although a number of workers have studied the losses caused by termites to wood matter, crops and trees yet this huge work can be accomplished by study of conversion efficiency, and soil enrichment by the termites (Holt and Lepage, 2000, Bignell and Egglton, 2000).

Although, termites are major converters of lignocellulosic matter to animal biomass, it would seem that they have potential for improving human utilization of lignocellulosic residues and wastes. Examples of such materials include scrap lumber and sawdust from saw mills; agricultural residues such as straw, bean pods, and sugar cane pulp; and animal dung from dairies and feed lots. Termites might be cultivated on such wastes and then harvested as feed for aquaculture or poultry production. The chemical energy in lignocellulosic wastes is usually dissipated to carbon dioxide by microbial degradation. By feeding such waste materials to termites, vast amounts of biochemical energy could be channeled into food production. Because termites have symbiosis with nitrogen fixing bacteria, they possess the rare metabolic machinery needed to convert plant cell wall matter into animal biomass. The substantial flow of plant biomass through termite intestines represents a significant pathway in the terrestrial carbon cycle that humankind has yet to productively tap into. Termites could be important organisms for humans to learn how to cultivate. The promise of large-scale termiticulture, however, will require much more research on termite physiology, nutrition, and respiration before many technical obstacles are overcome.

The present work has an attempt to measure the conversion efficiency infested with termites. It is fondly hoped that besides richly adding to our knowledge about the termites, the results will provide useful clues and guidance to future workers on the termites in general.

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