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Preliminary studies on the use of liquefied biomass as wood preservative against subterranean termites

OLUFEMI B. and OLANIRAN S.O.
Department of Forestry and Wood Technology, Federal University of Technology, Akure
olufemibabatola@yahoo.com

Abstract
Liquefied biomass preservative was examined for its potential to resist termite attack on wood. Wood species of *Hevea brasiliensis* and *Pterocarpus milbraedii* were prepared in dimension 20 × 20 × 60 mm blocks. Wood samples were oven-dried at 103±2^{o}C to a constant weight, treated with preservatives using cold-soaking method for 24 hr and conditioned for 72 hr in the laboratory before exposure to termites for 12 weeks. Creosote oil and CCA were used as standards for measuring effectiveness of liquefied biomass because result of their long history of performance as termicides. Results showed that liquefied biomass had the highest retention of 2.42 kg/m^3 compared with CCA (2 %) and creosote oil with mean retention of 0.35 kg/m^3 and 1.60 kg/m^3 respectively. The result of 12 week exposure to termites however showed that wood samples treated with liquefied biomass attained a visual rating of 0 and mean weight loss of 95.13 %. This showed that the active ingredients in liquefied biomass were not as toxic as those of CCA and Creosote oil that were not attacked throughout the exposure period.

Keywords: Liquefied biomass, *Hevea brasiliensis*, *Pterocarpus milbraedii*, Termites.

Introduction

Wood preservation industries in Nigeria have witnessed an influx of imported preservatives while little efforts have been made to produce them locally. Most of these imported chemicals though very effective against bio-deteriorating agents have been restricted in their use due to the side effects they have on human and the environment in general. According to FPL (2010),industrial wood preservation chemicals are not generally available to the public and may require special approval to import or purchase them depending on the product and the location where they are being used. As a result of this, efforts have been made in recent times to discover locally made chemicals which could replace these imported preservatives. Adetogun (1998) researched into the use of cashew nut shell liquid as fungicide against wood decay while its effectiveness as termicide was examined by Owoyemi *et al*, (2011). The use of spent engine oil as wood preservative was also studied by Omole and Onilude (2001); and Olaniran *et al*, (2010) for its effect on strength properties of wood and effectiveness on subterranean termites. A recent development is the production of Liquefied biomass (LB) a bye product of bio-diesel produced from cassava and groundnut oil through a process known as transesterification. This process yields a three layered product; the first layer is the unpurified bio-diesel, the second is the sludge or de-ethanolized sludge while the third layer is the glycerin. The sludge from the second layer is used as raw material for bio-emulsion from which LB preservative was produced. This paper examines the potentials of liquefied biomass for its effectiveness in preventing the attack of termites for timbers in ground contact.

Materials and Method

Hevea brasiliensis and *Pterocarpus milbraedii* wood samples of dimension 20 × 20 × 60mm were prepared for the field test. The test pieces were prepared and treated as specified in the ASTM D1413 - 76 Standard. The samples were divided into 2 sets A and B. The first set was sub-divided into three sub-groups with 5 replicates in a subgroup (A1, A2 and A3) and each was treated with CCA with 2% active ingredient, undiluted creosote oil and the undiluted liquefied biomass respectively using the cold soaking method. The second set (B) with 5 replicates was left as the control (untreated). A total of 40 samples were used for the durability test (20 samples for each wood species). All the test pieces were oven-dried at 103 ± 2o C till a constant weight was achieved.

This weight was recorded as the oven-dry weight (T1). The samples were allowed to cool before treatment with chemicals. The method of treatment used was cold-soaking for 24 hr. After the chemical treatments, the samples were drained of excess preservatives after which they were re-weighed (T2).

Retention Test

Retention which is the measure of the active ingredients of preservatives left in the wood, was calculated according to ANSI/ASTDM D1413-74 standard as shown in below:

$$\text{Retention in kg/m}^3 = 10\times\left(\frac{GC}{V}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where G = ($T_2 - T_1$) Treated weight – oven-dried weight

C = Weight of preservative in 100g of treating solution (g)

V = Volume of sample in cm^3.

Test samples were conditioned for 72 hr to enable the preservative fix in the wood and then reweighed as (T3). The termite resistance of the treated samples was then tested by exposing them to termite attack for 12 weeks. Exposure of the treated samples to termite attack was carried out at a site located at the Federal University of Technology, Akure. Long before the commencement of the field test, the site had been prepared by spreading wood and other cellulosic materials to increase termite activities on the site. Samples were exposed for 12 weeks and the readings were taken accordingly as established by the ASTM D 3345 – 74 standards below:

10 = Sound, surface nibbles permitted.
9 = Light attack
7 = Moderate attack penetration
4 = Heavy attack, 30 – 40% of the wood cross-section eaten up by termites
0 = Failures, over 50% of the wood cross-section eaten up by termites

The wood samples were removed at the end of the 12-week exposure and weighed to assess the proportion of treated wood attacked by termites. Weight loss due to termites' attack was calculated thus:

$$\text{Weight loss (\%)} = 100\times\left(\frac{T_3 - T_4}{T_3}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where: T_3 = conditioned weight after preservation treatment.

T_4 = Weight after exposure to termites' attack

Results and Discussion

Retention of Preservatives

Results of mean retention for the preservatives are shown in Table 1. The results showed that Liquefied biomass (LB) had the highest mean retention of 2.42 kg/m^3. Creosote oil had a mean retention of 1.60 kg/m^3 while CCA had a mean retention 0.35 kg/m^3. Results in Table 2 also revealed that *H. brasiliensis* had a higher retention capacity (1.81 kg/m^3)than*P. milbraedii* wood with a mean retention of 1.11 kg/m^3. From Figure 1 it could also be observed that except for CCA, retention was higher in *H. brasiliensis* wood. The result of analysis of variance in Table 3 further showed that the wood species and the nature of preservatives had a significant effect on retention. These results indicated that liquefied biomass had the highest retention compared to other preservatives. The lower retention of CCA could be attributed to the lower concentration used in this study. Owoyemi (2008) observed a corresponding increase in retention as concentration of CCA increases. Thus the active ingredients of LB retained by the wood species were higher than creosote oil and CCA.

Table 1: Mean Retention of Preservatives

Preservatives	Mean Retention (kg/m^3)
CCA (2%)	0.35 ± 0.31^a
CREO	1.60 ± O.28^b
LB	2.42 ± 0.16^c

Means with different alphabets are significant (p<0.05)

Table 2: Mean Retention capacity of the wood species

Wood Species	**Mean Retention (kg/m^3)**
H. brasilensis	1.81 ± 0.32^a
P. milbraedii	1.11 ± 0.18^b

Means with different alphabets are significant (p<0.05)

Table 3: Analysis of variance for comparing retention of preservatives by the wood species

Source	**SS**	**df**	**MS**	**F**	**Sig.**
Species	3.647	1	3.647	32.203	.000*
Preservatives	21.846	2	10.923	96.448	.000*
species * Preservatives	3.007	2	1.504	13.278	.000*
Error	2.718	24	.113		
Total	**31.218**	**29**			

*Significant (p<0.05)

Resistance of the treated wood samples to subterranean termite attack

The result of weekly visual observation of the treated samples of *P. mibraedii* and *H. brasiliensis* is illustrated in Figures 1 and 2. Mean visual rating for the 12-week period revealed that both wood species are not naturally resistant to termite attack. The untreated samples (control) were attacked by subterranean termites after the first week of exposure. The control samples were heavily attacked after the 3rd week with *P.milbraedii* and *H. brasiliensis* having a mean rating of 0 at the 12th week. Samples treated with CCA and Creosote were still sound till the 12th week. Moderate attack began on the samples treated with the liquefied biomass at the 4th week with mean rating of 9.3 and 8.8 for *P. milbraedii* and *H. brasiliensis* respectively. They were however attacked and finally degraded with a mean visual rating of 0 at the end of the 12-week field exposure period. The result of weight loss conducted for the wood species is shown in Figure 4. The result revealed that *H. brasiliensis* wood treated with Liquefied biomass had a mean weight loss of 96.28 % comparable with the control with 99.26 % while those treated with CCA and Creosote oil had a mean weight loss of 7.08 % and 7.52 % respectively. *P. milbraedii* samples treated with CCA and Creosote oil had a mean weight loss of 6.96 % and 8.02 % while those treated with liquefied biomass had a mean weight loss of 93.98 % which is very close to the control with a mean weight loss of 98.48 % at the end of the 12-week exposure. From these results, wood samples treated with CCA performed well throughout the period of exposure even at the lowest concentration with 2 % active ingredient.

CCA have been reported by Kenneth (1998) and Willeitner (1977) to be toxic to termites especially for timber in ground contact. The presence of chromium in CCA solution prevents leaching even during the raining season of the year.Samples treated with LB preservative were degraded from the 2nd week and failed completely before the 12th week. It should however be noted that this experiment was conducted during the raining season. This might have led to the low potency of the liquefied biomass probably because of leaching of the water-soluble salt due to heavy rainfall. It was observed in the course of the experiment that the preservative produced a white salt that was soluble in water and could easily be washed off the wood surface. The Creosote treated samples on the other hand were not degraded at all throughout the 12-week period. This could be attributed to its strong odour that had kept the termites away from the wood samples. Despite the heavy rain, the creosote treated samples performed well as reported by Owoyemi*et.al,* (2011). The control (untreated) samples were degraded by the termites and they finally attained a mean visual rating of 0 before the expiration of 12-week exposure. The result of weight loss presented in Figure 4 further indicated that the wood species (*H. brasiliensis* and *P. milbraedii*) are not resistant to termite attack. This implies that they should be treated with chemical preservatives to extend their service life. Furthermore, the result also indicated that although the Liquefied biomass had a higher retention than CCA and Creosote, the active ingredients were not toxic enough to resist the attack of termites on the wood species as demonstrated by Olufemi and Olanipekun (2008). Even though CCA and Creosote had a lower retention values they were very potent in resisting termite attack.

Conclusion

The results of this study has shown lower potency of liquefied biomass as termicide compared with existing preservatives used as standards. The active ingredients in the preservative were either not toxic enough to resist termite attack or the leaching of the preservative in during the heavy rainfall might have reduced the potency. The preservative could be made more effective by adding a toxicant. It could also be furtherexamined to know its performance as during dry season to confirm its susceptibility to leaching. This will enable the user of the preservatives to know its performance and its use either for indoor or outdoor applications. Since the study did not cover the use of the chemical as fungicide, it could be further examined for any fungicidal property.

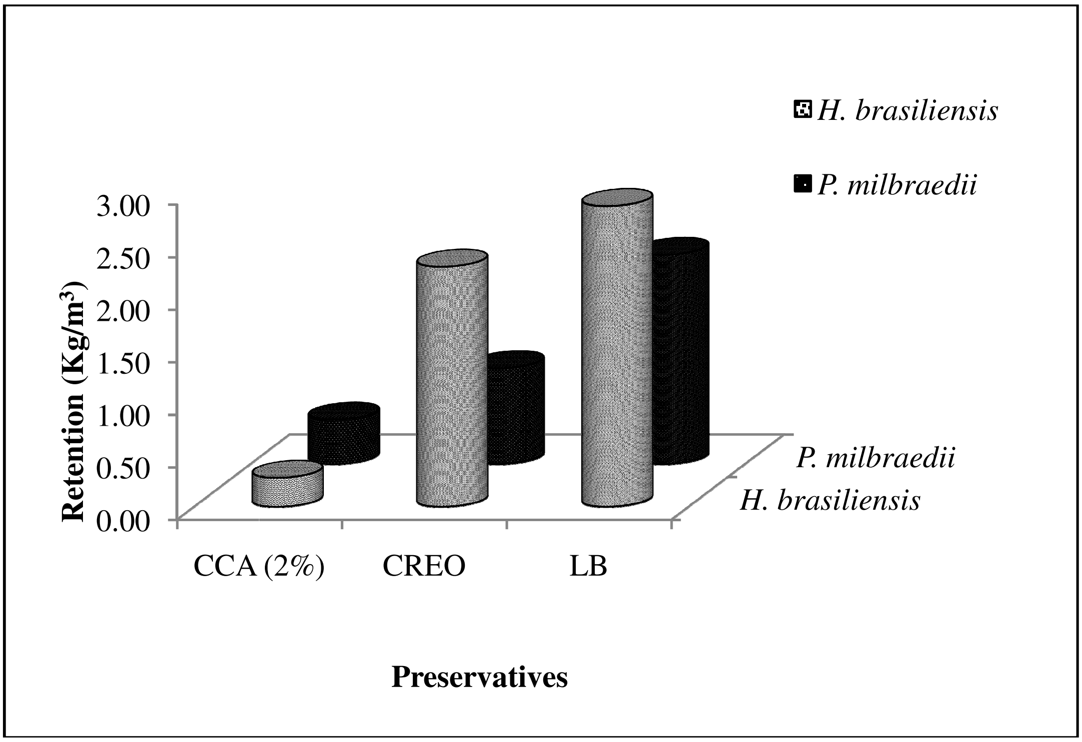

Fig. 1: Retention of preservatives by *H. brasiliensis* and *P. milbraedii* wood

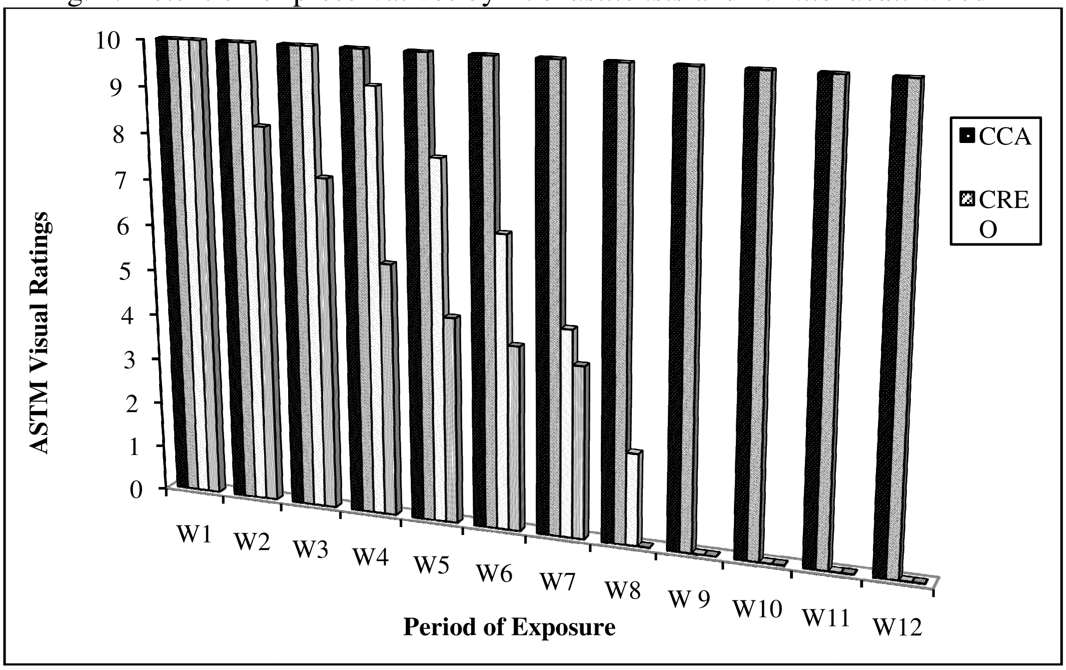

Fig. 2: Resistance of treated *P. milbraedii* wood to subterranean termites after exposure for 12 weeks

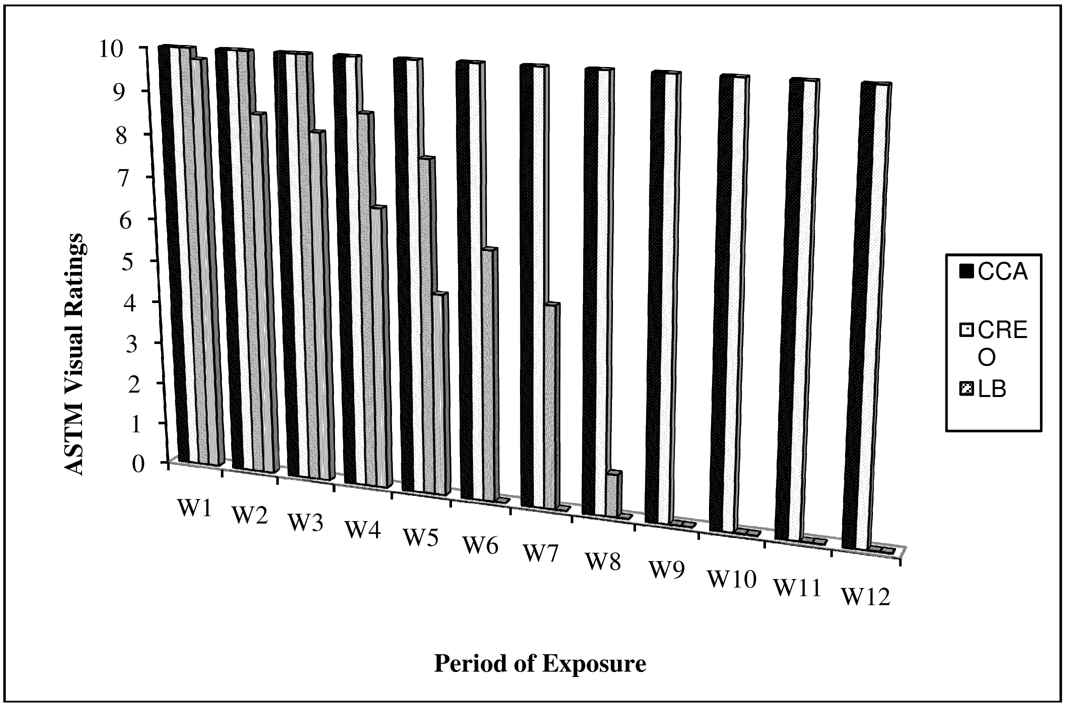

Fig. 3:Resistance of treated *H. brasiliensis* wood to subterranean termites after exposure for 12 weeks

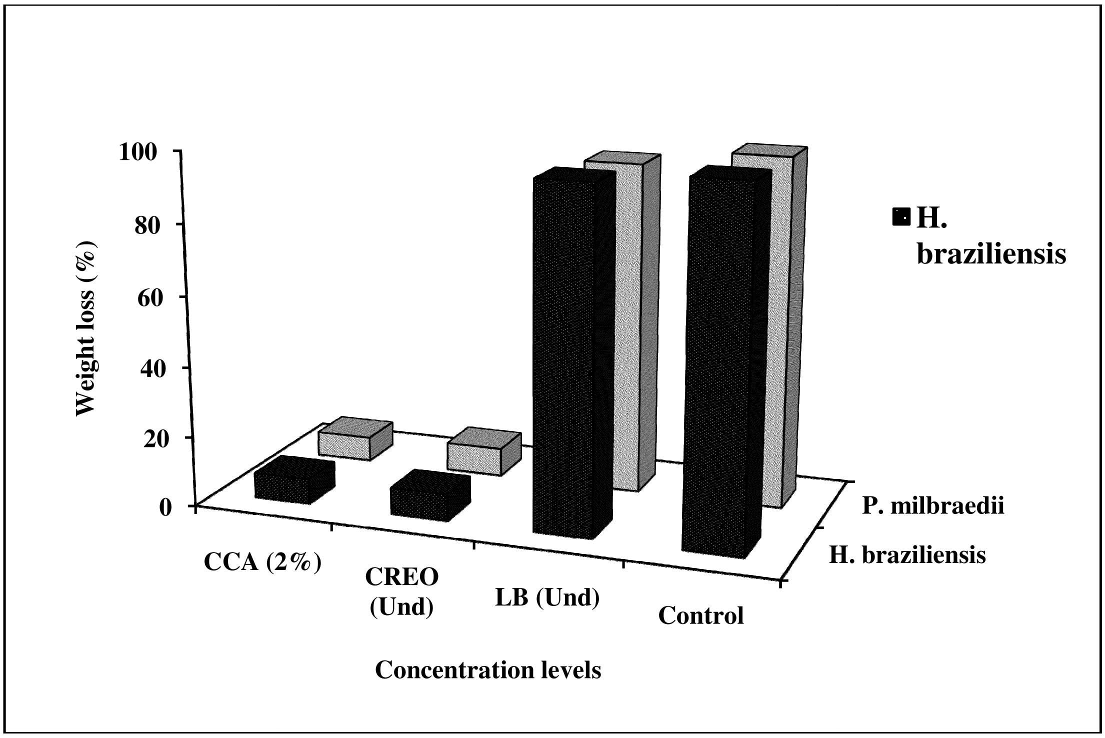

Fig. 4: Weight loss result for treated wood samples after 12-week exposure to termite attack

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