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Efficiency of used oil engine as preservative of Amazonian woods submitted to xylophagous termites

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ABSTRACT This study aimed to evaluate the efficiency of used oil engine as preservative of Amazonian woods submitted to xylophagous termites. *Trattinnickia rhoifolia* (amescla), *Erisma uncinatum* (cedrinho) and *Copaifera langsdorffii* (copaíba) samples, measuring 2x2x10cm, were submitted to preservative treatments by fast (5 minutes) and prolonged (24 hours) soak in oily product with different viscosities, SAE 10 and SAE 15. The used oil engine retention rate in each sample was determined after preservative treatments performance. Treated and untreated samples were submitted to feeding preference test with *Nasutitermes* sp. (xylophagous termite) for 45 days for preservative treatment efficiency evaluation, with mass loss determination at the end of this period. The soak period and the used oil engine viscosity had not statistically influence the retention rate, except for cedrinho wood. Regarding the assessed woods, copaiba wood showed the highest retention rate, differing statistically from amescla and cedrinho woods. Any samples treated with used oil engine showed xylophagous termites attack, demonstrating the efficiency of this substance in the preservative treatment. Among the untreated wood, copaíba and cedrinho showed the highest and the lowest rates of mass loss, respectively.
Keywords: biodeterioration of wood, wood preservation, *Nasutitermes* sp., tropical wood.

Eficiência do óleo queimado como preservativo de madeiras amazônicas submetidas ao ataque de cupins xilófagos

RESUMO Este estudo teve como objetivo avaliar a eficiência do óleo queimado como preservativo de madeiras amazônicas submetidas ao ataque de cupins xilófagos. Para tanto, amostras de *Trattinnickia rhoifolia* (amescla), *Erisma uncinatum* (cedrinho) e *Copaifera langsdorffii* (copaíba), com dimensões de 2x2x10 cm, foram submetidas aos tratamentos preservativos por imersão rápida (5 minutos) e prolongada (24 horas) em produto oleoso com viscosidades distintas, SAE 10 e SAE 15. Após a realização dos tratamentos preservativos foi determinada a taxa de retenção do óleo queimado em cada amostra. Para avaliação da eficiência do tratamento preservativo, amostras tratadas e não tratadas foram submetidas ao ensaio de preferência alimentar com cupim xilófago *Nasutitermes* sp. durante 45 dias, sendo determinada a perda de massa das amostras ao final desse período. O tempo de imersão e a viscosidade do óleo queimado não influenciaram estatisticamente na taxa de retenção, exceto para a madeira de cedrinho. Com relação às madeiras avaliadas, a copaíba apresentou a maior taxa de retenção, diferindo estatisticamente da amescla e cedrinho. Nenhuma das amostras tratadas com óleo queimado apresentou ataque dos cupins xilófagos, evidenciando a eficiência dessa substância no tratamento preservativo. Dentre as madeiras não tratadas, a copaíba e o cedrinho apresentaram os maiores e menores percentuais de perda de massa, respectivamente.
Palavras-chave: biodeterioração da madeira, preservação da madeira, *Nasutitermes* sp., madeira tropical.

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Introduction

The Amazon region covers about 30% of the tropical wood world stock, however, its wood production is not in agreement with the real potential (BARBOSA et al., 2001), due to production system consisting of a traditional forest species selective cutting. In addition, Araújo et al. (2012) highlight the selective cutting practice, allied to deforestation anthropic actions, mainly by new agricultural frontiers opening, has caused a forest resources original stock reduction.

Among the States inserted in Amazon Basin, Mato Grosso is highlighted, especially the northern region, which is responsible for the second largest wood production, behind only Pará State. In Mato Grosso State, the wood trade, especially to the South and Southeast of Brazil, has been restricted to sawn products from forest species of greatest commercial value, e.g. *Apuleia leiocarpa*, *Dipterxy odorata* and *Mezilaurus itauba*, which present as main feature its high natural durability. The lower natural durability wood utilization has increased due to availability reduction and business value increasing of these more traditional woods in local market, especially in rural scale, aimed at producing fences, fencepost and small structures.

Wood products may be attacked by a range biodeterioration agents that include bacteria, marine borers, wood borers, fungi (mould, stain and decay) and termites, especially the last two agents. Mendes; Alves (1988) stated that knowledge of the natural durability of wood are determinant for its use, mainly in tropical countries.

In Amazon region, termites present favorable soil and climate conditions for its development, especially termites from *Nasutitermes* genus, which is characterized as an underground type with preference for deterioration of dry wood or in early-stage attack by other xylophagous organisms (PERES FILHO et al., 2006; CORASSA et al., 2014).

Wood may presents a high or low resistance to action of deterioration agents according to its physical (porosity and specific weight) and chemical (extractives and lignin content) properties (STANGERLIN et al., 2013). However, wood is not permanently resistant to deterioration agents, which affects its structural integrity. Thus, preservative treatments either through chemical modification or by chemicals products impregnation may increase wood durability, as well as improve value-added of this material.

Wood preservation with used oil engine has been reported by some authors (OLANIRAN; OLUFEMI, 2010; SSEMAGANDA et al., 2011; MATTOS et al., 2013; GALLON et al., 2014) as effective alternative to improve wood resistance to deterioration. Omole; Onilude (2000) and Mattos et al. (2012) emphasized the easy access and the low cost of used oil engine, since the application pressure is not required, which is recommended for wood preservative treatment in rural properties by soak or brushing. Furthermore, this oil is a residue from automotive sector, which may be intended for reuse.

Thus, this study aims to evaluate the efficiency of used oil engine as preservative of Amazonian woods submitted to xylophagous termites.

Materials and Methods

Wood samples of Trattinnickia rhoifolia (amescla), *Erisma uncinatum* (cedrinho) e *Copaifera langsdorffii* (copaíba) were obtained to conduct this study. The samples were obtained from tangentially sawn logs with central boards without visual defects and submitted to natural drying to obtain 15% equilibrium moisture content. Forty-five and fifteen samples of each species measuring 2x2x10 cm (larger dimension in axial direction) were prepared to conduct the biodeterioration tests, and chemical and physical characterization, respectively.

Density, extractives, ash and Klason lignin content were determined by Brazilian Standard (Norma Brasileira Reguladora – NBR) 11941, 14853, 13999 and 7989 of the Brazilian Association for Technical Standards (Associação Brasileira de Normas Técnicas – ABNT) (2003a, 2002, 2003b and 2003c), respectively.

Wood samples were keep in an electric kiln with forced air circulation at 100°C to reach the anhydrous mass (0% moisture content). Then, samples were submitted to four different preservative treatments using the soak method. Two factors were considered in this study: soak time (fast: 5 minutes; prolonged: 24 hours) and used oil engine nominal viscosity (SAE 10 and SAE 15). Nine samples of each Amazon woods were used for each preservative treatment. Other nine samples were not impregnated with used oil engine, characterizing the control treatment to evaluate the preservative effectiveness.

The used oil engine excess was removed with paper towels at the end of the impregnation step. Wood samples were dried, and the final weight was determined. The used oil engine retention rate was determined by relation between difference of mass before and after the impregnation step and volume of each sample.

Biodeterioration test was performed using similar method proposed by Calegari et al. (2014), which is the wood joint provision to xylophagous termites (feeding preference test).

Biodeterioration test was carried out in a polyethylene water tank with capacity up to 500 liters. Sterile sand layer with a thickness 10 cm was put inside the tank, and was maintained at water saturation during the test. As a protective measure, the water tank was covered with a nylon grid to avoid termites escape.

Forty five samples of each species were divided into three randomized blocks and partially buried in the sand layer up to half its length, i.e. 5 cm, and spaced in 2 cm. Above the untreated and treated wood samples, an active colony of *Nasutitermes* sp. supported on a leaked metal surface was prepared. The colony of termites with 55 cm length and 33 cm in diameter was obtained from a deteriorating stage tree within a forest plantation fragment.

The feeding preference test was carried out in a climate room for 45 days with temperature and air relative moisture of 25 ± 5°C and 65 ± 10%, respectively.

After exposure period to xylophagous termites, the samples were cleaned to remove the adhered sand and termites, and submitted to drying, until its reach the anhydrous mass. The mass loss of each wood sample provided by xylophagous termite attack was determined by the ratio between the initial mass and the final mass.

The preservative distribution in the wood was assessed by samples colorimetric characterization before submitted to the preservative treatment and at the end of biodeterioration tests. Treated samples were cut in two faces, external (sample surface) and internal (half the sample). The colorimetric characterization was performed by colorimeter with 3 nm resolution, equipped with a diffuse reflectance integrating sphere, illuminating D65 and with 10° observation angle. The colorimetric parameters L* (lightness), a* (green-red chromatic coordinate), b* (yellow-blue chromatic coordinate), C* (color saturation) and h (hue angle) were obtained by CIEL*a*b* system. Five readings were performed in each wood samples.

The data (retention rate and mass loss) were assessed by analysis of variance ($p<0.05$), when the null hypothesis was rejected, the mean values were compared by the Fischer's LSD (Least Significant Difference) test at 5% significance level.

Results and Discussion

The highest used oil engine retention rate was observed for copaiba wood, regardless the interactions between soak period and the product viscosity (Table 1), although the copaiba wood showed higher extractives content and density than other species (Table 2). However, Mattos et al. (2012) and Gallon et al. (2014), in similar studies, had also non-direct relation between the wood lower porosity (due to higher extractives content and density) and the used oil engine retention rate increase applied in different woods species.

Regarding the different preservation processes, considering the interaction between soak period and viscosity, there was non-statistical difference between the retention rates for amescla and copaiba woods. However, cedrinho wood showed that the samples submitted to prolonged soak treatment (24 hours) were statistically different from those submitted to fast soak (5 minutes). This result corroborates with Jankowsky; Aguiar (1981) when tested the soak period intervals effect from 5 minutes to 45 minutes. The authors observed an increase of preservation retention rate with increasing of treatment periods. Lepage et al. (1986) also affirmed the higher preservative absorption applied by soak method occurs in the first 5 minutes, decreasing with the time progression, followed by a stabilization after 24 hours.

Regarding oil viscosity, the highest retention rates were verified using a more viscous product (SAE 15), regardless of treatment period, except for the cedrinho wood.

Table 3 shows that used oil engine penetration was more superficial, since the surface of treated samples, regardless of the species, showed a color darkening (lower L*) in relation to the internal face. The samples treated with a more viscous oil (SAE 15) showed great changes in the wood surface color, reducing the intensity of three colorimetric parameters (L*, a* and b*).

Table 2. Chemical and physical characterization of amescla, cedrinho and copaiba woods.

Wood	Ash (%)	Extractives (%)	Klason lignin (%)	Density ($g.cm^{-3}$)
Amescla	0.58	2.94	25.17	0.43
Cedrinho	0.76	3.79	30.75	0.48
Copaíba	0.65	4.52	28.89	0.55

Despite the difference in used oil engine retention rates, any samples submitted to the preservation processes showed xylophagous termite attack (Table 4), demonstrating the efficiency of used oil engine. Ssemaganda et al. (2011) reported satisfactory results with the impregnation of used oil engine in *Eucalyptus grandis* wood. The authors did not observed de-

Table 1. Retention rate of used oil engine of amescla, cedrinho and copaíba woods.

Soak period * Oil viscosity	Wood					
	Amescla		Cedrinho		Copaíba	
5 minutes * SAE 10	51.42 (6.31)	aA[1]	50.73 (4.67)	aAB	69.62 (5.12)	bA
5 minutes * SAE 15	55.71 (5.57)	aA	45.84 (3.85)	aA	77.56 (28.88)	bA
24 hours * SAE 10	58.29 (11.93)	abA	52.46 (5.34)	aB	72.21 (7.27)	bA
24 hours * SAE 15	63.46 (25.67)	abA	51.39 (7.03)	aB	72.77 (3.82)	bA

[1]Means with the same lowercase letter in line or uppercase letter in column are not statistically different at level of 5% probability of error by Fischer's LSD test. Values in parentheses corresponding to the standard deviation.

terioration signs after eight months of exposure to xylophagous termites. In addition, Mattos et al. (2013) highlighted that the preservative treatment efficiency with used oil engine is compared to CCB, since eucalypts wood treated with both products showed similar mass loss after field test exposure.

Table 3. Colorimetric characterization before submitted to the preservative treatment and at the end of biodeterioration tests.

Treatments	Position	L*	a*	b*	C*	h
Amescla						
Control	Surface/Internal	74.08	7.98	20.20	21.72	68.44
5 minutes * SAE 10	Surface	55.42	7.52	21.66	22.93	70.82
	Internal	72.74	5.68	16.76	17.70	71.27
5 minutes * SAE 15	Surface	36.53	1.47	8.02	8.16	79.56
	Internal	72.70	4.71	16.14	16.81	73.71
24 hours * SAE 10	Surface	47.71	7.41	17.18	18.93	65.98
	Internal	73.60	5.03	17.65	18.36	74.11
24 hours * SAE 15	Surface	36.80	1.43	8.15	8.28	80.87
	Internal	67.16	2.97	13.42	13.76	77.77
Cedrinho						
Control	Surface/Internal	48.09	12.64	19.17	22.97	56.61
5 minutes * SAE 10	Surface	31.36	10.01	11.80	15.50	49.66
	Internal	40.07	11.87	14.38	18.64	50.45
5 minutes * SAE 15	Surface	26.23	0.81	3.88	3.97	78.25
	Internal	42.47	14.61	16.65	22.15	48.71
24 hours * SAE 10	Surface	26.46	4.63	5.94	7.54	52.32
	Internal	35.89	10.57	12.52	16.39	50.04
24 hours * SAE 15	Surface	23.98	0.56	3.21	3.27	80.51
	Internal	41.41	13.97	15.79	21.09	48.52
Copaíba						
Control	Surface/Internal	58.09	8.23	18.08	19.87	65.51
5 minutes * SAE 10	Surface	43.97	12.68	16.02	20.43	51.65
	Internal	52.19	7.96	14.06	16.17	60.50
5 minutes * SAE 15	Surface	27.57	0.66	4.11	4.17	81.16
	Internal	56.65	7.06	14.22	15.88	63.48
24 hours * SAE 10	Surface	39.09	7.98	13.39	15.60	59.34
	Internal	51.38	9.00	16.94	19.19	62.01
24 hours * SAE 15	Surface	27.61	1.30	4.26	4.46	73.46
	Internal	50.11	5.45	12.02	13.2	65.66

Table 4. Mass loss of amescla, cedrinho and copaiba woods submitted to feeding preference tests.

Soak period * Oil viscosity	Wood					
	Amescla		Cedrinho		Copaíba	
Control	14.81 (13.01)	bB[1]	2.38 (0.91)	aB	34.34 (28.47)	cB
5 minutes * SAE 10	0.00 (0.00)	aA	0.00 (0.00)	aA	0.00 (0.00)	aA
5 minutes * SAE 15	0.00 (0.00)	aA	0.00 (0.00)	aA	0.00 (0.00)	aA
24 hours * SAE 10	0.00 (0.00)	aA	0.00 (0.00)	aA	0.00 (0.00)	aA
24 hours * SAE 15	0.00 (0.00)	aA	0.00 (0.00)	aA	0.00 (0.00)	aA

[1]Means with the same lowercase letter in line or uppercase letter in column are not statistically different at level of 5% probability of error by Fischer's LSD test. Values in parentheses corresponding to the standard deviation.

Among the woods that were not submitted to preservative treatments, copaiba and cedrinho showed the highest and the lowest mass loss, respectively. It might be emphasized that, despite the copaiba wood present higher extractives content and density, the wood natural durability is more influenced by the chemical constituent's toxicity (STANGERLIN et al., 2013). Regarding to cedrinho wood, Cardias (1985) and Carneiro et al. (2009) classified this wood as high natural durability. Thus, the results of this study corroborate with the respective authors. As a complement, Peres Filho et al. (2006) evaluating the extracts effect obtained from five different woods in xylophagous termites mortality of *Nasutitermes* genus, highlighted that cedrinho wood has good natural resistance.

Conclusions

The soak period and the used oil engine viscosity had not statistically influence the retention rate, except for cedrinho wood. Among the untreated wood, copaíba and cedrinho showed the highest and the lowest rates of mass loss, respectively. Any samples treated with used oil engine showed xylophagous termites attack, demonstrating the efficiency of this substance in the preservative treatment. Therefore, it's recommended the preservative treatment by fast soak (5 minutes) in lower viscous product (SAE 10), especially for woods in rural uses.

References

ARAÚJO H.J.B.; MAGALHÃES, W.L.E.; OLIVEIRA, L.C. Durabilidade de madeira de eucalipto citriodora (*Corymbia citriodora* (Hook.) K.D. Hill & L.A.S. Johnson) tratada com CCA em ambiente amazônico. **Acta Amazonica**, Manaus, v. 42, n. 1, p. 49-58, 2012

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS (ABNT). **NBR 14853**: Madeira - Determinação do material solúvel em etanol-tolueno e em diclorometano. Rio de Janeiro: ABNT, 2002. 3p.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS (ABNT). **NBR 11941**: Determinação da densidade básica. Rio de Janeiro: ABNT, 2003a. 6p.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS (ABNT). **NBR 13999**: Papel, cartão, pastas celulósicas e madeira - Determinação do resíduo (cinza) após a incineração a 525°C. Rio de Janeiro: ABNT, 2003b. 4p.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS (ABNT). **NBR 7989**: Pasta celulósica e madeira – Determinação de lignina insolúvel em ácido. Rio de Janeiro: ABNT, 2003c. 5p.

BARBOSA, A.P.; VIANEZ, B.F.; VAREJÃO, M.J.; ABREU, R.L.S. Consideração sobre o perfil tecnológico do setor madeireiro na Amazônia Central. **Biodiversidade, Pesquisa e Desenvolvimento na Amazônia**, Manaus, n. 12, p.42-61, 2001.

CALEGARI, L.; LOPES, P.J.G.; SANTANA, G.M.; STANGERLIN, D.M.; OLIVEIRA, E.; GATTO, D.A. Eficiência de extrato tânico combinado ou não com ácido bórico na proteção da madeira de *Ceiba pentandra* contra cupim xilófago. **Floresta**, Curitiba, v. 44, n. 1, p.43-52, 2014.

CARDIAS, M.F. **Durabilidade natural de algumas espécies de madeiras brasileiras**. Manaus: CPPF, 1985. 150 p.

CARNEIRO, J.S.; EMMERT, L.; STERNADT, G.H.; MENDES, J.C.; ALMEIDA, G.F. Decay susceptibility of Amazon wood species from Brazil against white rot and brown rot decay fungi. **Holzforschung**, Berlin, v. 63, n. 6, p. 767-772, 2009.

CORASSA, J.N.; PIRES, E.M.; ANDRADE NETO, V.R.; TARIGA, T.C. Térmitas associados à degradação de cinco espécies florestais em campo de apodrecimento. **Floresta e Ambiente**, Seropédica, v. 21, n. 1, p. 1-7, 2014.

GALLON, R.; STANGERLIN, D.M.; SOUZA, A.P.; PARIZ, E.; GATTO, D.A.; CALEGARI, L.; MELO, R.R. Resistência à deterioração de madeiras amazônicas tratadas por imersão simples em óleo queimado. **Nativa**, Sinop, v. 2, n. 1, p. 48-52, 2014.

JANKOWSKY, I.P.; AGUIAR, O.J.R. Tratabilidade de lâminas de madeira de *Pinus* spp. para a confecção de recipientes. **IPEF**, Piracicaba, n. 127, p. 1-5, 1981.

LEPAGE, E.S.; GERALDO, F.C.; ZANOTTO, P.A.; MILANO, S. Métodos de tratamento. In: LEPAGE, E.S. (Org.). **Manual de preservação de madeiras**. São Paulo: IPT, 1986. v. 2, p. 343-420.

MATTOS, B.D.; GATTO, D.A.; MISSIO, A.L.; LOURENÇON, T.V. Influência de tratamentos preservativos na propagação da onda ultrassônica na madeira de eucalipto. **Scientia Plena**, São Cristóvão, v. 8, n. 4, p. 1-6, 2012.

MATTOS, B.D.; GATTO, D.A.; CADEMARTORI, P.H.G.; STANGERLIN, D.M.; BELTRAME, R. Durabilidade a campo da madeira de três espécies de *Eucalyptus* tratadas por imersão simples. **Revista Brasileira de Ciências Agrárias**, Recife, v. 8, n. 4, p. 648-655, 2013.

MENDES, A.S.; ALVES, M.V.S. **A degradação da madeira e sua preservação**. Brasília: IBDF/LPF, 1988. 57 p.

OMOLE, A.O.; ONILUDE, M.A. Preliminary study on use of engine oil as wood preservative. **Journal of Tropical Forest Resources**, Ibadan, v. 16, n. 1, p. 66-71, 2000.

OLANIRAN, S.O.; OLUFEMI, B. Absorption and effect of used engine oil as wood preservative. **ProLigno**, Brasov, v. 6, n. 3, p. 5-12. 2010.

PERES FILHO, O.; DORVAL, A.; DUDA, M.J.; MOURA, R.G. Efeito de extratos de madeiras de quatro espécies florestais em cupins *Nasutitermes* sp. (Isoptera, Termitidae). **Scientia Forestalis**, Piracicaba, v. 71, n. 2, p. 51-54, 2006.

SSEMAGANDA, I.E.; MUGABI, P.; TUMWEBAZE, S.B. Effectiveness of selected preservatives in protecting ugandan grown *Eucalyptus grandis* wood against termite attack. **Maderas. Ciencia y tecnología**, Concepción, v. 13, n. 2, p. 135-142, 2011.

STANGERLIN, D.M.; COSTA, A.F.; GARLET, A.; PASTORE, T.C.M. Resistência natural da madeira de três espécies amazônicas submetidas ao ataque de fungos apodrecedores. **Ciência da Madeira**, Pelotas, v. 4, n.1, p.15-32, 2013.