Journal of Research in Forestry, Wildlife & Environment Vol. 12(2) June, 2020
E-mail: jrfwe2019@gmail.com; jfewr@yahoo.com
http://www.ajol.info/index.php/jrfwe
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ISBN: 2141 – 1778
Ogutuga et al., 2020

ASSESSMENT OF BIO-PRESERVATIVE POTENTIAL OF *Gmelina arborea* Roxb. SEED-OIL ON LAMINATED BAMBOO AGAINST TERMITE ATTACK

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ABSTRACT

The efficacy of Gmelina arborea seed-oil as preservative on laminated bamboo against termite attack was investigated. Gmelina arborea fruits and ten matured Bambusa vulgaris of over 4 years were sourced from Oyo State, Nigeria. Oil was chemically extracted from the G. arborea seeds using n' hexane and ethanol solvents and thereafter mixed with kerosene (at 50%) using volume-to-volume method to increase its quantity. The phytochemical screening of the seed of Gmelina arborea revealed the presence of tannins, alkaloids, flavonoids, saponins and phenols at different quantity. Strips from the base, middle and top of the harvested bamboo culms were soaked in the hexane and ethanol extracted G. arborea seed-oil while, the untreated samples served as the control and thereafter used to produce boards. The production of laminated bamboo board was carried out in Bamboo and Rattan Workshop of Forest Products Development and Utilization Department, Forestry Research Institute of Nigeria, Ibadan, Nigeria. Durability test was carried out and data were analysed using descriptive statistics and ANOVA at P<0.05. From the results, the weight loss from termite attack of the laminated boards ranged from 7.93 to 27.75% with increase from top to base resulting in decrease in weight loss of the boards produced. Boards preserved with G. arborea seed-oil ethanol extract were more resistant to termite attack (12.29%) compared to those preserved with the G. arborea seed-oil n' hexane extract (13.59%). Based on the result obtained, G. arborea seed-oil extracts have the potential of being an effective wood preservative.

Keywords: Bamboo, *G. arborea* seed-oil, chemical extraction, phytochemical, weight loss

INTRODUCTION

Bamboo is the most important non-wood forest species which grows abundantly in the tropical and sub-tropical regions of the world (Lobovikov *et al.*, 2007). Bamboo is one of the oldest building materials used by mankind (Abd.Latif *et al.*, 1990). Bamboo can be used as an alternative source of raw materials for the wood industry due to its fast growth, ability to grow in various soils, short rotation period and other desirable properties (Razak *et al.*, 2010). For generations, villagers have been using bamboo as construction materials and for furniture, household utensils and handicrafts. However, there are so many problems associated with the utilization of bamboo in housing and furniture sectors and one example is the short shelf-life of bamboo as a result of its insect-pest infestation. Sun *et al.*, (2012) reported a high content of sugar, starch and protein in bamboo thereby, making it prone to bio-deteriorating agents, as a result, reducing its shelf-life. Thus, it becomes imperative that bamboo should be treated prior to its use in order to enhance its shelf-life.

Wood preservatives are pesticides that protect wood against attack by insects, fungi or bacteria. Wood preservation on the other hand is an indirect form of forest management to ensure the supply of timber on a sustained yield basis (Brain, 1992).

Also, treating wood with the appropriate preservative increases its service life (Falemara *et al.,* 2014). The conventional wood preservatives although found to be very effective against wood destroying organisms, are said to cause environmental pollution and are hazardous to animals and human beings (Adetogun, 1998; Onuorah, 2000). This has thus led to the restriction of the use of these non-biodegradable chemicals for wood preservation primarily due to the increased disposal problems of the treated woods taken out of service. This therefore calls for research to develop environmentally benign biological preservatives that will serve as alternatives to the hazardous synthetic ones.

Of recent, research has been directed towards the exploration of the potentials of naturally durable tropical wood species in the preservation of non-durable ones. Results from the use of plants extracts in preserving wood have been so far encouraging (Ogunsanwo *et al.,* 2008; Adegeye *et al*., 2009 and Olajuyigbe *et al*., 2010). The potentials of using extracts derived from herbaceous plants, seeds, or fruit wastes, so-called essential oils, to protect wood against degrading fungi and insects has also received much attention worldwide (Vanneste *et al*., 2002, Maoz *et al*., 2007) thus, necessitating a research into assessing the efficacy of the seed-oil of *Gmelina arborea* in the control of termites degradation in bamboo. *Gmelina arborea* seed-oil has been found to be a sustainable material for biodiesel in terms of its availability and renewability. *Gmelina arborea* seed-oil based biodiesel have been produced keeping two criteria in mind; the biodiesel met all the ecologically relevant standards and all the technical and industrial standards of ASTM D6751 and EN 14214 (Basumatary *et al*., 2012; Sangay *et al*., 2014). However, no research has been conducted into the use of *G. arborea* seed-oil extract as bio-preservative in the control of bio-deteriorating agents like, termites. *Gmelina arborea* is bio-degradable and environmental friendly. There is therefore a need to further explore the anti-termite potentials of the seed oil of this species as preservative on bamboo and as well add to the groups of the existing environmental friendly preservatives.

MATERIALS AND METHODS

Collection of *Gmelina arborea* Fruits, De-pulping and Extraction of Oil

Ripe fruits of *Gmelina arborea* were sourced in large quantities from *G. arborea* trees in Federal College of Forestry located on the northern edge of the city of Ibadan, Nigeria (lies between Latitude 7°23′15″ to 7°24′00″ N and Longitude 3°51′00″ to 3°52′15″ E). The fruits were de-pulped to separate the seeds, sun-dried and ground into powder. Thereafter, oil was extracted chemically from the grounded seeds with n’ hexane and ethanol in Soxhlet apparatus. 33g of the grounded *G. arborea* seeds (powdered) was filled into the thimble of the Soxhlet and 350 mL of solvent was poured into a Round Bottom Flask so as to extract the oil from the *G. arborea* seeds using soxhlet apparatus. This procedure was repeatedly carried out for the n’ hexane and ethanol solvents used. The extracted oil was then stored in a covered bottle prior to its use.

Plate 1: *Gmelina arborea* fruits

Plate 2: *Gmelina arborea* seeds

Plate 3: *Gmelina arborea* seeds powder **Plate 4: Oil extraction using soxhlet apparatus**

Plate 5: *G. arborea* seed-oil n' hexane extract

Phytochemical Screening of *G. arborea* Seed
Phytochemical screening of *G. arborea* seed was done following the standard procedure by the method of (Brain and Turner, 1976). The seeds were ground and subjected to phytochemical screening for the presence and amount of tannins, alkaloids, flavanoids, saponins and phenols.

Harvesting of Bamboo
Ten matured *Bambusa vulgaris* of over 4yrs were harvested from Asanmagbe Stream of Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State, Nigeria. It lies between Latitude 7°23′34″ to 7°23′36″ N and Longitude 3°51′36″ to 3°51′38″ E.

Preparation of Bamboo Strips for Treatment
The harvested bamboo culms were sampled at the base, middle and top. They were further cross-cut and splitted into strips size of 500 mm (length) x 25 mm (width) x 5 mm (thickness). Strips were then air-dried at indoor conditions to moisture content value ranging between 20 to 25%.

Method of Preservative Test
Volume-to-volume method as adopted by Adebawo *et al.*, (2015) was used to dissolve *G. arborea* seed-oil of n' hexane and ethanol extracts in kerosene. The dilution of 50% as well as the untreated (control) samples was used for the study. However, the 50% dilution that was used in this study was obtained by adding 50mL of *G. arborea* oil in 50mL of kerosene (diluent).

Treatment of Test Samples
The prepared bamboo strips from base, middle and top were soaked in the prepared test preservatives for 24 hours. After treatment, the samples were removed from the treatment solution and drained.

Laminated Bamboo Board Formation
The preserved bamboo strips were dried followed by the application of adhesive bond (top bond, a starch-based adhesive) on the split faces of the strips. The strips were cold-pressed with a clamp for proper penetration of adhesive at the bond lines to form strong boards. Thereafter, the boards formed were cured at room temperature for 14 days (2weeks) for proper bonding of the adhesive with the bamboo strips to enhance good machining.

Plate 6: Laminated bamboo boards

Laminated Bamboo Board Testing
At the end of the curing process, the bamboo boards produced were planed, edged and cut to 19 mm x 19 mm x 457 mm for weight loss determination in accordance with ASTM D 1758-74. Each treatment combination of sampling height and preservative were replicated five times and 45 samples were obtained for the weight loss test. The data obtained were analyzed using Analysis of Variance (ANOVA) and were separated using Duncan Multiple Range Test at 5% level of significance.

Grave Yard Test
Grave yard experiment was carried out for 24 weeks. Treated and control bamboo samples were buried in a graveyard with evidence of infestation by termite with spacing not less than 300 mm between samples and not less than 600 mm between rows in accordance with ASTM D 1758-74. The initial weight of samples was first determined before they were buried in the graveyard and the final weight after 24 weeks was assessed and weight loss was determined by using the formula below in accordance with ASTM D 3345-08 (2008).

$$W = \frac{W_1 - W_2}{W_1} X100 \quad \text{.........(1)}$$

Where:
W= % Weight loss
W_1= Initial weight before termite attack
W_2= Final weight after attack (after oven dried)

RESULTS
Results from Phytochemical Screening
The results of qualitative and quantitative phytochemical analysis of *Gmelina arborea* seed are presented in Table 1. The results showed the presence and mean values of 230.00±13.23mg/100g, 33.33±2.89mg/100g, 156.67±44.81mg/100g, 151.67±7.64mg/100g and 34.90±0.36GAE/g for tannins, alkaloids, flavonoids, saponins and phenols respectively.

Table 1: Qualitative and Quantitative Phytochemical Analysis of *G. arborea* Seed

Phytochemical Constituents	Qualitative value	Quantitative Value Mean±SDV
Tannins, mg/100g	+	230.00±13.23
Alkaloids, mg/100g	+	33.33±2.89
Flavonoids, mg/100g	+	156.67±44.81
Saponins, mg/100g	+	151.67±7.64
Phenols GAE/g	+	34.90±0.36

*+ Present; * Mean ± Standard Deviation of three replicate samples*

Effect of *G. arborea* Seed-oil Extracts on Weight Loss from Termite Attack
The results of the graveyard test conducted on the oil-treated and untreated laminated bamboo samples placed in ground contact for 24 weeks period is presented in Figure 1. It was observed that the weight loss of oil-treated and untreated laminated bamboo increases from the base to the top, as a result of its exposure to termites. Among the preservatives, weight loss from termite attack was least in laminated bamboo samples treated with *G. arborea* seed-oil ethanol extract

(GASOEE) followed by the laminated bamboo samples treated with *G. arborea* seed-oil n' hexane extract (GASOHE) while, the untreated (control) laminated bamboo samples had the highest weight loss from termite attack (Figure 1). Statistically, there is significant difference in the weight loss from termite attack of the laminated bamboo along the sampling height and among the preservatives (Table 2) at $p<0.05$ while, their level of interaction had no significant effect on weight loss from termite attack. The follow up test as presented in Table 3 showed that sampling height and preservatives were different from one another with the samples from the base and those treated with *G. arborea* seed-oil ethanol extract (GASOEE) having the highest durability.

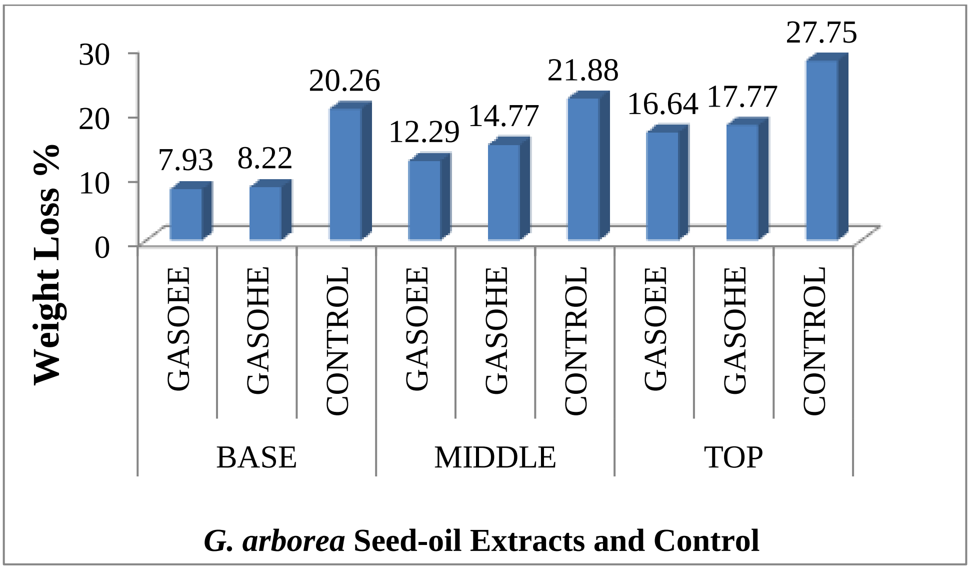

Figure 1: Weight Loss from Termite Attack of Laminated Bamboo Samples

Table 2: Analysis of Variance for Weight Loss from Termite Attack

Source	df	SS	MS	F-value	P-value
Sampling Height	2	552.605	276.303	43.993*	0.000
Preservative	2	1085.583	542.791	86.424*	0.000
Sampling Height * Preservative	4	30.884	7.721	1.229^{ns}	0.316
Error	36	226.100	6.281		
Total	44	1895.173			

** Significant at p<0.05 and **ns**= not significant at p>0.05*

Table 3: Follow-up Test for Sampling Height and Preservative

Variables	Mean±SDV
Sampling Height	
Base	$12.14^{c}\pm6.59$
Middle	$16.31^{b}\pm4.75$
Top	$20.72^{a}\pm5.47$
Preservative	
GASOEE	$12.29^{b}\pm3.84$
GASOHE	$13.59^{b}\pm4.61$
Control	$23.30^{a}\pm4.67$

Mean with the same superscript in the same column are not significantly different (p<0.05) from one another

DISCUSSION

Results from Phytochemical Screening

Tannins as observed in *G. arborea* seed have been reported by Barbehenn and Constabel, (2011) to possess anti-termite and anti-fungal properties. Alkaloids acts as attractants and as well act as deterrents for insects (Macel, 2011). Flavonoids have antioxidants and antimicrobial properties.

Saponins are produced by plants as a defence mechanism to stop attacks by foreign pathogens, which makes them natural antibiotics (Okwu and Emenike, 2006). Saponins have also been reported as deterrent for biological activity against insects. Several researchers (Singh and Sushilkumar 2008; Sotannde *et al.* 2011; Djenontin *et al.* 2012; Addisu *et al.* 2014; Faruwa *et al.* 2015) have reported efficacy of plants extracts as bio-preservative against fungi and termite attacks.

Mazhar *et al*., (2013) affirmed that the seed extracts of medicinal plant offers a source of naturally occurring chemicals that could be used as anti-termite. The anti-termite activity of these plants seed extracts is attributed to the presence of phytochemicals of different chemical structure that have repellent, anti-feedant or toxic effects on termites in feeding assays (Ahmed *et al.* 2007). Convincingly, the phytochemical constituents present in the seed from which the oil used in treating the laminated bamboo was extracted, can be attributed to its efficacy against termite attack. Hence, the highest quantity of tannins present suggests that it is the most contributing phytochemical against termite attack.

Effect of *G. arborea* seed-oil extracts on Weight Loss from Termite Attack

The increase in weight loss from termite attack of the oil-treated and untreated laminated bamboo from base to top as presented in Figure 1 is in line with several studies (Lukmandaru, 2011; Namujehe and Orikiriza, 2013). Lowest percentage recorded at the base may be due to highest ratio content of mature to juvenile wood.

The *G. arborea* seed-oil (especially the *G. arborea* seed-oil ethanol extract, GASOEE) increases the laminated bamboo samples resistance to attack by the termites thus, causing a reduction in the deterioration of the treated laminated bamboo samples. This agrees with the position of Wong and Cheok (2001) that wood unprotected by a preservative can be attacked by termites in any termite infested area and if infestation is not checked can lead to deterioration with the consequence of loss of structure, cost of replacement and even the loss of lives.

CONCLUSION

The study showed that the *G. arborea* seed-oil extracts have the potentials of being an effective wood preservative and as an alternative to the synthetic wood preservatives that are unsafe to the environment. The study further showed that *G. arborea* seed-oil enhanced the durability of laminated bamboo against termite attack. The samples preserved with *G. arborea* seed-oil ethanol extract (GASOEE) were more resistant to termite attack compared to those preserved with *G. arborea* seed-oil n’ hexane extract (GASOHE).

REFERENCES

Abd. Latif, M., Ariffin, W. T. W. and Ahmad, F. (1990). Anatomical features and mechanical properties of three Malaysian bamboos. *Tropical Forest Science*, 2(3): 227-234.

Addisu, S., Mohamed, D. and Waktole, S. (2014). Efficacy of Botanical Extracts against Termites, *Macrotermes spp.*, (Isoptera: Termitidae) under Laboratory Conditions. *International Journal of Agricultural Resources*, 9(2): 60-73.

Adegeye, A.O., Ogunsanwo, O.Y. and Olajuyigbe, S.O. (2009). Antifungal activities of heartwood extract (HWE) of Teak *Tectona grandis* Against two white rots in woods of *Gmelina arborea* and *Triplochiton scleroxylon*. *Academic Journal of Plant Sciences*, 2(4): 279-285.

Adetogun, A. C. (1998). The Potentials of Cashew Nut Shell Liquid as a Fungicide against Wood Decay. Ph.D Thesis. Department of Forest Resoruces Management. University of Ibadan, Nigeria. Pp 67.

Ahmed, S. Riaz, M.A., Malik, A.H. and Shahid, M. (2007). Effect of Seed Extracts of *Withanias omnifera*, *Croton tiglium*and *Hygrophila auriculata* on Behavior and Physiology of *Odontoter mesobesus* (Isoptera, Termitidae). *Biologia*. 62(6):770-773.

American Society for Testing and Materials (ASTM) ASTM D 3345-08, (2008). Standard Test Method for Laboratory Evaluation of Wood and Other Cellulosic Materials for Resistance to Termites. ASTM International, West Conshohocken, Pennsylvania.

American Society for Testing and Materials, ASTM, (1974). Standard D 1758-74: Standard Methods of Evaluating Wood preservatives by field test with stake. ASTM International. Philadelphia pp 490−498.

Barbehenn, R.V. and Constabel, P.C. (2011). Tannins in Plant-herbivore Interactions. *Journal of Phytochemistry* (in press).

Basumatary, S., Deka Dinesh, C., Deka Dibakar, C. (2012). Composition of Biodiesel from *Gmelina arborea* Seed Oil. *Advances in Applied Science Research*, 3 (5): 2745-2753.

Brain, B. I. (1992). The Journal of Light Construction MRI. Sealant Article and Information Restoring and Treatment of Wood. Pg 14-20.

Brain, K.R. and Turner, T.D. (1976). The Practical Evaluation of Phytopharmaceutical, (1st Edition, Britol Wright Scientechnia, pp 105.

Djenontin, T.S., Amusant, N., Dangov, J.,Wotto, D.V., Avlessi, F., Dahouenon-Ahoussi, E., Lozano, P., Pioch, D. and Sohounhloue, K.C.D. (2012). Screening of Repellent, Termiticidal and Preventive Activities on Wood of *Azadirachta indica* and *Carapa procera* (Meliaceae) Seeds oils. *ISCA Journal of Biological Science*, 1(3): 25-29.

Falemara, B.C., Obidike-Ugwu, E.O., Ukanyirioha, C.J. and Mus'ab, S.M. (2014). Evaluation of different Treatment Techniques on Preservative Absorption of *Triplochiton scleroxylon* (Obeche) against Fungi Attack. In the book of proceedings; Sudano-Sahelian Landscape and Renewable Natural Resources Development in Nigeria. 37th Annual conference of Forestry Association of Nigeria.Pp 525-537.

Faruwa, F.A., Egbuche, C.T., Umeojiakor, A.O. and Ulocha, O.B. (2015). Investigation into the Effectiveness of Selected Bio-Based Preservatives on Control of Termite and Fungi of Wood in Service. *Agriculture, Forestry and fisheries*. Special Issue: Environment and Applied Science Management in a Changing Global Climate, 4(3- 1): 59-63. Doi: 10.11648/j.aff.s.2015040301.20

Lobovikov, M., Paudel, S., Piazza, M., Ren, H. and Wu, J. (2007). World bamboo resources: A thematic study prepared in the frame work of Global Forest Resources Assessment. Non-wood Forest Products No. 18, FAO, Rome (Italy). 88p.

Lukmandaru, G. (2011). Variability in the Natural Termite Resistance of Plantation Teak Wood and its Relations with Wood Extractive Content and Colour Properties. *Journal of Forestry Research*, 8: 17 – 31.

Macel, M. (2011). Attract and Deter: A dual role for pyrrolizidine alkaloids in plant-insect interactions. *Phytochemistry Reviews*, 10(1): 75-82.

Maoz, M., Weitz, I., Blumenfeil, M., Freitag, C. and Morrell, J. J. (2007). Antifungal activity of plant derived extracts against *G. trabeum*. Doc. No. IRG/WP 07-30433. The Inter. Res. Group on Wood Preservation, Sweden.

Mazhar, A., Muhammad S., Munawar, I., Fozia, A., Sumaira, S., Sohail, A. and Tajnees, P. (2013). Antitermitic Activity and Phytochemical Analysis of Fifteen Medicinal Plant Seeds. *Journal of Medicinal Plants Research*, 7(22): 1608-1617.

Namujehe, G. and Orikiriza, L.J.B. (2013). Natural Durability of Eucalyptus Clones against Termite Attack. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 10(1): 176 – 183.

Ogunsanwo, O.Y., Adegeye, A. O. and Olajuyigbe, S. O. (2008). Effects of Heartwood Extract (HWE) of Teak and Cuprinol clear on Weight loss and Compressive Strength of Two Hardwood species from Nigeria. Proceedings of International Conference on Environmentally Compatible Forest Products. Fernado Pessoa University, Oporto, Portugal. September 10-12, 2008.

Okwu, D.E. and Emenike, I.N. (2006). Evaluation of the Phytonutrients and Vitamin Contents of Citrus Fruits. *International Journal of Molecular Medicine and Advanced Sciences*, 2(1): 1-6.

Olajuyigbe, S. O., Ogunsanwo, O. Y. and Adegeye, A. O. (2010). Compressive Strength in Heartwood Extract of Teak (HWE) Treated Hardwoods After Exposure to White Rot Attack. *International Journal of Biological and Chemical Sciences*, 4(3): 571-578.

Onuorah, E.O. (2000). Short communication: The wood preservative potential of heartwood extracts of *Milicia excelsa* and *Erythrophleum suaveolens. Bioresources Technology*, 75: 171-173.

Razak, W., Mohd, T.M., Othman, S., Aminuddin, M., Affendy, H. and Izyan, K. (2010). Anatomical and Physical Properties of Cultivated Two and Four year-old *Bambusa Vulgaris*. *Sains Malaysiana*, 39(4): 571-579.

Sangay, B., Priyanka, B., Dibakar, O.D. (2014). *Gmelina arborea* and *Tarbernaemontana. divaricate* Seed Oils as Non-edible Feedstock for Biodiesel Production. *International Journal of Chem Tech Research*, 6 (2): 1440-1445.

Singh, N. and Sushilkumar, A. (2008). Anti-termite Activity of *Jatropha curcas* Linn. Biochemicals. *Journal of Applied Sciences and Environmental management*, 12 (3): 67-69.

Sotannde, O.A., Yager, G. O., Zira, B. D. and Usman, A. (2011). Termiticidal Effect of Neem Extracts on the Wood of *Khaya senegalensis. Research Journal of Forestry*, 5(3): 128-138.

Sun, F.L., Bao, B.F., Ma, L.F., Chen, A.L. and Duan, X.F. (2012). Mold-Resistance of Bamboo Treated with the Compound of Chitosan-Copper Complex and Organic Fungicides. *Journal of Wood Science,* 58(1): 51 – 56.

Vanneste, J.L., Hill, R.A., Kay, S.J., Farrell, R.L. and Holland, P. T. (2002). Biological control of sapstain fungi with natural products and biological control agents: A review of the work carried out in New Zealand. *Mycological Research*, 106(2):228-232.

Wong, A. H. H. and Cheok, K.S. (2001). Observations of Termite-Fungus Interaction of Potential Significance to Wood Bio-deterioration Protection: *Timber Technology Bulletin* No. 24, Timber Technology Centre Kuala-Lumpur.