PERFORMANCE OF AN OIL-CURED TROPICAL BAMBOO *Gigantochloa scortechinii* IN A 6 MONTHS GROUND CONTACT TESTS

Razak Wahab, H. Samsi, Mahmud Sudin & Janshah Mokhtar

School of International Tropical Forestry, Universiti Malaysia Sabah
88999 Kota Kinabalu, Sabah, Malaysia

ABSTRACT. This paper investigates the durability performance of a tropical bamboo species *Gigantochloa scortechinii* in a 6-month ground contact test. The results of the study showed that the oil-cured process greatly enhanced the durability of bamboo against biodegradation agents particularly the fungi. There is an overall decrease in weight loss of oil-cured samples before and after the 6-month test. Green condition sample recorded a decrease in weight loss between 4.15% to 33.49% and 3.54% to 32.61% in air-dried samples. Control samples composed of untreated bamboo and rubberwood experienced weight loss of about 48% and 40% respectively. Compared to untreated bamboo, oil-cured bamboo performed much better in the ground contact test. The weight loss in terms of percentage after the 6-month test varies from 4% to 34%, with oil-cured samples at higher temperature and longer duration losing less weight.

KEYWORDS. Biodegradation, *Gigantochloa scortechinii*, oil-curing process, weight loss, durability.

INTRODUCTION

Bamboo being a cheap, fast growing plant and possess high mechanical properties among woody materials is being considered as an alternative to wood. However, bamboo is easily susceptible to fungal or insect attack (Liese, 1985). The properties of bamboo will deteriorate rapidly if the material is not treated with preservatives (Liese, 1985; Razak, 1998). The used of preservative in bamboo has been recognized as necessary and important if they are to be considered for utilization in furniture and construction purposes (Razak, 1998). However, the used of preservatives is not always effective as bamboo is not easily treated (Liese, 1986).

An alternative technique of treating bamboo by means of oil-curing process has been studied by several researchers in Europe, Africa and Asia. Their initial finding indicates that this technique is effective in enhancing the bamboo durability against insects and fungi biodegradation. However, the effectiveness of this technique

depends largely on the type of oil that is to be used as the heating medium. Oil with high boiling point is normally preferred.

An investigation in the oil-curing process using palm oil as the heating media has been conducted by Razak *et al.* (2002). The study showed positive results as the oil-cured bamboo possess good resistance against insects and fungi attacks. This is supported by an earlier studies conducted by Leithoff and Peek (2001) on the heat treated temperate bamboo using linseed oil.

This study explored an alternative eco-friendly method in protecting bamboo from biodegradation by means of heating process. A common and well known bamboo species, *Gigantochloa scortechinii* (*G. scortechinii)* were selected for the study and subjected to high temperature condition using palm oil as a heating media. The temperature applied were 140°C, 180°C and 220°C with exposuring duration of 30, 60 and 90 minutes respectively depending on types of testing. The treated bamboos were tested for their performance based on their moisture content, basic density, strength and durability.

MATERIALS AND METHODS

Variety of bamboo

G. scortechinii has been identified as one of the most important and extensively used species in the bamboo industry and is the most widely distributed in Peninsular Malaysia. *G. scortechinii* grows in closely and densely tufted clumps. The culms are stiffly erect with branches growing from the mid-culm node upwards. Branching consists of small and subequal branches. The culm is 15–20 m tall and 8–12 cm in diameter. The internode is 40–50 cm long with wall thickness of 4–12 mm (Razak *et al.*, 2002).

Supply of culms

All bamboo culms used in this study were taken from the forest research area in Nami, Kedah in Malaysia. There are about 500 ha of natural bamboo stands in Nami and about 20 ha has been developed by FRIM, Forest Department Malaysia and the International Development Research Centre, Canada (IDRC) under the "Management of Natural Bamboo Stands Project" since 1988. Almost all of the bamboos found in this area are of *G. scortechinii.*

Sampling of culms

Bamboo culms of known age were taken from randomly selected clumps. All culms used in this study possess diameters ranging from 8 to 10 cm. They were harvested immediately after the rainy season. Investigations indicated that bamboo harvested during this period contained a very minimum amount of starch (Liese, 1985; Sulthoni, 1983). All together about 100 bamboo culms consisting of four-year old were harvested. For practical purposes only internodes 6, 7 and 8 were used for the study.

Within a week after harvesting, all the culms samples were taken to FRIM for drying, oil-curing treatment and for subsequent investigations. Two sets of samples were investigated. The first set consists bamboo samples in green condition with average moisture content of 65% and the second set consists samples in air-dried condition with moisture content average 14%.

Oil-curing process

The oil-curing process of the bamboo were done using an electrical oil-curing machine. Palm oil was used as the heating medium as it is organic in nature, easily available and has high boiling point. The palm oil was first heated up to a temperature of 60°C. Then the bamboo samples were submerged in the heated oil by placing them in a metallic cage. Bamboo samples were taken out at 140°C, 180°C and 220°C interval after 30, 60 and 90 minutes of exposure. A control panel was used in controlling the temperature and the duration of the process. A procedure developed by Razak *et al.* (2001) was adopted in this study with modification to suit for bamboo.

Durability

The bamboo samples for this test were taken from the treated bamboo described earlier. These blocks were converted into 100 mm x 10 mm x culm wall thickness and were chosen from internode 6 of each culms. This test were conducted based on ASTM: D 1758-74 (1974) and procedure developed by Jackson (1957) with some modification.

•The test stakes were buried upright with 4/5 of their length in the ground. They were installed 200 mm apart within and between rows and were distributed randomly based on randomized complete-block design. The test stakes were exposed to the decay hazard as well as termites. The tests were monitored for a period of 6 months. The stakes were installed during the dry season. The testing site for the field/grave-yard study was located in Melaka, Malaysia. The site is located in a lowland area. The site is an ex-agriculture land having hot and humid climate throughout the year with an average daily temperature vary from 21°C to 32°C and average rainfall of about 2540 mm. The stakes were inspected at the end of the 6 months period. The criteria for testing were based on the weight lost experienced by the stakes. The stakes were conditioned to 12% MC before and after the ground contact tests.

RESULTS AND DISCUSSION

The results of the grave-yard test conducted on oil-cured green and air-dried bamboo samples placed in ground contact for 6 months period are tabulated in Figures 1 and Figure 2. Bamboos are considered to have a very low natural durability. When placed in contact with soil, in particular young bamboo culms or that has been insufficiently treated with preservatives, they usually deteriorate rapidly by the action of a mixed population of soil microorganisms and termites. Even those regarded as adequately treated with preservative may still be colonized by fungi and termites although decay and the attack rates may be slower, and patterns of fungal colonization of such bamboo may differ from untreated or less adequately treated bamboo.

There is an overall decreased in weight loss of oil-cured samples before and after 6 months tests. Green condition sample recorded a decreased in weight loss between 4.15% to 33.49% and 3.54% to 32.61% in air-dried samples. Oil-cured bamboo performed much better compared to those of untreated in the ground contact tests. The weight loss in term of percentage after 6 months tests varies from 4% to 34% with samples oil-cured at higher temperature and longer duration losing less weight.

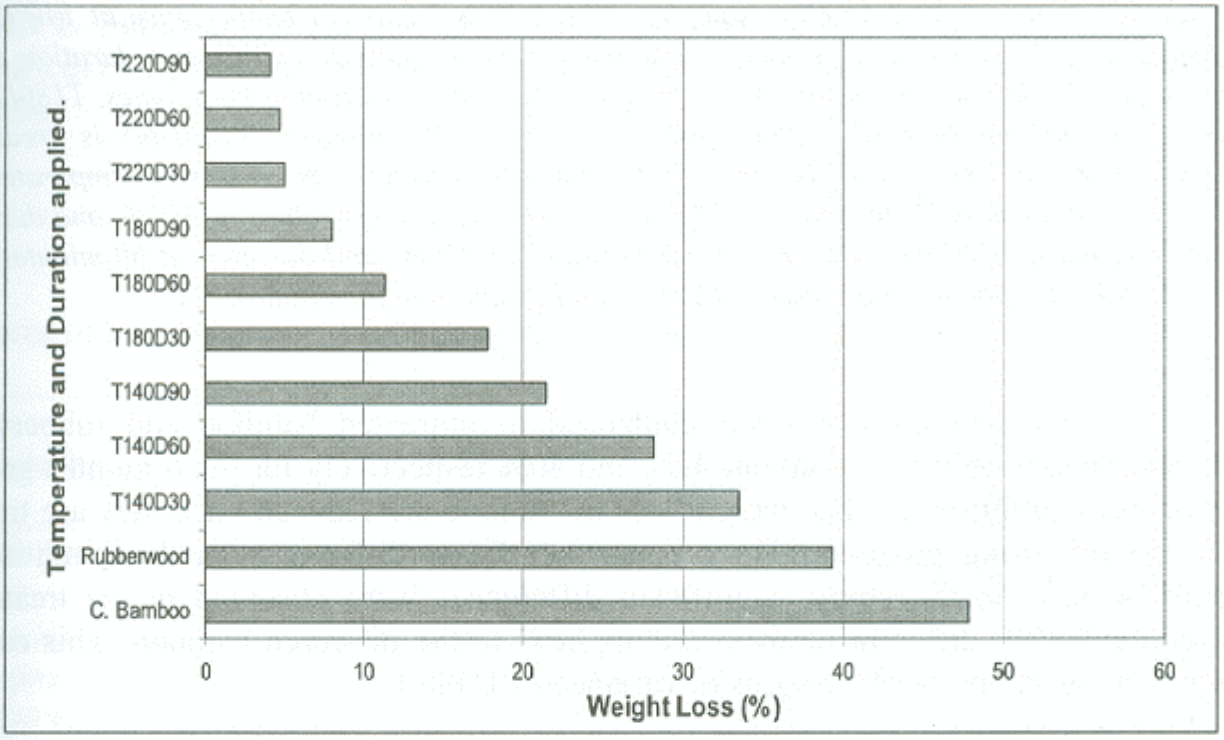

Figure 1. Means weight loss of oil-cured green bamboo after 6 months of grave-yard tests

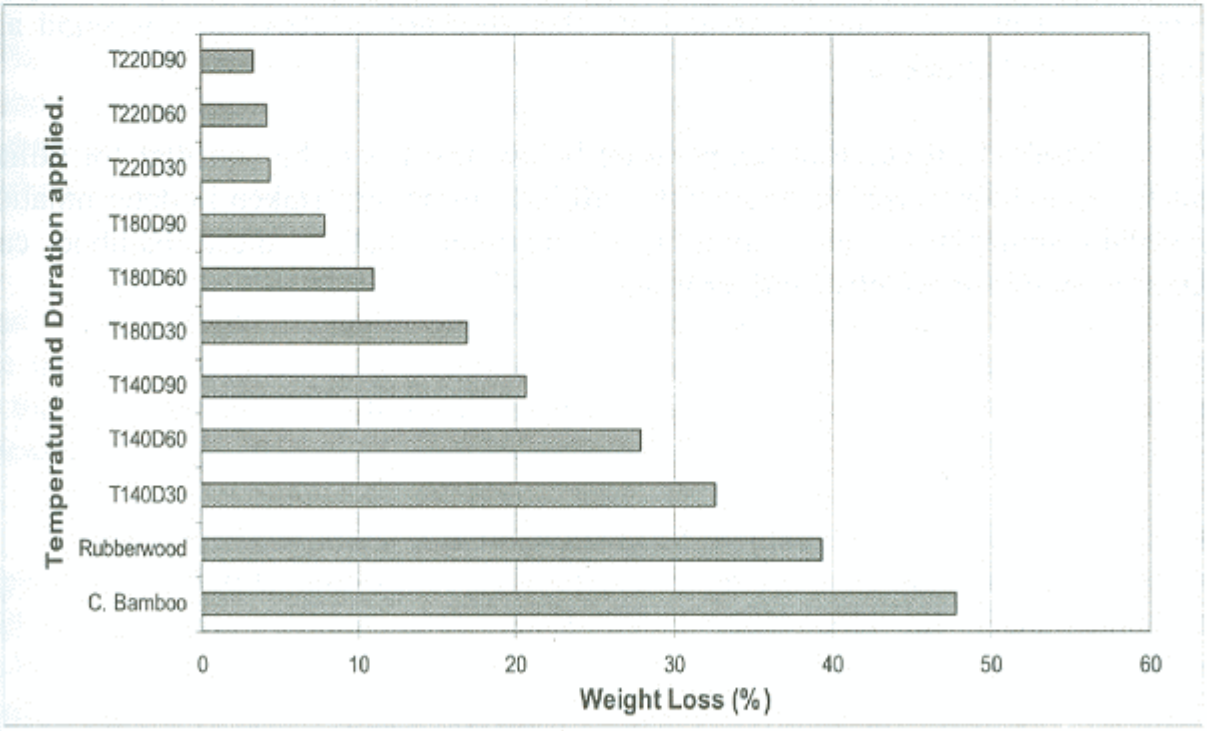

Figure 2. Means weight loss of oil-cured air-dried bamboo after 6 months of grave-yard tests

**Bamboo is the control bamboo samples, T140D30 is treatment temperature at 140°C and duration of 30 minutes, T140D60 is treatment temperature at 140°C and duration of 60 minutes, T140D90 is treatment temperature at 140°C and duration of 90 minutes, T180D30 is treatment temperature at 180°C and duration of 30 minutes, T180D60 is treatment temperature at 180°C and duration of 60 minutes, T180D90 is treatment temperature at 180°C and duration of 90 minutes, T220D30 is treatment temperature at 220°C and duration of 30 minutes, T220D60 is treatment temperature at 220°C and duration of 60 minutes, and T220D90 is treatment temperature at 220°C and duration of 90 minutes.*

Control samples that are composed of untreated bamboo and rubberwood experienced weight loss of about 48% and 40% respectively for the 6 months ground contact durability tests. The weight loss in bamboo are reduced once they are treated by the oil-curing process. There is no significant differences in the condition of bamboo used in the study. Significant differences were observed in the treatment duration and at different temperature applied to the oil-cured bamboo. This can be seen on the summary of analysis of variance in Table 1.

Bamboo that were oil-cured at 180°C and exposed for a duration of 60 minutes experienced an average weight loss of less than 12%. This temperature can be taken as an optimum temperature for effective treatment of bamboo through the oil-curing process using palm oil as the heating medium. Bamboo oil-cured at lower temperature experienced higher weight loss and are therefore not effective to withstand against fungi or insect attacked.

Bamboo oil-cured at temperature below 180°C can be consider for utilization but for an indoor usage. Further study will have to be undertaken in determination the optimum temperature and duration of treatment before these bamboo can be recommended for effective indoor usage

Table 1. Summary of analysis of variance on physical and mechanical properties of oil-cured bamboo at different condition, treatment duration and temperature applied

	F-value and statistical significance		
Source of variation	Bamboo condition	Treatment duration	Temperature
Durability	0.83 ns	47.00 **	480.79 **

ns is not significant; * significant at $P < 0.05$; ** highly significant at $P < 0.01$;

**Bamboo condition is referred to bamboo at green or air-dried condition; Treatment duration is referred to exposure period of 30, 60 or 90 minutes; Temperature is referred to temperature at 140℃, 180℃ or 220℃.*

CONCLUSIONS AND RECOMMENDATIONS

The green oil-cured bamboo experienced an average weight lost between 4.15% to 33.49% from their original weight before undergoing the 6 months period of ground-contact tests. Samples from the air-dried condition experienced an average weight lost between 3.54% to 32.61%. The untreated bamboo and rubberwood on the otherhand experienced an average weight lost of 47.9% and 39.4% respectively.

Oil-curing process starting from 180°C and at a duration of 60 minutes are found to be effective in increasing the durability of bamboo. Bamboo samples that were treated from these temperature onward experienced an average weight lost of less than 12% compared to those that were treated at lower temperature and duration of treatment.

For practical purposes, it is recommended that bamboo need to be oil-cured at temperature of 180°C and above for effective proction against fungi and insects attacked. Apart from increasing the durability of bamboo, the oil curing process can also be applicable in rapid drying and improving the colour of matured bamboo prior to utilization.

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