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*Research Article*

# Is 72-Hour Borax Acid Soaking Effective Against Powderpost Beetles?

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**ABSTRACT**

The research conducted a durability test to evaluate the efficacy of the prophylactic treatment practiced by the local bamboo industry in Northern Mindanao in producing laminated bamboo from two commercially important species: *Dendrocalamus asper* Backer ex K. Heyne and *Bambusa blumeana* Schult.f, against Powderpost beetles (PPB) (*Dinoderus minutus* Fabricius). Local manufacturers used prophylactic treatment on bamboo slats consisting of 6.67% boric acid and 4.44% borax and soaking the bamboo in the solution for 72 hours. After treatment and lamination, samples measuring 15 mm × 20 mm × 60 mm were then placed in the rearing chamber of PPB to serve as substrate and were observed for nine months. Beetle holes were subsequently counted to assess the durability of the laminated bamboo. The results showed that the current prophylactic treatment did not effectively reduce the beetle infestation in laminated bamboo. Panels made from both *D. asper* and *B. blumeana*, regardless of whether derived from the bottom or middle culm sections, were found to be not durable.

*Keywords:* Laminated bamboo, Bamboo Pest, Bamboo Preservative

## 1. INTRODUCTION

The growing need for sustainable building materials, along with the declining availability of timber, has led to the consideration of bamboo as a practical substitute for wood. In the Philippines, this concern is heightened by a 30% drop in total log production reported by the Philippine Wood Producers Association (PWPA) in 2020, further intensifying the shortage of wood and related products in the country. Consequently, the available supply cannot meet the annual average consumption of 6 million cubic meters in the Philippines (Del Castillo, 2021).

Bamboo possesses comparable physical and mechanical properties to wood, grows rapidly, and is readily accessible, making it a promising alternative to wood (Chaowana, 2013). In areas like Asia, Africa, and South America, bamboo has become a widely used construction material, valued for its strength, light weight, and adaptability (Pawan et al., 2021).

A comprehensive review conducted by Anokye et al. (2016) examined various advancements in the production of laminated bamboo timber, highlighting its potential as a substitute for wood. However, due to inherent limitations like bamboo's natural thickness, it is necessary to process it into a composite form known as laminated bamboo to improve its dimensional stability, structural strength, and overall uniformity (Li et al., 2013).

In the Philippines, the bamboo industry, particularly those involved in producing laminated bamboo, has been experiencing growth. Ensuring that locally manufactured products match the quality of commercially available alternatives is essential. A key factor to address is their resistance to Powderpost beetles (PPB), which remain a persistent challenge within the industry.

The PPB *Dinoderus minutus* (Fabricius) (Coleoptera: Bostrichidae) is a common pest that affects bamboo products in the Philippines (Caparida et al., 2021). Various chemical treatments have been investigated and proven effective in protecting bamboo products, especially laminated ones, against PPB infestation (Alipon et al., 2018). However, in the local industry in Mindanao, Philippines, the prophylactic treatment against PPB is limited to using borax boric acid.

This study aims to assess the durability of locally produced bamboo laminated products against PPB infestation and compare them with commercially available products. Factors such as bamboo species and sections of bamboo were considered in the evaluation. The findings of this study enable the identification of potential interventions and recommendations for improving the quality of our local bamboo products, making them more competitive in the global market.

## 2. M ETHODOLOGY

Preparation of laminated bamboo

The study utilizes two commercially important bamboo species, namely *Dendrocalamus asper* Backer ex K.Heyne and *Bambusa blumeana* Schult.f. Mature culms of these species were harvested and divided into poles, separating the middle and bottom sections. Subsequently, the poles were stripped to produce bamboo slats measuring 1200 mm x 32 mm x 10 mm (LxWxT), in accordance with the standard dimensions specified by the local processor. The slats were prepared to achieve the desired thickness, taking into account shrinkage by applying an adjusted allowance. Samples were air-dried until they reached a moisture content of 12%.

Two regional partner local manufacturers in Northern Mindanao carried out the production of laminated bamboo. These partners included Naawan LGU bamboo processing center, managed by the local government of Naawan in Misamis Oriental, Philippines, and Hombiz Crafts (privately managed), located in Iligan City, Philippines.

The collected slats, as previously prepared, were delivered to the identified local processors to produce laminated bamboo products.

### Prophylactic Treatment

Both manufacturers applied prophylactic treatment using a solution composed of 7.5% borax and 5.0% boric acid (w/v), resulting in a total solute concentration of 12.5% w/v. The dried slats were fully saturated with the preservative by immersing them in a biomass-heated treatment tub containing the solution, maintained at a temperature of 30–50°C, for a duration of 72 hours. This treatment formulation aligns with the recommended concentration range of 5–8% for each chemical, suitable for bamboo intended for indoor use. (NMBA, 2006; Borates Today 2024; Guadua Bamboo SAS, 2025).


*Figure 1.* The treatment process of laminated bamboo slats using a borax and boric acid solution. (A) Preparation of the treatment solution by dissolving borax and boric acid in heated water within the treatment tub. (B) Gradual submersion of bamboo slats into the solution using a pulley system. (C) Retrieval of bamboo slats after 72 hours of immersion in the heated treatment solution.

**Lamination**

The laminated bamboo was manufactured using a flatwise configuration, employing a polyvinyl acetate (PVA) based adhesive commercially known as "Apollo" for the lamination process. Jigs held the bamboo slats in place until stable bonding was achieved.

***Durability Test***

**PPB collection**

Bamboo heavily infested with PPB was collected and placed in a controlled room for mass rearing. The infested material was stored in a large plastic container serving as the rearing chamber, fitted with a screen cover to prevent beetle escape. Slats of *D. asper* and *B. blumeana* were used as substrates for the beetles. The rearing chamber was maintained under a 12:12-hour light-dark photoperiod until the beetles were required for bioassay testing.

**Preparation of sample boards**

Following the methodology outlined by Alipon et al. (2018), samples of laminated bamboo measuring 15 mm x 20 mm x 60 mm were prepared for each treatment. The study considered several factors, including manufacturers (two local manufacturers and one commercial product for comparison), species (*D. asper* and *B. Blumeana*), bamboo sections (bottom and middle), and exposure (indoor and outdoor). Each set-up was replicated three times. The prepared specimens were placed in covered plastic trays at ordinary room temperature. These trays served as the testing environment for the samples. The trays were then exposed to the PPB inside the rearing chamber.

The sample laminated bamboo was regularly monitored, and the number of beetle holes present in each panel was counted weekly for a period of nine months. Based on the results, the durability of the panels against PPB was classified according to the categories shown in Table 1.

**Statistical Analysis**

The test results were analyzed using Analysis of Variance (ANOVA) under a completely randomized design (CRD) to determine the significant effects of various treatments on the durability of laminated bamboo. To further assess these effects, a post-hoc Honestly Significant Difference (HSD) test was performed at a significance level of $\alpha = 0.05$. This test identified specific treatments that had a statistically significant impact on panel durability, offering a more detailed interpretation of the findings.

**Table 1.** Classification of the durability of sample laminated bamboo boards against Powderpost beetles (PPB). Modified from Alipon et al. (2018)

| Number of beetle holes | Classification |
|---|---|
| 0 or no hole except for boring attempts | Durable |
| 1–5 beetle holes | Moderately durable |
| 6–10 beetle holes | Slightly durable |
| ≥ 10 holes | Not durable |

## 3. RESULTS AND DISCUSSION

### Durability of locally produced laminated bamboo panels

Beetle holes, indicating PPB infestation, were observed in all sample panels, including the commercially manufactured panel from China. The locally manufactured laminated bamboo panels were not durable compared to a moderately durable commercial product. The findings suggest that the current prophylactic treatment involving soaking bamboo slats in borax/boric acid (BBA) for 72 hours is not effective against PPB. Jayanetti and Follet (1998) reported that boric/borax solutions are ineffective against fungi and bamboo borers. Walter and Kumar (2003) enumerated the characteristics of an ideal preservative, including toxicity to the target organism while minimizing toxicity to non-target organisms, permanent fixation within the bamboo culm, high penetration into bamboo tissues, easy disposal of treated products, and preservation of the strength of treated culms unaffected by preservative impregnation. In contrast, a separate study using different species showed that 5% of boric acid concentration was sufficient to control wood borer (Sing et al., 2011).

Soaking for 72 hours may not be sufficient for the borax-boric acid (BBA) solution to adequately penetrate the bamboo. Wahab et al. (2005) reported that soaking bamboo slats for seven days resulted in higher net dry salt retention (NDSR) compared to other preservatives. Further investigation is needed to determine the effectiveness of BBA against PPB, including the optimal concentration and most effective method of application. Sierras et al. (2018) found that boric acid is effective against the common bed bug only through ingestion, not through contact, suggesting that application method plays a critical role in efficacy.

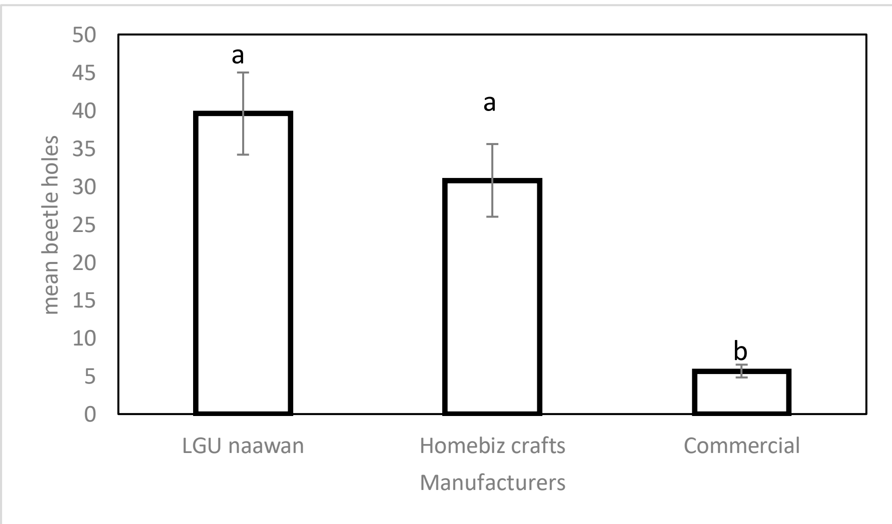


*Figure 2.* Mean number of beetle holes in sample panels (mean ± sem) after 9 months of exposure to Powderpost beetle (PPB). Bars with the same letter are not significantly different.

Bamboo Species

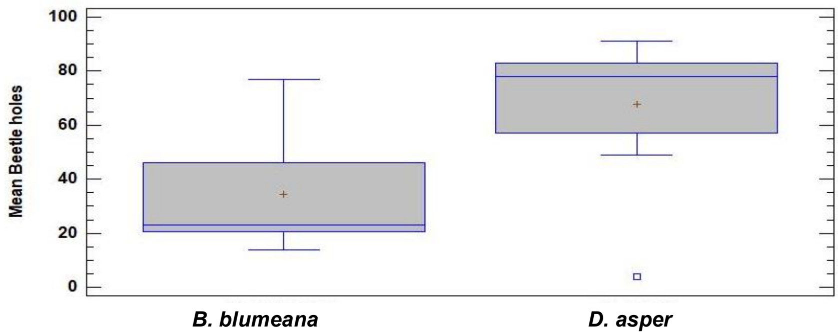


*Figure 3.* Comparison of number of beetle holes between bamboo panels from commercially important bamboo species after 9 months of exposure to Powderpost beetle (PPB).

Figure 3 shows that neither panel demonstrates resistance to PPB, as one of the sample panels recorded over sixty beetle holes. These results strongly suggest that the commercially important bamboo species evaluated are highly susceptible to PPB infestations. This supports the findings of Caparida et al. (2021), who reported that *B. blumeana* is particularly vulnerable to PPB attacks.

Despite the use of pre-processing treatments—such as seasoning and prophylactic measures like BBA treatment—the infestation levels remain alarmingly high, as indicated by the substantial number of beetle holes in the panels. According to Watanabe et al. (2020), bamboo culms are vulnerable to biodeterioration despite undergoing seasoning, making them more prone to insect attacks. Likewise, Norhisham et al. (2015) reported that infestations may start immediately after felling and tend to intensify as the moisture content declines to approximately 15%.

The vulnerability of bamboo to PPB is largely due to its chemical composition, which includes high levels of starch (2–6%), sugar (2%), and protein (1.5–6%), and low concentrations of natural deterrents like resin, wax, and tannin (Gauss et al., 2021). In this study, *D asper* exhibited a significantly greater number of beetles compared to *B. blumeana*, indicating a stronger preference of PPB for *D. asper* as a food source.

Both the middle and bottom sections of bamboo are vulnerable to PPB infestation. This indicates that laminated panels made from *B blumeana* and *D asper*, even when treated with BBA, lack sufficient durability. The natural durability assessment also revealed no significant difference in the number of beetle holes between the middle and bottom sections (Caparida et al., 2021). To enhance resistance, practices aimed at reducing starch content in bamboo culms should be considered before processing. Santhoshkumar and Bhat (2014) found that soaking bamboo for 1 to 12 weeks and boiling it significantly improved its durability.

Bamboo sections

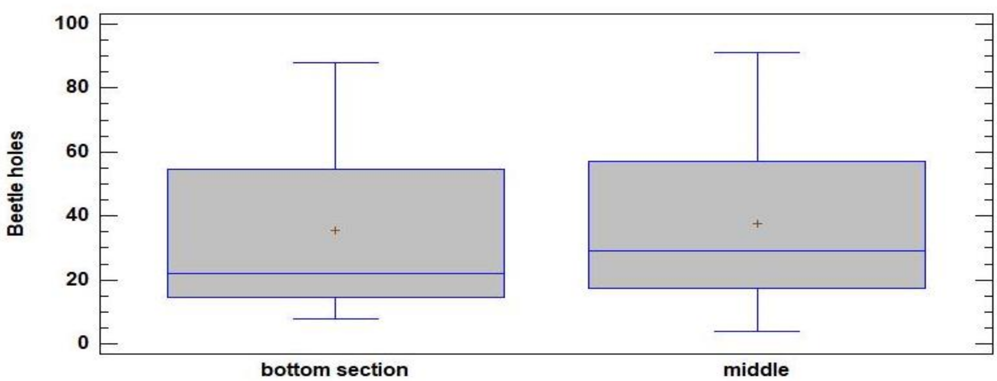


*Figure 4.* Comparison of number of beetle holes between bamboo panels manufactured from the two sections of bamboo after 9 months of exposure to Powderpost beetle (PPB).

## 4. CONCLUSION

The 72-hour soaking in BBA solution is insufficient to protect locally manufactured bamboo panels from PPB infestation. Panels made from both *D. asper* and *B. blumeana*, regardless of whether sourced from the middle or bottom sections, remain susceptible to PPB and therefore lack durability. To enhance product quality and global market competitiveness, local manufacturers should explore more effective pre-processing treatments that reduce the vulnerability of bamboo panels to insect attack.

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**Data Availability Statement:** The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Public access is currently restricted due to institutional data management policies.

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**Conflicts of Interest:** The authors declare no conflicts of interest

## 5. REFERENCES

Alipon, M. A., Garcia, C. M., & Bondad, E. O. (2018). Glue and preservative effects on the properties and durability of engineered bamboo boards. Philippine Journal of Science, 147(4), 601-616.

Anokye, R., Bakar, E. S., Ratnansingam, J., & Awang, K. (2016). Bamboo properties and suitability as a replacement for wood. Pertanika Journal of Scholarly Research Reviews, 2(1).

Borates Today. (2022, November 14). Bamboo tree treatment with borax-boric acid solution. https://borates.today/bamboo-tree-treatment-with-borax-boric-acid-solution/

Chaowana, P. (2013). Bamboo: an alternative raw material for wood and wood-based composites. Journal of Materials Science Research, 2(2), 90.

Del Castillo Marie Christine. (2021) Philippine Wood Products Report. USDA. Foreign Agricultural Service.https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Philippine%20Wood%20Products%20Report_Manila_Philippines_10-10-2021.pdf

Caparida, Devina, Rojo, Mark Jun, Parlucha Jason, Paquit Joseph. (2021), Natural durability of commercially important bamboo species in the Philippines against powderpost beetle (Dinoderus minutus Fabricius); IJB, V19, N6, December, P103-109

Gauss, C., Kadivar, M., Pereira, R. G., & Savastano Jr, H. (2021). Assessment of *Dendrocalamus asper* (Schult and schult f.) (Poaceae) bamboo treated with tannin-boron preservatives. Construction and Building Materials, 282, 122723.

Guadua Bamboo. (2025). Chemical bamboo preservation. https://www.guaduabamboo.com/blog/chemical-bamboo-preservation accessed July 17, 2025

Li, H. T., Zhang, Q. S., Huang, D. S., & Deeks, A. J. (2013). Compressive performance of laminated bamboo. Composites Part B: Engineering, 54, 319-328.

National Mission on Bamboo Applications (NMBA). (2006). Preservation of bamboo (Training Manual TM 05 07/06). Technology Information, Forecasting, and Assessment Council (TIFAC), Department of Science and Technology, Government of India.

Norhisham, A. R., Faizah, A., & Zaidon, A. (2015). Effects of moisture content on the bamboo borer *Dinoderus minutus*. Journal of Tropical Forest Science, 334-341.

Pawan KP, Vinayak U, Hanunamantha, Manjunatha GO, Kumari S. (2021) BAMBOO: A SUBSTITUTE FOR WOOD AND WOOD-BASED INDUSTRIES. Available from: https://www.researchgate.net/publication/355182540_BAMBOO_A_SUBSTITUTE_FOR_WOOD_AND_WOOD-BASED_INDUSTRIES [accessed Jul 13, 2023].

Santhoshkumar, R., & Bhat, K. V. (2014). Various changes of starch content in the culms of selected bamboo species, *Bambusa bambos* (L.) Voss and *Dendrocalamus strictus* Ness at different storage methods. The Journal of Indian Botanical Society, 93(1and2), 82-86.

Sierras, A., Wada-Katsumata, A., & Schal, C. (2018). Effectiveness of boric acid by ingestion, but not by contact, against the common bed bug (Hemiptera: Cimicidae). Journal of economic entomology, 111(6), 2772-2781.

Singh, D. K., Faizah, A., Hazandy, A. H., Zaidon, A., & Arifin, A. (2011). Boric acid toxicity trials on the wood borer *Heterobostrychus aequalis* Waterhouse (Coleoptera: Bostrychidae). American Journal of Agricultural and Biological Sciences, 6(1), 84-91.

Wahab, R., Sudin, M., Mokhtar, J., & Yunus, A. A. M. (2005). Penetration class and net dry salt retention of ammoniacal copper quartenary, borax boric acid and copper chrome arsenic in 2- and 4-year-old bamboo *Gigantochloa scortechinii*. Journal of Biological Sciences, 5(4), 511-518.

Watanabe, H., Yanase, Y., & Fujii, Y. (2020). Nondestructive evaluation of oviposition behavior of the bamboo powderpost beetle, Dinoderus minutus, using X-ray computed tomography and acoustic emission. Journal of Wood Science, 66(1), 1-11.

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