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## Research Article

# Feeding Preference of Vexatious *Microtermes obesi* (Wheat Termite) (Blattodea: Termitidae)

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## Abstract

**Background and Objective:** *Microtermes obesi* is a termite species extensively present throughout Pakistan and causes detrimental effects on standing trees, crops and timbers. In this study, the feeding preferences of *M. obesi* for 16 different wood species were determined through choice trials under natural field conditions. **Materials and Methods:** In choice field trials, different combinations of wooden blocks were used to determine wood consumption by *M. obesi*. Wood weight loss, consumption and rate of survival of different wooden species were calculated. **Results:** *Cordia myxa* was found to be the most susceptible wood species and *Cassia fistula* the most resistant one. Sixteen different wood combinations were used under choice field conditions, maximum feeding was recorded in *Cordia myxa* and *Moringa oleifera* (39.15-33.00 g). Though, minimum feeding was noted in *C. fistula* (1.41 g) and *Heterophragma adenophyllum* (24.38 g). Under choice natural field conditions, minimum feeding was recorded in *C. fistula* (1.41 g) and maximum feeding in *Cordia myxa* (39.15 g). Feeding preference in descending order were as follows: *Cordia myxa moringa oleifera*, *Bombax ceiba*, *Bambusa bamboo*, *Syzygium cumini*, *Albizia lebbeck*, *Dalbergia sissoo*, *Psidium guava*, *Pinus roxburghii*, *Acacia nilotica*, *Bauhinia variegata*, *Azadirachta indica*, *Eucalyptus camaldulensis*, *Mangifera indica*, *Heterophragma adenophyllum* and *Cassia fistula*. **Conclusion:** This study communicates the basis for developing a baiting strategy for the efficient control of pest termites.

Key words: Feeding preferences, *Microtermes obesi*, choice field trials, *Cordia myxa*, *C. fistula*, *Heterophragma adenophyllum*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Termites are social insects with the division of labour as follows: Soldiers, reproductive adults and workers. Termite forms both subterranean and above-ground networks of colonies for living. Cellulose material in wood is eaten by subterranean termites thus imparting serious damage to buildings and agricultural plants[1,2]. They are present especially in the tropical and sub-tropical regions of the globe. The symbiotic association of termite gut microbes is important in digesting wood[3]. Termites play a crucial role in recycling and decaying materials and play havoc with crops and buildings. Many plant extracts have been found to have anti-termite properties. Ecologically termites are significant through a negative and positive role similar to breaking down wood debris which greatly benefits the forest's environment and therefore assumes them as a pest[4,5]. Wood species were cut into blocks (L×W×T = 8×9×1 cm) and dry in the oven at 42°C for 72 hrs. It was found that *P.* × *euramericana*, *M. indica* and *V. nilotica* were the most palatable woods to termites as maximum feeding was noted for these two kinds of wood under field conditions. They informed the high density of termite population in the fields of cotton (148.2 $m^{-2}$) was noted during October. Four termite species namely, "*M. obesi*, *M. mycophagous*, *E. paradoxalis* and *O. guptai*," foraging in the crops of wheat was reported from the Bahawalpur Division. During the wheat-growing season, they reported the population density of termites was different from 113.25-3437.0 $m^2$ [6]. The current study shows that termites population density ranges from 2.40-124.44 $m^2$ which also involves soil cores from the district Bahawal Nagar. In developed countries like America and Asia the economic role of termites is important in commercial entomology, causing many millions of pounds of cost destruction in buildings. The damage caused by natural disasters, fires etc. in a single year in some countries is of less cost than the damage caused by termites to houses. Antique temples are to be pounced by termites in Asia[7]. An important role is also by the interaction of animals to manipulate environmental conditions according to concentration and nature, thus interaction among termites and ants manipulate the environment being a natural predator of termites thus limiting the role of the environment[8]. Bahawalnagar District is located from 28°51'39-30°22'39, North latitude and from 72°17'39-73°58'39, East longitude. The climate of Bahawalnagar in summer is very hot and dry and during winter it is cold and dry. The beginning of the summer season is in April and it lasts up to October. During May, June and July the weather is very hot, while in December, January and February the weather is too cold. From different ecological regions of Pakistan, 53 species of termites have been recorded, however, due to the scarcity of data concerning their large quantity and foraging activities in various climatic zones of Pakistan. The polymorphic morphological forms of termite with eusocial insects belong to Infraorder isoptera. The wood consumption factors affecting termites are numerous and highly interrelated. In termite wood consumption the influential parameters in palatability are wood species. The preferences of wood-feeding and their resistance will differ according to the hardness of the wood and its lignin contents or chemical composition. The occurrence of carbon-based compounds such as phenol, aromatic ketones (Quinones), terpenoids and high contents of lignin can also affect the feeding of the wooden species. Wood contents pH is also important in the termite's feeding. It is a cheap source to protect structural timbers from the attack of termites and destruction. The presence of termite-resistant components of wood prevents it from termite attacks which are unequally distributed to the all plant parts[9]. The presence of carbon-based chemicals like phenols, quinone, terpenoids and a higher amount of lignin affects the feeding area in plants. These components are present in greater quantity in heartwood and sapwood and lower in the tip of the stem. The occasional presence of vital oils in plants prevents them from the attack of termites. In the research, it was observed that the sufaida (*Eucalyptus*) vital oil is an active toxic agent and causes gastrointestinal toxicity in termites[10]. Natural resistance against termites is present in the tropical forests plants species and it might provide an alternative usage of the chemical products. The hardness of the wood, the occurrence of toxic materials, inhibitors of feeding or deterrent, the occurrence of fungal absence, level of mycological decay and contents of moistness in woods and soil are considered the most important factors of timber species. The objective of the current research work was to check the feeding preferences of various timber species contrary to *Microtermes obesi* an underground termite species under natural field conditions[11]. Termites also consider the type and amount of pre-existing fungus attack for the selection of timber. The redwood extract has lethal effect on protozoan present in gut of termite thus causing high mortality in redwood found that the wood having high contents of resin and lignin are termite resistant. Reported an association between termites' resistance to wood and the amount of lignin, ashes and proteins contents of many types of timbers[12,13]. Keeping in view the damage due to termites to the environment and important woods, the current study was designed to compare preferences of the feeding of *Microtermes obesi* on sixteen different timber species under natural conditions. The main objective of this study was to explore the termiticidal potential of termiticidal wood.

## MATERIALS AND METHODS

**Study area and termite sampling:** The study was carried out at Minchinabad, Bahawal Nagar, from March to August, 2021 Pakistan. Maximum termites were collected from dead-infested logs. These termites were moved in the Petri dishes along with some dead wooden fragments and were carried to the laboratory to adjust them under laboratory conditions. All samples were skillfully handled with a camel hair brush, only active and with good physical condition, termites were used for bioassays.

**Identification of termite:** The third instar of workers and soldiers were collected through variable techniques e.g., wetted toilet roll, bucket traps and card board paper roll in plastic bottles having small pores at their base and also having holes on lateral sides for the entry of termite into the bait. The traps were brought to the laboratory and all termites along with moist filter paper kept in a container. The baits were installed in the soil and regularly visited on a quarter-monthly basis. The termites were identified based on the soldier caste using the taxonomic keys of Jones and Eggleton[14] and Chhotani[15] (Fig. 1).

**Woods selection:** Economically important species of wood were selected from different regions of Tehsil Minchinabad and Bahawal Nagar. The diverse tree species which were economically important present above said localities, but among these only sixteen were selected for choice bioassay under field conditions. The wood species consisted of the following wooden blocks, *Mangifera indica* (Mango), *Psidium guava* (Guava), *Cassia fistula* (Amaltas), *Azadirachta indica* (Neem), *Eucalyptus camaldulensis* (Safaida), *Dalbergia sissoo* (Sheesham), *Syzygium cumini* (Jaman), *Heterophragma adenophyllum* (Beri Patta), *Albizia lebbeck* (Shreen), *Bauhinia variegata* (Kachnar), *Bambusa bamboo* (Bamboo), *Acacia nilotica* (Kikar), *Pinus roxburghii* (Chir Pine), *Bombax ceiba* (Sumbal), *Cordia myxa* (Lasura) and *Moringa oleifera* (Sohanjana).

### Field feeding bioassays

**Choice bioassay (under field conditions):** Blocks of wooden species were desiccated at 60°C for 48 hrs. Each wooden block was replicated thrice (n = 3). Every block was bounded and arranged together by using copper wire. These blocks were then buried 30 cm deep in the soil in a vertical and horizontal position, in different localities in Tehsil Minchinabad and Bahawal Nagar[17].

As the properties of absorption vary for different species of wood which effect termites' feeding preferences. This experiment lasted for 3 months under natural conditions at Minchinabad, Bahawal Nagar as shown in Fig. 2a-d. Wooden blocks were dismantled after experimentation and hence subjected to post-weight assessment active.

**Choice field trials:** All the replicates (n = 3) of wood were used for every pair of wooden species. So that, a total of 48 wooden blocks were prepared and put into the nest of *Microtermes obesi*, with newly formed humid passageways on the nest surface. Likewise, the termite's nests were excavated and the fungal examines were explored and checked for the activeness of the nest. All the wooden blocks were treated with molasses before inserting into the nests. The wood used as bait for termites was observed more competitive than other resources of termite food. Three months later, all the paired wooden blocks were removed from the nests to evaluate the consumption rate of wood by the formula given below according to Rasib *et al.*[18]:

$$WC = W_1 - W_2$$

Whereas, $W_1$ was considered as the pre-weight of wood, while $W_2$, was the post-weight of infested wood. Different species of woods have different absorption properties, which have a different effect on preferences of termite feeding. The food resources with high contents of moisture are preferred by subterranean termites. All wooden blocks were removed from the field after three months, dried at 60°C for about 72 hrs and were reweighed to estimate the percentage of wood quantity loss of the wooden chunks due to *Microtermes obesi* by the given method:

$$WL = \frac{W_1 - W_2}{W_1} \times 100$$

**Statistical analysis:** After the conclusion of the trial, the data of consumption of wood, percentage of wood consumption and percentage of woods survival were subjected to one-way ANOVA using Minitab (Version-3.8) and Paired comparison t-test were used for field bioassays. Correspondingly, the percentage of mass loss of wooden species and their means in the choice field bioassays were analyzed by Tukey's Test.

Fig. 1: *Microtermes obesi*
Ahmed *et al*.[16]

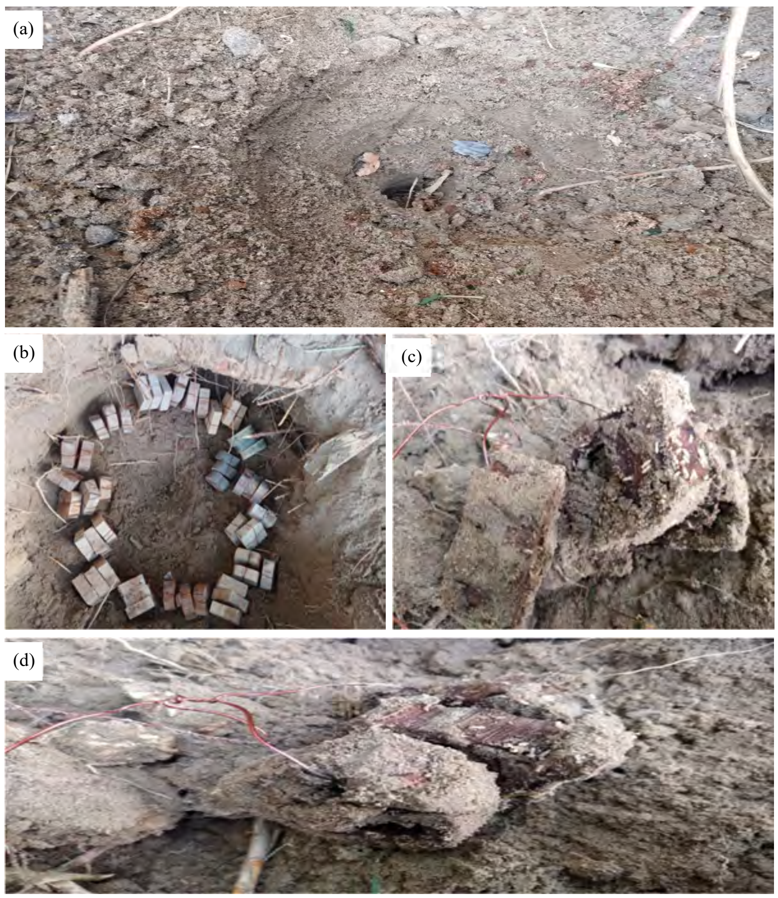


Fig. 2(a-d): Nest of *Microtermes obesi* for choice field trial, (a) Nest of *Microtermes obesi* after digging for choice field trial, (b) Wooden blocks at trial site, (c) Infested with different wooden blocks *Microtermes obesi* and (d) Infested different wooden blocks with *Microtermes obesi*

## RESULTS

Wooden baits of sixteen different timber species offered to *Microtermes obesi* showed variation in feeding behaviour under field conditions. The wooden blocks after *M. obesi* infestation were shown in Fig. 3a-p.

Different eight wooden pairs of various timber species when offered to *Microtermes obesi* shows variation in feeding behaviour as in Fig. 4a-h.

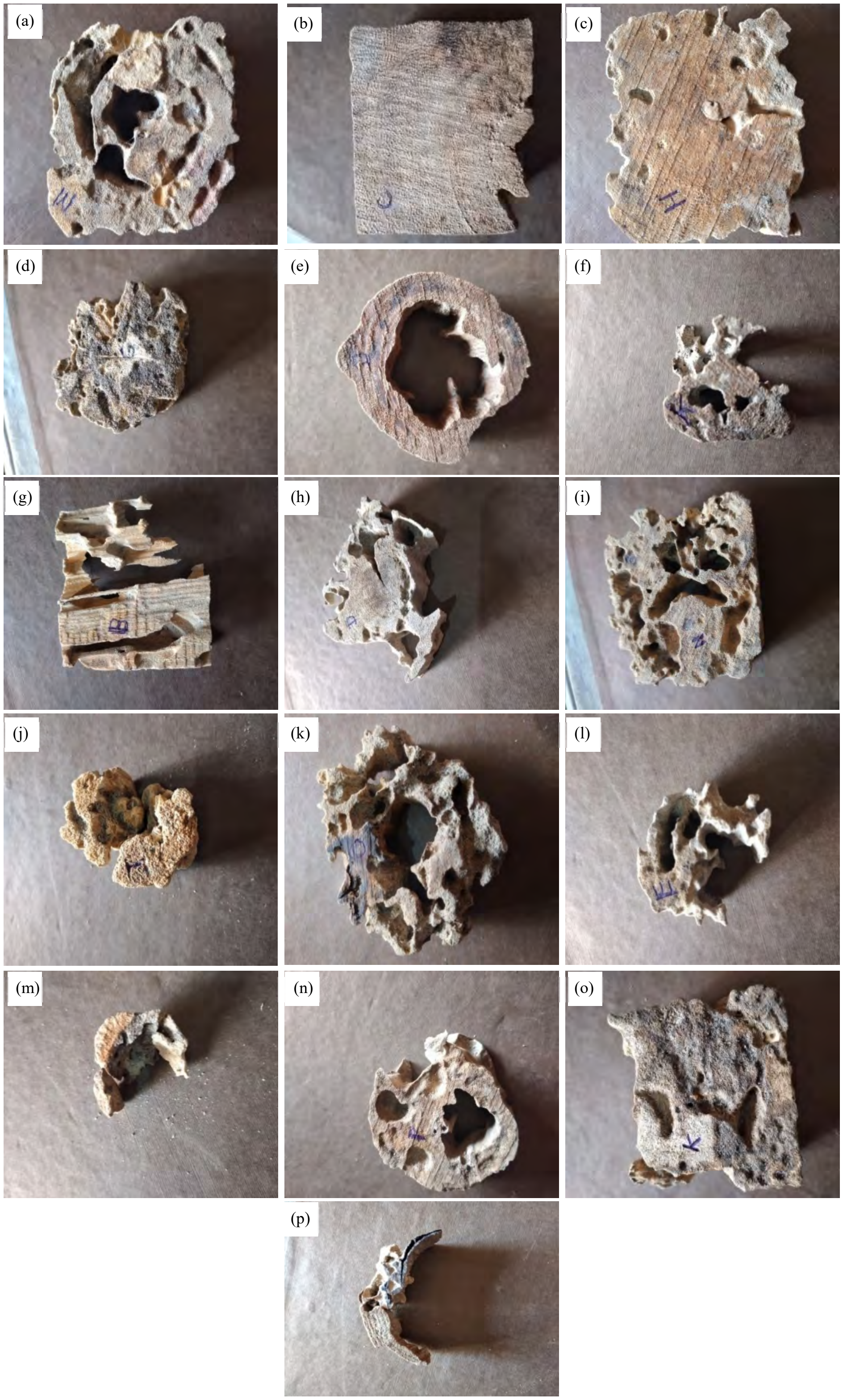


Fig. 3(a-p): Damage range caused by *Microtermes obesi* workers on 16 different wood species blocks, (a) *Azadirachta indica*, (b) *Cassia fistula*, (c) *Heterophragma adenophyllum*, (d) *Mangifera indica*, (e) *Acacia nilotica*, (f) *Cordia myxa*, (g) *Eucalyptus camaldulensis*, (h) *Eucalyptus camaldulensis*, (i) *Dalbergia sissoo*, (j) *Moringa oleifera*, (k) *Albizia lebbeck*, (l) *Syzygium cumini*, (m) *Bombax ceiba*, (n) *Psidium guajava*, (o) *Bauhinia variegata* and (p) *Bambusa bamboo*

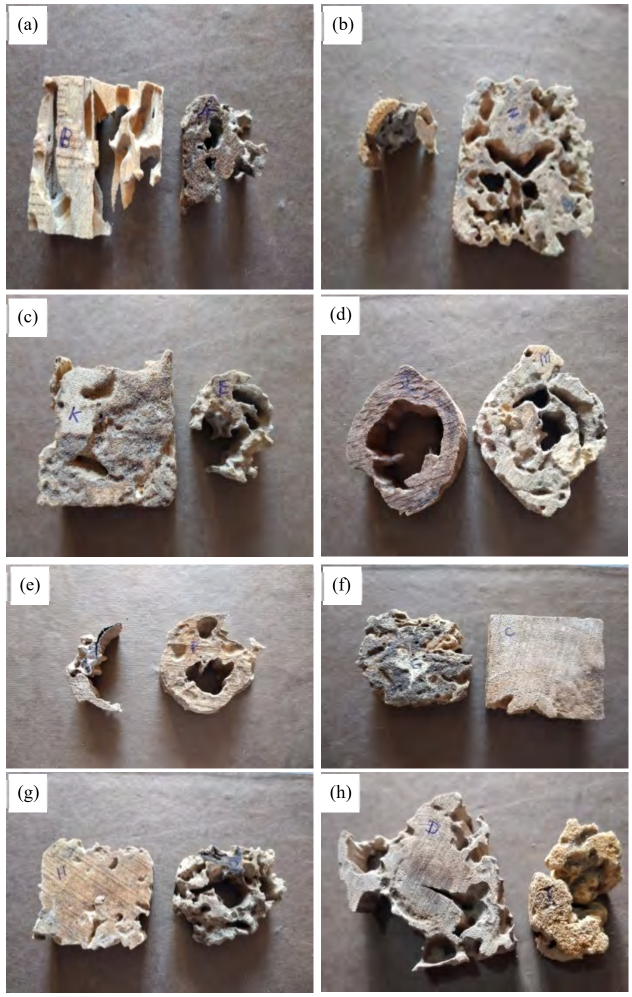


Fig. 4(a-h): Damage caused by the workers and feeding preferences *Microtermes obesi* on eight different pairs of wooden blocks when exposed under choice natural field conditions after 3 months, (a) *Pinus roxburghii/Cordia myxa*, (b) *Bombax ceiba/Dalbergia sissoo*, (c) *Bauhinia variegata/Syzygium cumini*, (d) *Acacia nilotica/Azadirachta indica*, (e) *Bambusa bamboo/Psidium guava*, (f) *Mangifera indica/Cassia fistula*, (g) *Heterophragma adenophyllum* and (h) *Eucalyptus camaldulensis/Moringa oleifera*

The preference of feeding for sixteen different wooden species by *Microtermes obesi* under choice natural field conditions. These choice feeding trials showed that among the 16 different wooden species *Cordia myxa* was the most palatable wood species (39.15 g) by *M. obesi*. The *M. obesi* consumed wood of *Cordia myxa* about 93.01%. While the minimum amount of consumption of wood (1.41 g) was practised in *Cassia fistula*. And the percentage of wood consumption of *Cassia fistula* was 3.77% as shown in Table 1. These results were important for estimating the repellent quality and antifeedant property of different wooden species against *M. obesi*. It was also helpful to determine the foraging behaviour of the termites. Feeding preference in descending order is as follows: *Cordia myxa* (93.01%), *Moringa oleifera* (92.83%), *Bombax ceiba* (87.98%), *Bambusa bamboo* (84.61%), *Syzygium cumini* (77.33%), *Albizia lebbeck* (76.48%), *Dalbergia sissoo* (67.86%), *Psidium guajava* (65.96%), *Pinus roxburghii* (62.69%), *Acacia nilotica* (58.16%), *Bauhinia variegata* (55.79%), *Azadirachta indica* (51.13%), *Eucalyptus camaldulensis* (49.28%), *Mangifera indica* (47.29%), *Heterophragma adenophyllum* (33.00%) and *Cassia fistula* (3.77%) as shown in Table 1.

Table 2 represented the Means, t-value and significance level at 5% of diverse wood feeding preferences of termites. The maximum feeding was recorded on *Cassia fistula* (Amaltas) at 35.97 mg and the minimum feeding was recorded on *Bombax ceiba* (Sumbal) at 1.56 mg. The feeding on such woods could lead to the development of a bait to control termite activities (Table 2).

Table 1: Mean consumption (g) and percentage of consumption of 16 different timber species exposed to *Microtermes obesi* in choice feeding bioassay after 3 months under natural field conditions

| Wood used | Wood consumption (g) | Mass loss (%) |
|---|---|---|
| *Pinus roxburghii* (Chir) | 19.71[a] | 62.69 |
| *Cassia fistula* (Amaltas) | 1.41[b] | 3.77 |
| *Eucalyptus camaldulensis* (Safaida) | 16.63[a] | 49.28 |
| *Syzygium cumini* (Jaman) | 22.49[c] | 77.33 |
| *Bauhinia variegata* (Kachnar) | 20.51[d] | 55.79 |
| *Mangifera indica* (Mango) | 14.40[a] | 47.29 |
| *Heterophragma adenophyllum* (Beri pata) | 12.01[e] | 33.00 |
| *Moringa oleifera* (Sohanjna) | 33.04[f] | 92.83 |
| *Acacia nilotica* (Kakar) | 22.98[d] | 58.16 |
| *Cordia myxa* (Lasora) | 39.15[g] | 93.01 |
| *Bombax ceiba* (Sumbal) | 11.42[e] | 87.98 |
| *Azadirachta indica* (Neem) | 18.65[a] | 51.13 |
| *Dalbergia sissoo* (Sheesham) | 24.70[d] | 67.86 |
| *Albizia lebbeck* (Shreen) | 26.21[d] | 76.48 |
| *Psidium guajava* (Guava) | 27.29[d] | 65.96 |
| *Bambusa bamboo* (Bamboo) | 18.43[d] | 84.61 |

Alphabets representing similar letters are not significantly different at $p<0.05$

Table 2: Feeding preference of *Microtermes obesi* ($\bar{X}\pm SE$) under choice trials in the field conditions after three months

| Wood used | $\bar{X}\pm SE$ | t-value | Significance |
|---|---|---|---|
| *Pinus roxburghii* (Chir) | 11.73±3.046 | 11.73 | 5.274 |
| *Cassia fistula* (Amaltas) | 35.97±0.214 | 35.97 | 0.370 |
| *Eucalyptus camaldulensis* (Safaida) | 17.11±2.233 | 17.11 | 3.868 |
| *Syzygium cumini* (Jaman) | 6.59±0.831 | 6.59 | 1.439 |
| *Bauhinia variegata* (Kachnar) | 16.25±0.664 | 16.25 | 1.132 |
| *Mangifera indica* (Mango) | 16.05±0.625 | 16.05 | 1.082 |
| *Heterophragma adenophyllum* (Beripata) | 24.38±0.639 | 24.38 | 1.106 |
| *Moringa oleifera* (Sohanjna) | 2.55±0.015 | 2.55 | 0.026 |
| *Acacia nilotica* (Kakar) | 16.53±0.804 | 16.53 | 1.392 |
| *Cordia myxa* (Lasora) | 2.94±0.276 | 2.94 | 0.478 |
| *Bombax ceiba* (Sumbal) | 1.56±0.405 | 1.56 | 0.702 |
| *Azadirachta indica* (Neem) | 17.82±0.702 | 17.82 | 1.217 |
| *Dalbergia sissoo* (Sheesham) | 11.40±2.703 | 11.40 | 4.682 |
| *Albizia lebbeck* (Shreen) | 8.06±0.965 | 8.06 | 1.672 |
| *Psidium guava* (Guava) | 14.08±0.427 | 14.08 | 0.739 |
| *Bambusa bamboo* (Bamboo) | 3.35±0.029 | 3.35 | 0.050 |

**Choice field trials:** A chain of paired choice field trials was also conducted to compare the preference of *M. obesi* for *Pinus roxburghii* versus *Cordia myxa* (PR/CM), *Bombax ceiba* versus *Dalbergia sissoo* (BC/DS), *Bauhinia variegata* versus *Syzygium cumini* (BV/SC), *Acacia nilotica* versus *Azadirachta indica* (AN/AI), *Bambusa bamboo* versus *Psidium guajava* (BB/PG), *Mangifera indica* versus *Cassia fistula* (MI/CF), *Heterophragma adenophyllum* verses *Albizia lebbeck* (HA/AL) and *Eucalyptus camaldulensis* versus *Moringa oleifera* (EC/MO).

Wooden blocks of different trees were arranged to evaluate the mass loss of wood by comparing one pair of wood with another wood pair. This comparison of feeding preference was thought to be the more suggestive choice for termites feeding that termites came across in their natural environment. Consequently, termites had the choice of eating either the wooden block they select to feed or they avoid non-preferred or unpalatable wooden blocks as shown in Table 3.

Statistically, values in different wooden blocks in pairs showed significant results at 95 and 99% confidence intervals as shown in Table 4.

Table 5 represented that Mean ($\bar{X}\pm SE$) wood consumption/wood mass loss (g) in eight wooden pairs when subjected to the workers of *Microtermes obesi* for paired choice tests series to compare the feeding preferences of *M. obesi* for *Pinus roxburghii* versus *Cordia myxa* (PR/CM), *Bombax ceiba* versus *Dalbergia sissoo* (BC/DS), *Bauhinia variegata* versus *Syzygium cumini* (BV/SC), *Acacia nilotica* versus *Azadirachta indica* (AN/AI), *Bambusa bamboo* versus *Psidium guava* (BB/PG), *Mangifera indica* versus *Cassia fistula* (MI/CF), *Heterophragma adenophyllum* verses *Albizia. lebbeck* (HA/AL) and *Eucalyptus camaldulensis* versus *Moringa oleifera* (EC/MO) in 12 weeks choice trials under field conditions.

Table 3: Feeding preference of *Microtermes obesi* (X̄±SE) at 95% significance level on eight wooden pairs under choice trials in the field conditions after three months

| Wood used | X̄±SE | t-value | Significance level 95% |
|---|---|---|---|
| PR-CM | 8.79667±3.01715 | 2.916 | 0.100 |
| BC-DS | 9.83667±3.10725 | 3.166 | 0.087 |
| BV-SC | 9.65333±0.46642 | 20.697 | 0.002 |
| AN-AI | 1.28333±1.42595 | 0.900 | 0.463 |
| BB-PG | 10.72667±0.41898 | 25.602 | 0.002 |
| MI-CF | 19.91667±0.81948 | 24.304 | 0.002 |
| HA-AL | 16.32000±1.52333 | 10.713 | 0.009 |
| EC-MO | 14.56000±2.24849 | 6.475 | 0.023 |

Statistically, values in different wooden blocks in pairs showed significant results at 95 and 99% confidence intervals

Table 4: Feeding preference of *Microtermes obesi* (X̄±SE) at 99% significance level on eight wooden pairs under choice trials in the field conditions after three months

| Wood used | X̄±SE | t-value | Significance level 99% |
|---|---|---|---|
| PR-CM | 8.79667±3.01715 | 2.916 | 0.100 |
| BC-DS | 9.83667±3.10725 | 3.166 | 0.087 |
| BV-SC | 9.65333±0.46642 | 20.697 | 0.002 |
| AN-AI | 1.28333±0.46642 | 0.900 | 0.463 |
| BB-PG | 10.72667±0.41898 | 25.602 | 0.002 |
| MI-CF | 19.91667±0.81948 | 24.304 | 0.002 |
| HA-AL | 16.32000±1.52333 | 10.713 | 0.009 |
| EC-MO | 14.56000±2.24849 | 6.475 | 0.023 |

Table 5: Choice trials under field conditions by *M. obesi*

| *Comparison | Wood 1 | Wood 2 |
|---|---|---|
| PR-CM | 11.7333±3.04473 | 2.9367±0.27606 |
| BC-DS | 1.5600±0.40509 | 11.3967±2.70335 |
| BV-SC | 16.2467±0.65351 | 6.5933±0.83109 |
| AN-AI | 16.5333±0.80367 | 17.8167±0.70243 |
| BB-PG | 3.3533±0.02906 | 14.0800±0.42673 |
| MI-CF | 16.0533±0.62462 | 35.9700±0.21385 |
| HA-AL | 24.3833±0.63855 | 8.0633±0.96534 |
| EC-MO | 17.1100±2.23330 | 2.5500±0.01528 |

*Each wooden block was paired with a block of another species (wood 1/wood 2) under natural field conditions. The difference in the mass loss for each pair of wood blocks indicated by the asterisk at 0.05 is significantly different (paired comparison t-test)

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Cordia myxa* and less on *Pinus roxburghii* and the volume of wood consumed was significantly different (t = 2.916) as represented in Fig. 5 and indicated by alphabets a and b.

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Bombax ceiba* and less on *Dalbergia sissoo* and the volume of wood consumed was significantly different (t = 3.166) as represented in Fig. 6 by alphabets a and b representing significant differences at $p<0.05$.

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Syzygium cumini* and less on *Bauhinia variegata* and the volume of wood consumed was significantly different (t = 20.697) as represented in the graphs as indicated by numbers representing a significant difference at $p<0.05$ (Fig. 7).

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Acacia nilotica* and less on *Azadirachta indica* and the volume of wood consumed was significantly different (t = 0.900) as represented in Fig. 8.

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Bambusa bamboo* and less on *Psidium guava* and the volume of wood consumed was significantly different (t = 25.602) as represented in Fig. 9 as indicated by alphabets a and b.

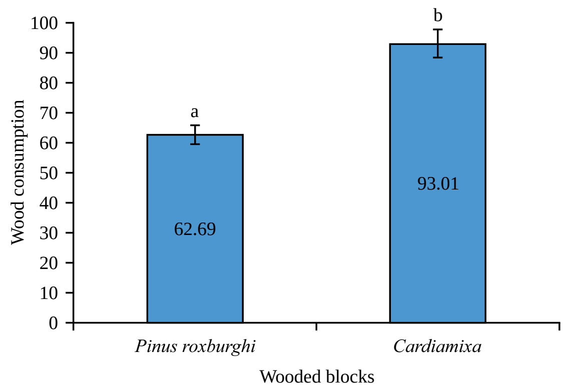


Fig. 5: Comparison of wood consumption by *Microtermes obesi* between *Cordia myxa* and *Pinus roxburghii*

a,bAlphabets represent significant differences at $p<0.05$

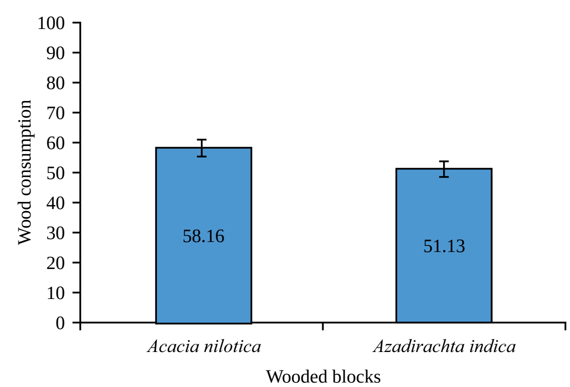


Fig. 8: Comparison of wood consumption by *Microtermes obesi* between *Acacia nilotica* and *Azadirachta indica*

Different figures in the word represent significant differences at $p<0.05$

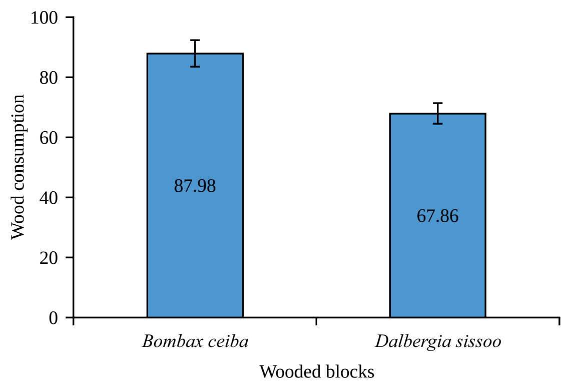


Fig. 6: Comparison of wood consumption by *Microtermes obesi* between *Bombax ceiba* and *Dalbergia sissoo*

Different figures in word represent significant differences at $p<0.05$

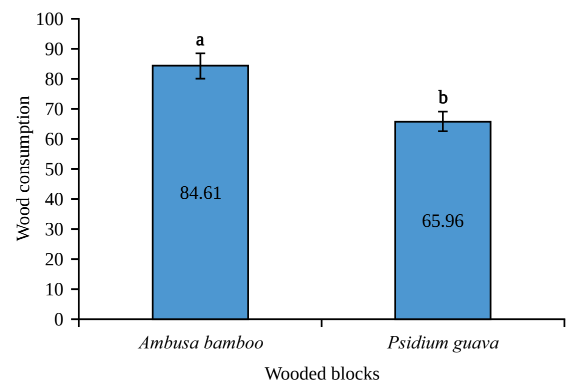


Fig. 9: Comparison of wood consumption by *Microtermes obesi* between *Bambusa bamboo* and *Psidium guava*

a,bAlphabets represents significant differences at $p<0.05$

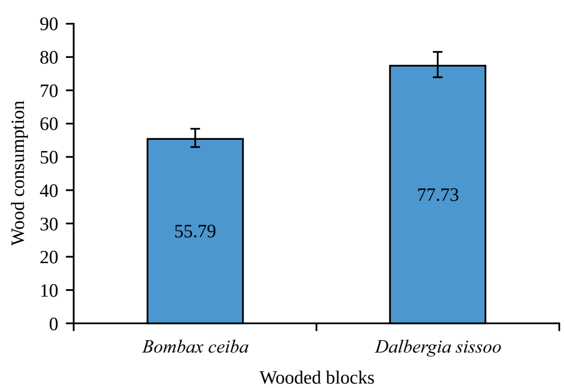


Fig. 7: Comparison of wood consumption by *Microtermes obesi* between *Syzygium cumini* and *Bauhinia variegata*

Different figures in words represent significant differences at $p<0.05$

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Mangifera indica* and less on *Cassia fistula* and the volume of wood consumed was significantly different (t = 24.304) as represented in Fig. 10 and indicated by alphabets a and b.

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Albizia lebbeck* and less on *Heterophragma adenophyllum* and the volume of wood consumed was significantly different (t = 10.713) as represented in Fig. 11.

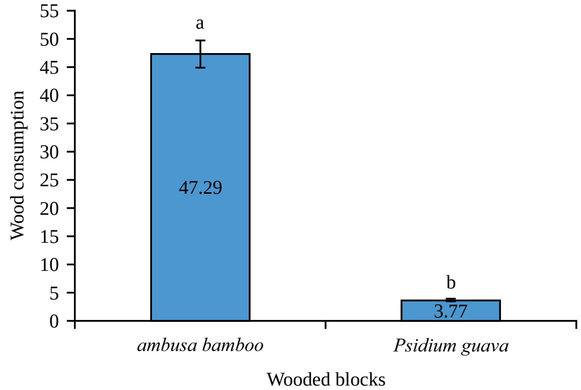


Fig. 10: Comparison of wood consumption by *Microtermes obesi* between *Mangifera indica* and *Cassia fistula*
[a,b]Alphabets represents significant differences at $p<0.05$

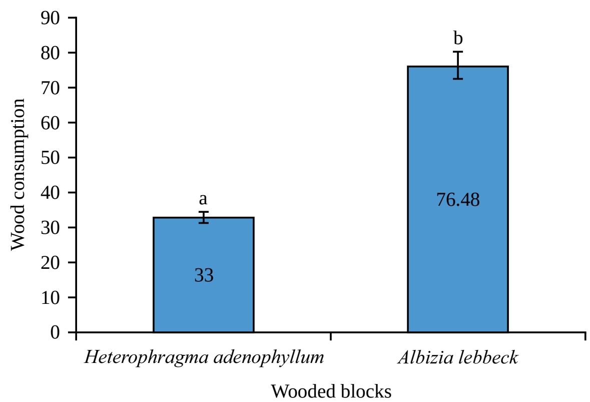


Fig. 11: Comparison of wood consumption by *Microtermes obesi* between *Albizia lebbeck* and *Heterophragma adenophyllum*
[a,b]Alphabets represent significant differences at $p<0.05$

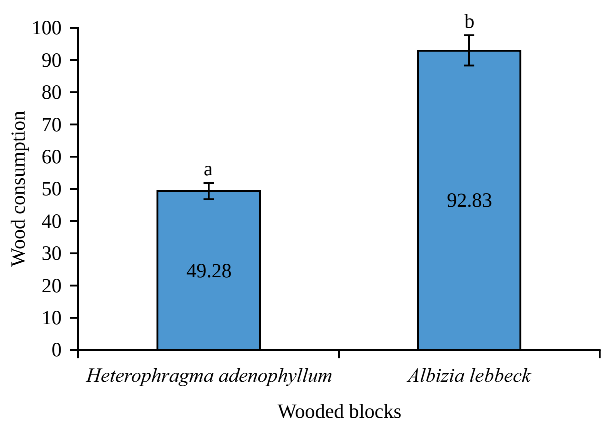


Fig. 12: Comparison of wood consumption by *Microtermes obesi* between *Albizia lebbeck* and *Heterophragma adenophyllum*
[a,b]Alphabets represent significant differences at $p<0.05$

In a choice of two kinds of wood, *Microtermes obesi* showed an instinct of having preferred wood when a comparison was offered between two different kinds of wood. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Moringa oleifera* and less on *Eucalyptus camaldulensis* and the

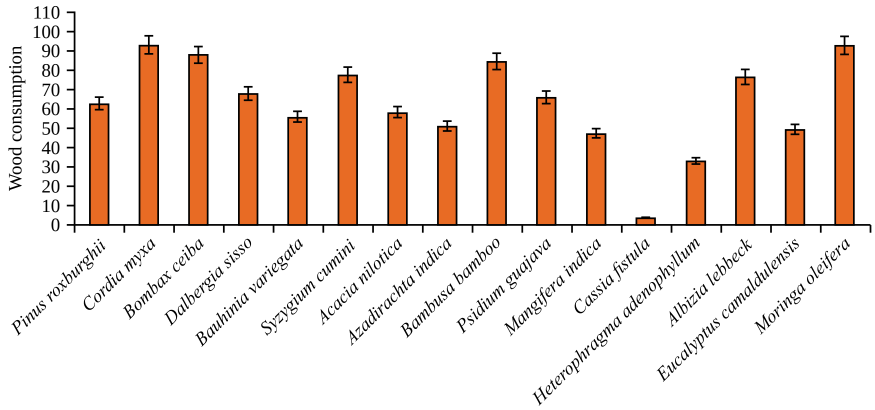


Fig. 13: Comparison of wood consumption by *Microtermes obesi* on sixteen different wooden species

volume of wood consumed was significantly different (t = 6.475) as represented in Fig. 12 and indicated by alphabets a and b.

In a choice of sixteen kinds of wood, *Microtermes obesi* showed the instinct of having preferred wooden blocks, when a comparison was offered between different woods. The combination of different wooden blocks to *Microtermes obesi* exhibited maximal feeding on *Cordia myxa* (93.01%) and less on *Cassia fistula* (3.77%) as shown in Fig. 13.

## DISCUSSION

Feeding preferences of *Microtermes obesi* to sixteen different wooden species were studied as termite control efforts could only be planned by having profound knowledge of feeding tendencies and feeding behaviour of termites. To control termites' basic knowledge is of prerequisite for termite control. Termite experts have perceived that some of the wood types are termite resistant. Termites being the most prevalent soil macro fauna in tropical and subtropical ecosystems and can be a noteworthy natural source of greenhouse gases[19]. Specific termite-repellant chemicals present in wood cause resistance against termite attack. Many symbiotic protozoans in termites are affected directly or indirectly by the toxic chemicals of wood. Termites are primarily wood-feeding insects, consisting of approximately 2,650 species worldwide. The higher the density of the wood, the lower the degradation. Similarly, higher amount of lignin and total phenolic contents ensured higher resistance, whereas cellulose drives the termites towards the wood[20].

A high concentration of lignin and hardness does not prevent wood from being consumed by dry wood termite species[21]. In Pakistan and other developing countries, the termite control cost may exceed the cost of renewing or replacing the damaged lumber, as compared to severe termite infestation of wooden structures which is almost tolerated. However, in the big cities of Pakistan due to improvement in living standards and increase in income, this trend has changed and people are now aware of termites' damage to their valued wooden structures. Around 53 species of termites in Pakistan have been described but amongst them, only eleven species have caused economic damage to wooden constructions[22-24]. However, in Pakistan, indigenous information related to termites showed that wooden plant species such as, "*P. roxburghii, D. sissoo* and *T. grandis*" retain anti-termite materials and however, several chitin synthesis inhibitors have been used or tested against subterranean termites, but the current study results in a sense that indicate more resistance than more consumption done on *Cordia myxa* and *Moringa oleifera*, whereas, *Cassia fistula* was reasonably more resistant. However, it is also important to mention that the extractive contents of wood are also one of the parameters determining the resistance against the damaging agents. The current study results revealed that the natural wood resistance protects it from termite attack. Also, the results favour a former report that the higher specific gravity of the timber species is related to the natural resistance of wood to termite attack[25]. Feeding preferences of timber and its resistance will modify with the chemical constitution of woods, rigidity and lignin contents. The ecology of the feeding area of termites is also affected by the presence of organic chemicals, such as phenol, quinones, terpenoids and lignin at high concentrations. The pH of timber contents was also important in its resistance. Starch and sugar contents of sapwood are generally desired over heartwood by termites. Except for a toxic effect by one of the oil borne preservatives, the anti-termitic properties of the preservatives and the natural woods were due primarily to repellency or feeding deterrence factors. The feeding propensity of *M. championi* (Snyder) was *Acacia arabica* > *Ficus religiosa* > *Azadirachta indica* > *Morus alba* > *Melia azederach* > *Mangifera indica*) > *Cedrus deodara* > *Tectona grandis*.

The quantity of these chemicals in trees can vary from the outer to the inner layers. Cracks that formed in the bark of older trees and the resistant chemicals might not exist in the cracked bark of the trees may probably permit the attack of termites on the trees[26]. Likewise, Rasib and Ashraf[25] examined the resistance that naturally exists in several wooden species against the *Coptotermes heimi* attack. The more over studied survival of the *C. heimi* on the sawdust of twelve commonly found wooden species of Pakistan in the laboratory. Based on the long life of soldiers and workers, *T. grandis* and *C. deodara* were stated for having resistance against termite attack, whereas the most susceptible species were, "*Picea smithiana*, *Salmalia malabarica* and *Acacia pindrow"*. In Jhang and Faisalabad Districts a survey was conducted on termite infestation on the trees linked with agricultural farms and discovered that Sheesham (*D. sissoo*) and Kikar (*A. Arabica*) are very common trees located beside the border of various crops farm. These trees are the source of timber for agriculturalists for many purposes. The research work was carried out in the District of Lahore, where the most commonly planted tree is *P.* × *euramericana*. The commercial applications and thick canopy of *P.* × *euramericana* make it the favorite cultivated plant. Due to this reason, *P.* × *euramericana* is extremely infested by *C. heimi* in the Lahore Region. The current study demonstrates that the information on feeding preferences earlier to bait is essential for the assessment of behavior towards feeding and the nutritive ecology of the species of termites. On the bases of termite feeding preference, the utmost palatable wooden species can be carefully chosen as an attractant material to increase the efficacy of the bait for an active program of termite baiting. The maximum palatable species of wood in the current study can be used for the detection of termites in natural conditions where other numerous reasonable means of food are too accessible. Weight loss, consumption and survival rate of different woods were assessed. *Cordia myxa* found the most attacked than *Cassia fistula* and thus more feeding was recorded on these wooden blocks and therefore, *Microtermes obesi* was noted in *Cordia myxa* and *Moringa oleifera* (39.15-33.00 g). On the other hand, minimum feeding was noted in *C. fistula* (1.41 g) and *Heterophragma adenophyllum* (24.38 g). Under the choice natural condition of the field, the lowest feeding was noted in *C. fistula* (1.41 g) and maximum feeding was observed in *Cordia myxa* (39.15 g). Feeding preferences in descending order based on consumption of wood as a quantitative parameter documented are as follows: *Cordia myxa moringa oleifera*, *Bombax ceiba*, *Bambusa bamboo*, *Syzygium cumini*, *Albizia lebbeck*, *Dalbergia sissoo*, *Psidium guava*, *Pinus roxburghii*, *Acacia nilotica*, *Bauhinia variegata*, *Azadirachta indica*, *Eucalyptus camaldulensis*, *Mangifera indica*, *Heterophragma adenophyllum* and *Cassia fistula*. In other parts of the world termite investigators have tried to control using, Microbes, IPM approaches, termite as ecological indicators, toxicity and horizontal transfer, composite gel, baits application, nanocapsules, sociality and control, molecular studies, diverse field applications of fipronil, cellulose baiting matrix and chemical application.

## CONCLUSION

The pairing of susceptible and resistant wooden species can prevent wood damage by termites. Since food choices are almost always available to termites in nature, bait attractiveness is of critical importance for bait performance. Feeding bioassays for an effective baiting strategy could prove beneficial in developing and improving the efficiency of bait while choosing the most palatable wooden species. Studies in the future on extracts of the most resistant wood in eco-friendly termite management can reveal the analysis of resistant components and wood resistance could be an actual goal.

## SIGNIFICANCE STATEMENT

This study discovers two new species of wood which has allowed us to update the exciting data on a pestiferous termite. Thus, this discovery will allow reorienting the knowledge on termite control in improving and developing a bait for the effective termite control.

## ACKNOWLEDGMENT

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