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# RESPONSE OF SUBTERRANEAN TERMITE *AMITERMES DESERTORUM* (Desneux) TO WOOD EXTRACTS OF NEEM, BOLONIA AND GAMBOSIA TREES

Hoda. M. Abd El Wahab

Zoology Department , Faculty OF Science, South Valley University, Aswan, Egypt

## *ABSTRACT*

*The heart wood and sap wood interface of the Azadirachta indica (Meliaceae), and Bolonia sp. (Ascelpedaicea) are found resistant to attack by the subterranean termite Amitermes desertorum (Desneux). While the Pleiognium solandari (Moraceae) is found susceptible.*

*Successive extraction with pentane, acetone, ethanol and water reduced the resistance to the termites.*

*Generally, percentages of termite survival were significantly higher on extracted sawdust of the three tested wood types than on the original sawdust or on the filter papers treated with all solvents except water. The results indicated significant differences between the solvents. The best solvent system for removing the detrimental materials from the two resistant woods can be ordered ethanol, acetone, pentane and water, respectively.*

*To improve the durability of timbers susceptible to termites attack, ethanol extract of the two resistant timbers was applied to the sawdust of susceptible timber. It was found that the extracted compounds by ethanol rendered the susceptible wood species resistance, and the termites could not live on it more than two weeks.*

*The obtained results would be of value for using of certain extraction(s) from resistant timbers for protection of susceptible ones.*

## INTRODUCTION

Subterranean ground nesting termites, are world wide distributed including all uper Egypt. It was found that subterranean

termite family Termitidae, genus Amitermis could attack and cause severe damage to many different crops and trees ( Haverty and Nutting, 1974; Hott and Coventry, 1982; and Kumar, 1989). Other literature (Smythe and Carter, 1970; Ali *et al.*, 1982; and Lai *et al.*, 1983) recorded that the species *desertorum* belonging the previous genus has the same property. In 1976, El-Hemasy observed that *A. desertorum* (Desneux) infesting young and old live trees and shrubs in Aswan, Egypt.

An counteraction of this problem was tried by seeking for woods having natural resistance to termites (Bultman *et al.*, 1978). Wood may contain various inclusions: that are collectively called extractives. They are not part of the wood substances, but are deposited in cell lumina and cell walls (George, 1968). These extractives can be isolated by many different solvents. The various effects of the extractives on these insects include attractivity, repellence, toxicity, stimulation or inhibition of feeding and growth( Carter, 1976; French *et al.*, 1979; Ahmed said and Hamami, 1983; Hanif *et al.*, 1988; Scheffrahn, 1991 and Reyes-Chilpa *et al.*, 1995).

In this study, three tree species were selected: 1- the neem tree, *Azadirachta indica* renowned, especially in India and some areas of Africa, for its anti-insect properties (Gullan and Cranston, 1994). 2-The Bolonia tree *Bolonia sp.* newly introduced in Egypt from China and its nursery-plant transplant in the Botanical Island of Aswan governorate. 3-The Gambosia tree *Pleiognium solandari,* which proved susceptible to termites attack.

The aim of the present work is testing the response of this pest *A. desertorum* to : 1-Solvent- extracted sawdusts of the three tree species, 2-Filter papers treated with wood extracts. 3-Susceptible wood sawdusts treated with ethanol extract of resistant woods.

## MATERIALS AND METHODS

Termites :Termite workers from colony of subterranean termite, *Amitermes desertorum* "Desneux" were used as test insects. (insects beyond the 3rd stage ).

Woods: Three wood species, Viz.; neem, *Azadirachta indica* (Meliaceae) Bolonia, *Bolonia sp.*, (Ascelpedaicea) and gambosia, *Pleiognium solanderi* (Moraceae) were collected from the Botanical island in Aswan city. Wood samples were chosen from branches, not less than 10 cm in diameter of living trees. These left to dry out of door, for a period of three months, separated stacks were prepared from the heart wood and sapwood interface precisely. Wood specimens Of 2 x 2 x 1 cm. were prepared and over dried at 105 C( for 24 hr.

Solvents : Four solvent systems were used for the extraction of materials from wood. These systems were N-Pentane, Acetone, Ethanol and Water.

Sawdusts : Each wood of the three species was ground as sawdust in order to facilitate the extraction.

**Preparation of extracts :**

For this purpose, a 50 g. sample of sawdust of each wood was placed in a flask with 300 ml of the first solvent n-pentane, blended for 5 minutes and extracted at room temperature. Eight consecutive extractions were applied with n-pentane solvent. For the first extraction, a mixture of the sawdust and solvent was allowed to stand for one hour and then filtered. In the subsequent extraction, 50 ml fresh solvent was added to the residue, the mixture was blended for 4-5 minutes and then filtered, and the process was repeated. The extracts were combined, refiltered and collected in bottles and kept in a refrigerator for the subsequent tests.

Approximately, 10g. of the sawdust was set aside after extraction for the feeding tests. After the extraction with n-pentane, the 40g of the residual preextracted sawdust was placed in a soxhlet apparatus to be extracted with two successive solvent, acetone, and ethanol. Ten grams of the sawdust was set aside after each extraction for the feeding tests also. The extracts for every solvent were collected in bottles and flasks then were kept for later use. In case of water as a solvent, the 20 grams residue sawdust was placed in a conical flask and extracted by water at room temperature in the same way as described before. So, four successive extractions were obtained.

**Force Feeding Test on :**

A - Unextracted sawdusts (Original)
B - Solvent - extracted sawdusts
C - Wood extracts on paper pads

The amount of extract added to the paper pads was equivalent to that extracted from 2g. of wood. Small pieces (3 cm diameter ) of paper pads were dipped in the extract solution and dried at room temperature for 1 hr. Paper pads treated with pure solvents were used as control. Samples (2g) of extracted sawdust and unextracted sawdust, treated and untreated paper pads were placed separately in plastic containers 15 cm diameter and 3.5 cm height and 100 workers were released into each container. The test materials were kept in an incubator at 25-26 C. Three replicates with a total of 300 termites individuals were used.

Weekly observations were made and the numbers of surviving termites were recorded until the end of the experiment (5 weeks).

D - Susceptible sawdusts treated with ethanol extract of a

resistant wood species.

That trial was carried out to test survival of the tested termite on susceptible wood sawdust treated with ethanol extract of resistant wood species. Sawdust of the suscebtible wood, Pleiognium solandari was treated with ethanolic extracts of resistant woods,Azadirachta indica and Bolonia sp The amount of ethanol extract of a resistant wood species added to the susceptible sawdusts was equivalent to that extracted from 2g. of wood. The treated sawdusts was placed in plastic containers ( 5 cm diameter and 3.5. cm height ) , and packed with 50 g sterile sand. The sand was moistened with 7 of distilled water to keep relative humidity near saturation.100 workers were released into each container. The test materials were kept in an incubator of 26°C. Three replicates with a total of 300 termites individuals were used. Weekly observations were made and the numbers of surviving termites were recorded in each replicate until the end of the experiment ( 5 weeks).

**The statistical analysis:**

The obtained data were transformed to their arcsigns, as they were percentages. The resulted (transformed data) were analyzed using factorial analysis of Mstat-C computer program, Michigan State University. The interaction effects were neglected and their mean squares were used as the error.

## RESULTS AND DISCUSSION

(Table 1) and (Fig1) represents a comparison between survival percentage of *A. desertorum* on original sawdust (unexctrated) and successive extracted ones. (Table 2) and (Fig.2) represent percentages of the same pest maintained on unextracted sawdusts of different timbers compared with those maintained on filter paper

Table (1) : Survival percentage of *Amitermes desertorum* on sawdust extracted with different solvents in force feeding test of 5weeks.

| Wood Scientific Name | Sequencely Survival in Percent on | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unextracted* Sawdust (Original) | | | | | Extracted sawdust by different solvents | | | | | | | | | | | | | | | | | | | |
| | | | | | | Pentane | | | | | Acetone | | | | | Ethanol | | | | | Water | | | | |
| | Week | | | | | Week | | | | | Week | | | | | Week | | | | | Week | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| *Azadiracht a indica* | 87 | 52 | 12 | 2 | 0 | 100 | 100 | 100 | 56 | 22 | 100 | 94 | 73 | 30 | 0 | 100 | 96 | 82 | 30 | 15 | 100 | 98 | 25 | 21 | 0 |
| *Bolonia sp.* | 68 | 34 | 15 | 3 | 0 | 100 | 96 | 96 | 45 | 35 | 100 | 100 | 38 | 33 | 0 | 100 | 92 | 84 | 70 | 22 | 100 | 96 | 62 | 24 | 0 |
| *Pleiognium solanderi* | 100 | 100 | 84 | 31 | 22 | 100 | 92 | 84 | 45 | 28 | 100 | 96 | 60 | 34 | 33 | 100 | 75 | 72 | 50 | 24 | 100 | 96 | 64 | 37 | 35 |

Every week (Means of 3 replicates)

Table (2) : Survival percentage of *Amitermes desertorum* on filter paper treated with solvent extracts of certain wood species in force feeding test of 5 weekks.

| Wood Scientific Name | Sequencely Survival in Percent on | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unextracted* Sawdust (Original) | | | | | Filter paper treated with extrats of: Pentane | | | | | Acetone | | | | | Ethanol | | | | | Water | | | | |
| | Week | | | | | Week | | | | | Week | | | | | Week | | | | | Week | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| *Azadirachta indica* | 87 | 52 | 12 | 2 | 0 | 39 | 36 | 30 | 0 | 0 | 48 | 24 | 10 | 0 | 0 | 54 | 21 | 0 | 0 | 0 | 100 | 92 | 24 | 7 | 0 |
| *Bolonia sp.* | 68 | 34 | 15 | 3 | 0 | 74 | 24 | 17 | 0 | 0 | 44 | 30 | 4 | 0 | 0 | 46 | 13 | 0 | 0 | 0 | 100 | 83 | 43 | 15 | 0 |
| *Pleiognium solanderi* | 100 | 100 | 84 | 31 | 22 | 100 | 100 | 78 | 45 | 22 | 68 | 15 | 0 | 0 | 0 | 100 | 77 | 29 | 4 | 0 | 100 | 100 | 77 | 65 | 42 |

| Filter papers treated with pure solvents | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Untreated filter paper* | | | | | | Pentane | | | | | Acetone | | | | | Ethanol | | | | | Water | | | | |
| 100 | 100 | 100 | 100 | 85 | 100 | 100 | 71 | 0 | 0 | 100 | 93 | 83 | 0 | 0 | 90 | 83 | 63 | 51 | 34 | 100 | 100 | 100 | 91 | 90 |

* L.S.D. value between the solvent species = 4.91
L.S.D. Value between the five weeks of filter paper treated with extract = 9.82
L.S.D. Value between the timber species = 4.35

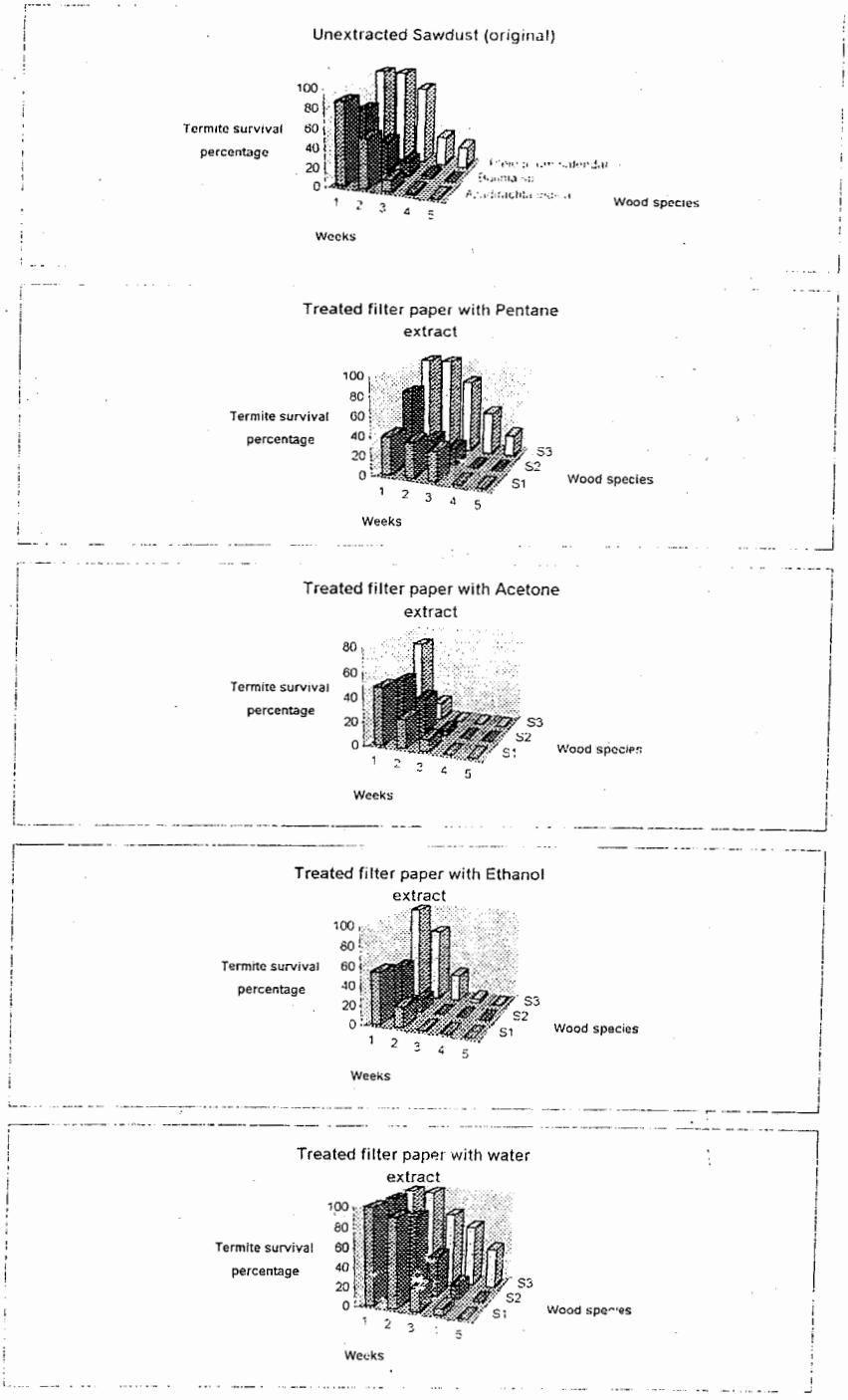


Fig. (2). Survival of *A. desertorum* on untreated and treated filter paper with different solvents extracts in force feeding tests for five weeks (Ref. Table, 2)

treated with different extracts. From these two (tables 1,2) and (Figures 1,2) the following could be evident :

The first extraction (pentane) : when sawdust of *Azadirachta* and *Bolonia* timber were extracted in the first step with pentane ,the survival of termites improved through the time of experiment, whereas the survival was not significantly affected in case of *Pleiognium* timber.when termites maintained on filter paper treated with pentane extract (table 2) ,their survival decreased greatly due to *Azadirachta* and *Bolonia* timber extracts. The degree of decreasing was high on Bolonia following by *Azadirachta,* and the termites could not live more than three weeks. This may indicate that pentane has removed certain chemical compounds responsible for resistance from the wood species.Accordingly, the extracted sawdusts of these species became more suitable for the survival of termites.

The second extracts (Acetone): When sawdust of each timber was extracted with acetone after pentane (sequential extraction), the survival of termites significantly increased throughout the trial. Termites survival decreased greatly when they were maintained on filter paper treated with acetone extracts. The results of this experiment showed that the sawdusts became more preferable to termites than the original ones which were not extracted. This means that acetone had removed some additional anti-survival substances making the sawdusts better for termites than the unextracted ones. The detrimental substances which were extracted from the three wood species made the filter paper unsuitable for the survival of termites, which lived only 3 weeks on the treated filter paper in case of *Azadirachta* and Bolonia timbers.Although the unext -racted *Pleiognium* timber is susceptible to the termites attack it was observed that the termites lived only for two weeks when fed on filter paber treated with its acetone extract. This could be interpreted that

the acetone solvent system could combine with the extracted the substances existing in this timber, and may be not suitable for *Pleiognium* extraction. 83% of termites lived 3 weeks on the filter papers treated with pure acetone. These results are in agreement with that found by: Carter *et al.* (1983) who stated that acetone extracts of *Cedrela odorata* and *Ocetea cymbarum* had a repellent effect to the Formosan subterranean termite. Also Hanif *et al.* (1988) found that termite longevity was reduced by extractives obtained from *Pinus oxyburghi* with acetone. Sayed (1991) observed that acetone was effective in removing antitermitic materials from sidder and Nile acacia timbers.

The third Extraction (Ethanol): Sawdusts of the three timbers extracted with ethanol after acetone, and filter paper treated with pure ethanol caused improved survival of termites through the five weeks of experiment. Generally, the extracted sawdusts were more suitable than the original ones. Filter papers treated with ethanol extracts of *Azadirachta* and *Bolonia* timbers caused death of termites after two weeks.In comparison,those treated with *Pleiognium* timber extract ,survived 4 weeks, whereas in control group 34% of termites lived for 5 weeks.The result indicate that ethanol is capable to extract detrimental compounds from *Azadirachta* and *Bolonia* timber. Becker (1969) recorded that his test wood contains a termite repellent substance which can be extracted by alcohol. In 1991, Sayed observed that the survival of termites on untreated filter paper is higher than on treated with sidder and red gum ethanol extracts.

The fourth Extraction (with water): Water extraction was the last step in the successive extraction. The survival of the termites on extracted *Azadirachta* and *Bolonia* timber was higher along 4 weeks than that on the unextracted ones. The same result was observed in case of *Pleiognium* timber but for 5 weeks. The treated filter papers

with water extractions of tested timbers (Table 2) showed higher termite survival than those of the unextracted and extracted sawdust. This indicates that water is very weak in extracting the antitermitic substances. These findings are in agreement with that found by Ahmed and Rahim (1986) who reported that water was the least effective solvent for removing anti-termites substances. From the previous results it is quite clear that ethanol is the best solvent system for extracting the detrimental materials from *Azadirachta* and *Bolonia sp.*, acetone and ethanol appear not suitable solvent in case of *Pleiognium*, that the survival of termites decreased on filter papers treated with it is acetone and ethanol extracts.

Survival of termites Maintained on susceptible woods treated with resistant wood extract:-

In an attempt to modify the durability of susceptible timbers to termite attack. ethanol extract of the resistant timbers (*Azadirachta indica* and *Bolonia sp.*) was applied to the sawdusts of susceptible timber (*Pleiognium solanderi*).

From (Table 3) it is evident that survival was drastically decreased after 1 week on the *Pleiognium* treated sawdusts.The survival decreased from 100 to 28% on *Pleiognium* sawdust treated with Azadirachta extract, and from 100 to 29% on Pleiognium sawdust treated with *Bolonia* extract. After 2 weeks of the survival on sawdusts treated with *Azadirachta* and *Bolonia* extract were 18.7% and after 3 weeks no termite could survive on *Azadirachta* extract treated sawdust.

This experiment showed that the susceptible wood species became very unfavorable for the survival of termites after treatment with ethanol extracts of the resistant timbers. Also ,it indicates that ethanol could remove certain anti-termitic substances from the

resistant wood species, *Azadirachta indica* and *Bolonia sp.* These extracted compounds made the susceptible wood species resistant.

Termite feeding on filter paper treated with extracts of tested timbers by using different solvent (Table 2) indicated variable differences on the survival of termites.

Average termite survival for pentane and water treatment were 76.07 and 74.19, respectively. The observed difference was not significant. The Average termite survival for acetone and ethanol treatment were 61.52 and 64.74, respectively. This difference also did not reach the significant limit. But the two groups show significant difference (Table 4).

The termite survival significantly decreased along the experiment period from 99.58 at the experiment starting to 12.79 at the end of the experimental period.

The results of the statistical analysis partitioned the wood type used in the present investigation to two groups, Susceptible one, gambosia timber which giving 59.02 termite survival. The second group consisted of neem and bolonia timbers which give average termite survival about 50.71 and 50.74, respectively. The average termite survival significantly differed between the two groups.

## CONCLUSION

The present work showed that the termite survival varied with the wood species and solvent used. By using suitable solvent system certain repellent, antifeeding, anti-survival or anti-termite agents could be extracted from some resistant wood species to be used for management of termite pests and for protection of other susceptible woods.However,further investigations are needful the analysis of the extractives which lead to development of repellents or feeding deterrents.

Table (3) : Survival percentage of *Amitermis desertorum* on sawdusts of susceptible wood treated with Ethanol extract of two resistant wood in force feeding test.

| Susceptible wood | Survival % on | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Survival % on | | | | | | | | |
| | Control | | | *Azadirachta (resistant)* | | | *Bolonia (resistant)* | | |
| | After | | | After | | | After | | |
| | 1 week | 2 weeks | 3 weeks | 1 week | 2 weeks | 3 weeks | 1 week | 2 weeks | 3 weeks |
| | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean |
| *Pleiognium solandor* | 100 | 100 | 19 | 28 | 18.7 | 0 | 29 | 0 | 0 |

Means are calculated from 3 replicates after the mentioned weeks.

Table (4) : Average survival of different treatments.

| | Average survival | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Solvent | | | Wood type | | | Weeks | |
| | transformed data | transformed data | | transformed data | transformed data | | transformed data | transformed data |
| *Original* | 50.20 | 59.02 | Untreated FP | 59.85 | 74.77 | 1 | 86.30 | 99.58 |
| *Pentane* | 60.71 | 76.07 | Neem | 50.71 | 59.89 | 2 | 75.96 | 94.12 |
| *Acetone* | 51.66 | 61.52 | Bolonia | 50.74 | 59.95 | 3 | 58.30 | 72.39 |
| *Ethanol* | 53.57 | 64.74 | Gambosia | 59.02 | 73.78 | 4 | 34.09 | 31.41 |
| *Water* | 59.47 | 74.19 | | | | 5 | 9.82 | 12.79 |
| *L.S.D.* | 4.91 | 42.5 | L.S.D. | 4.35 | 33.70 | L.S.D. | | 42.5 |

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## أستجابه النمل الابيض التحت أرضى أميترمس ديزرتورم (ديزينوكس) لمستخلصات أخشاب أشجار النيم، البولونيا والجامبوزيا

وجد أن الجزء المتداخل من الخشب الصميمى والخشب العصارى لنوعى الخشب الأزاديرشتا انديكا (النيم) والبولينيا (بولينيا) كان مقاوم لهجوم النمل التحت الأرضى اميترميس ديزرتورم. بينما كان خشب البليوجنيم سولانداري (الجامبوزيا) حساس .

الاستخلاص المتتابع بمذيبات البنتان، الأسيتون، الإيثانول ثم الماء يؤدى إلى نقص مقاومه الاخشاب للنمل الابيض. عموما، كانت النسب المئوية لبقاء النمل حيا معنوية أكثر على نشارة الأخشاب الثلاثة السابق استخلاصها عنها فى حاله النشارة الأصلية (الغير مستخلصة) أو فى حاله أورق النشاف المعاملة بكل أنواع المذيبات فيما ما عدا الماء .

أوضحت النتائج إن افضل مذيب استخدم فى عزل المواد المعوقة أو المانعة للتغذية من نوعى الخشب المقاوم كان الأيثانول ثم الأسيتون فالبنتان ، وأخر هم الماء .

لتحوير الخشب الحساس لهجوم النمل استخدم مستخلص الايثانول لنوعى الخشب المقاوم وعوملت به نشارة الخشب الحساس .

وجد بالتجربة إن المركبات المستخلصة بواسطة الايثانول جعلت الخشب الحساس ضار بالنسبة للافه حيث لم يستطيع النمل البقاء حيا عليه أكثر من أسبوعين .

هذا البحث يدعم فكرة استخدام بعض مستخلصات الأخشاب المقاومة فى حماية أنواع الاخشاب الحساسه للاصابه .