UNCONVENTIONAL CONTROL OF DRY WOOD TERMITE *CRYPTOTERMES BREVIS* (WALK.) (FAMILY KALOTERMITIDAE)

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Abstract

Obtained results of using inorganic salts, Zinc chloride, Copper sulphate, Borax and Boric acid as wood preservatives against *Cryptotermes brevis* (Walk.). revealed the following data, Zinc chloride ,Copper sulphate and Borax gave 100 % mortality at the 6th week of treatment at 16 x10000 ppm.. While Boric acid, gave 100% mortality at the same period of time at 2 x 10000 ppm.
Inorganic oils, $CAPL_I$, Masrona, and $CAPL_{II}$ gave complete mortality at the 10th week of treatment at concentration of 32 x 10000 ppm.

INTRODUCTION

Dry Wood Termites, *Cryptotermes brevis* (Walk.), Family Kalotermitidae ,order Isoptera, infest the structural timbers of buildings, furniture and other dry timbers having less than 12% timber moisture content. This termite species require no ground contact and obtain their required moisture intake from the timber they infest. And they are sometimes called "powder-post" termites or "furniture" termites due to their small faecal droppings and the fact that they commonly attacks timber and furniture.

(Inoue 1982), found that the main wood preservatives used for protection of wood used in building construction against decay and termites infestation are creosote oil, phenol-fluoride, chromium-copper-arsenate and oil born chemicals such as chlordane which is very widely accepted as the only chemical among chlorinated hydrocarbons.

El-Sebay (1991), studied the effect of borone as wood preservative against two wood borers *Lyctus africanus* and *Sinoxylon sudanicum*. The author found that vaccum-impregnation of seasoned wood by 4% of boric acid equivalent of 117 p.p.m. of borone is most effective technique against wood borers and gave 100% mortality for new infestation over 3 years of protection.

Also the effects of inorganic salts copper sulphate, sodium fluoride and borax against nymphs of the drywood termite *C. brevis* Walker were studied by Moein and Farrag (1997). Sulastiningsih (2000) tested the effect of alfamethrin as wood preservative of particleboard used as furniture components against the attack by the subterranean termite (*Coptotermes formosanus*) and the drywood (*Cryptotermes Cynocephlus*) termite.

MATERIALS AND METHODS

Experiments were conducted at Wood Borers and Termite Res. Dept. PPRI, during 1999-2001. Unconventional materials were tested against *C. brevis* termite as follows :

Inorganic compounds, Zinc chloride, Borax, Copper sulphate and Boric acid

A weight of 20 grams of each compounds were dissolved in water to obtain a constant volume of 100 ml. to obtain the concentration of 20×10^4 p.p.m. as a stock solution for each compound. Volumes of 2.5, 5, 10, 20, 40 and 80 ml from stock solution were diluted in water to obtain constant volume of 100 ml. which represent the 6 concentrations 0.5×10^4, 1×10^4, 2×10^4, 4×10^4, 8×10^4, and 16×10^4, p.p.m. for each compound, respectively.

Petroleum oil fractions,($CAPL_I$), ($CAPL_{II}$) and Masrona oil

A volume of 40 ml of each petroleum oils was completed by water until 100 ml to obtain a concentration of 40×10^4 p.p.m. as a stock solution for each oil. Volumes 2.5, 5, 10, 20, 40, and 80 ml from stock solution were diluted by water to reach 100 ml to obtain 1×10^4, 2×10^4, 4×10^4, 8×10^4, 16×10^4 and 32×10^4 p.p.m. for each oil, respectively.

Fourth and Fifth nymphal instars were exposed to the different compounds in the Mirbecks wooden blocks (4 × 2 × 2 cm.) perforated with a rectangular chamber (2 × 1 × 1 cm.). One milliliter of each concentration of the compound to be tested was carefully pipette and evenly poured into the chamber, to insure equal distribution the blocks were shacked well until complete absorption at the room conditions (temperature 27 ± 1 °C and R.H. 70 ± 5 %) , all chambers were left for 24 hours till dry. Ten large and active nymphs were then introduced into each wooden blocks.

Six concentrations were used for each treatment and each treatment was replicated three times. The control wooden blocks were treated with water only. Before exposing the nymphs to treated, they were starved for 6 hours in order to obtain rapid simultaneous ingestion of the contaminated food.

Statistical analysis

1-Mortality percentages were recorded weekly and were corrected according to Abott 1925.

2-The results obtain were used for probit analysis according to Finney (1971).

3- Combination treatment: to find out the joint toxicity of combined action, the simple method of Sun and Johnson (1960) was followed.

$$\text{Co-toxicity factor} = \frac{\text{Observed \% mortality} - \text{Expected \% mortality}}{\text{Expected \% mortality}} \times 100$$

This factor was used to differentiate the results into three categories. Appositive factor of 20 or more meant potentiation, a negative factor of 20 or more meant antagonism, and any intermediate value (i.e., between -20 and + 20) was considered only additive effect.

RESULTS AND DISCUSSION

1- Effect of Inorganic compounds

The large nymphs of *Cryptotermes brevis* were introduced in treated wooden blocks of Mirbecks oak (*Quercus mirbekii*) by different concentrations of Zinc chloride, Copper sulphate, Borax and Boric acid. The differences in percentages of weekly nymphal mortality of *C. brevis* are presented in (Tables 1, 2, 3 and 4), while the calculated LC_{50} and LT_{50} values are shown in (Tables 5 and 6).

Zinc chloride treatment

The corrected mortality percentages after 3 weeks for the large treated nymphs of *C. brevis* with Zinc chloride were ranged from 16.67 to 80.00 % while those of the 4th week were from 23.33 to 86.67 % opposed to 26.67 to 93.33 % for the 5th week till the complete mortality after 6th week (Table 1).

As shown in (Table 5) the LC_{50} values were 4.11, 2.33 and 1.67 × 10^4 p.p.m. for the 3rd , 4th , and 5th week, respectively.

Data of LT_{50} values (Table 6) indicated a negative relationship between the applied concentration of Zinc chloride and LT_{50} values i.e. the shorter LT_{50} occurred by increasing Zinc chloride concentration. These values were 5.49, 3.99, 2.69 and 1.75 weeks using the concentration of 1.0, 2.0, 4.0 and 8.0 × 10^4 p.p.m., respectively.

In agreement with present results Balfas and Sumarni (1995) used the inorganic salt, Zinc chloride as a wood preservative by soaking specimens of two wood species *Pinus* and *Acacia* for 24 hours in a 98 % furfural alcohol as solvent containing 0.35 (V /V) of Zinc chloride.

Copper sulphate treatment

Data presented in (Table 2) revealed that the mortality percentages increased by increasing the tested concentration of Copper sulphate. At the 3rd week of treatment the mortality percentages ranged from 20.00 to 83.33 % and from 26.67 to 90.00 % for the 4th week, while for the 5th week it ranged from 36.67 to 93.33 % using concentrations treatments from 0.5 to 16.0 × 10^4 p.p.m., respectively .

The LC_{50} values were 2.50, 1.72 and 1.26 × 10^4 p.p.m. (Table 5). Also a negative relationship appeared between the applied concentration of Copper sulphate and the LT_{50} values. These values were 6.53, 4.90, 3.08, 2.05 and 1.42 weeks at the concentrations of 0.5, 1.0, 2.0, 4. and 8.0 × 10^4 p.p.m., respectively. (Table, 6).

The obtained data concerning the effect of Copper sulphate on percent mortality of termite are in complete accordance with those recorded by Mostafa (1982)which indicated that mortality percentages of *Psammotermes hybostoma* increased gradually from 10 to 30 % for one day exposure to Copper sulphate (1 – 15 % concentrations) however after 3 days of exposure it was increased from 20 to 66 % . On the other hand he showed that percentages mortalities of *P. hybostoma* which were exposed to Copper sulphate for six days 1 to 15 % concentration was increased gradually from 43 to 90 % with LC_{50} of 1.5 %. Moein and Farrag (1997) indicated that the mortalities percentage of *C. brevis* increased from 8.33 to 68.89 % using Copper sulphate at 0.5 and 5 % concentration for 2 days exposure. The same authors in (1997) indicated that at 0.5 % concentration of Copper sulphate and long period of exposure (4 weeks) the obtained mortalities of *C. brevis* was 83.3 %.

Borax treatment

The corrected mortality percentages (Table 3) after 3 weeks for large nymphs of *C. brevis* treated with Borax were 23.33, 36.67, 56.67, 66.67, 76.67 and 86.67 % while in the 4^{th} week were 30.00, 43.33, 63.33, 73.33, 88.33 and 90.00 % opposed to 43.33, 53.33, 66.67, 80.00, 86.67 and 93.33 % in the 5^{th} week at concentrations of 0.5, 1, 2, 4, 8 and 16×10^4 p.p.m.

The corrected mortality percentages after 3, 4 and 5 weeks (at which LC_{50} were estimated) , increased by increasing borax concentrations (Table 3). Whereas as shown in (Table 5) the LC_{50} values were 1.99, 1.39 and 0.92×10^4 p.p.m. for the 3^{rd} , 4^{th} and 5^{th} week, respectively.

Also by regarding LT_{50} values (Table 6) a negative relationship could be detected between the applied concentration of Borax and LT_{50} values i.e. the LT_{50} was shorted with the increasing in Borax concentrations. These values were 6.04, 4.12, 2.51, 1.88 and 1.15 weeks for the used concentration of 0.5, 1.0, 2.0, 4.0, and 8.0×10^4 p.p.m., respectively.

The present results are in agreement with those of Mostafa (1982) who found that percentage mortalities of *P. hybostoma* increased gradually from 11 to 22 % for one day exposure to borax by using a filter paper dipped in water solutions of tested chemicals. However after 3 days of exposure it was increased from 16 to 43 % with LC_{50} at 25 %. On the other hand he showed that percentage mortalities after 6 days of exposure to 1 to 15 % attained 38 to 78 % with LC_{50} at 39 %. Also Salman and Sayed (1990) in their study carried out in the two southern governorates Assiut and New Valley on *P. hybostoma* in rural buildings, they reported that borax at the rate of 100 gm/l as chemical barrier maintain houses free from the infestation for 12 months.

Table 1. Corrected mortality rates for the drywood termite (*Cryptotermes brevis*) large nymphs treated with Zinc chloride.

Con. p.p.m.	Cumulative mortality % after weeks of treatment													Surviving nymphs reached the adult stage
	1 st	2nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	
0.00	0.0	0.0	3.33	3.33	3.33	6.67	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
½ × 10^4	3.33	6.67	16.67	23.33	26.67	28.57	28.89	37.03	44.44	44.44	44.44	44.44	44.44	
1 × 10^4	6.67	16.67	23.33	33.33	43.33	49.99	55.56	62.97	70.37	70.37	70.37	70.37	70.37	
2 × 10^4	10.0	23.33	33.33	46.67	56.67	60.71	70.37	77.78	85.19	85.19	85.19	85.19	85.19	
4 × 10^4	16.67	33.33	50.0	56.67	73.33	82.14.	92.85	100.0						
8 × 10^4	33.33	53.33	56.67	73.33	83.33	92.85	100.0							
16 × 10^4	56.67	66.67	80.0	86.67	93.33	100.0								

Table 2.Corrected mortality rates for the drywood termite (*Cryptotermes brevis*) large nymphs treated with Copper sulphate.

Con. p.p.m.	Cumulative mortality % after weeks of treatment													Surviving nymphs reached the adult stage
	1 st	2nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	
0.00	0.0	0.0	3.33	3.33	3.33	6.67	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
½ × 10^4	6.67	13.33	20.0	26.67	36.67	42.86	49.99	55.56	62.97	62.97	62.97	62.97	62.97	
1 × 10^4	13.33	23.33	33.33	40.0	46.67	49.99	55.56	62.57	74.08	74.08	74.08	74.08	74.08	
2 × 10^4	23.33	33.33	46.67	53.33	60.0	64.29	74.08	81.48	89.29	89.29	89.29	89.29	89.29	
4 × 10^4	30.0	43.33	53.33	70.0	76.67	85.72	92.59	100.						
8 × 10^4	43.33	53.33	76.67	83.33	90.0	96.43	100.0							
16 × 10^4	60.0	73.33	83.33	90.0	93.33	100.0								

Table 3. Corrected mortality rates for the drywood termite (*Cryptotermes brevis*) large nymphs treated with Borax.

Con. p.p.m.	Cumulative mortality % after weeks of treatment													Surviving nymphs reached the adult stage
	1 st	2nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	
0.00	0.0	0.0	3.33	3.33	3.33	6.67	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
½ × 10^4	10.0	16.67	23.33	30.0	43.33	42.86	49.99	59.26	66.67	66.67	66.67	66.67	66.67	
1 × 10^4	16.67	23.33	36.67	43.33	53.33	53.57	62.97	70.37	81.48	81.48	81.48	81.48	81.48	
2 × 10^4	26.67	36.67	56.67	63.33	66.67	71.42	81.48	92.59	100.0	100.0	100.0	100.0	100.0	
4 × 10^4	33.33	46.67	66.67	73.33	80.0	85.79	92.55	100.0						
8 × 10^4	46.67	66.67	76.67	83.33	86.67	92.85	100.0							
16 × 10^4	66.67	76.67	86.67	90.0	93.33	100.0								

Table 4. Corrected mortality rates for the drywood termite (*Cryptotermes brevis*) large nymphs treated with Boric acid.

Con. p.p.m.	Cumulative mortality % after weeks of treatment													Surviving nymphs reached the adult stage
	1 st	2nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	
0.00	0.0	0.0	3.33	3.33	3.33	6.67	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
½ × 10^4	16.67	23.33	30.0	43.33	53.33	64.29	74.08	74.08	74.08	74.08	74.08	74.08	74.08	
1 × 10^4	26.67	33.33	43.33	60.0	66.67	75.00	89.29	89.29	89.29	89.29	89.29	89.29	89.29	
2 × 10^4	46.67	56.67	63.33	83.33	93.33	100.0								
4 × 10^4	53.33	63.33	76.67	93.33	100.0									
8 × 10^4	66.67	76.67	86.67	100.0										
16 × 10^4	80.0	93.33	100.0											

In the same trend Moein and Farag 1997 reported that borax had an effect against nymphs of the drywood termite *C. brevis* by using block of sapwood *Picea sp.* which were impregnated with the treated chemicals, they indicated that mortality percentages was 0.00 % after 2 days exposure at 0.5 % concentration whereas at 5 % concentration the corresponding result was 26.67 % and increased to 100 % after 4 weeks of exposure.

Boric acid treatment

Weekly mortalities among treated *C. brevis* large nymphs are shown in Table (4) , the corrected mortality percentages after 3 weeks of treatment increased by increasing Boric acid concentration and ranged from 30.00 to 100.00 % at the concentrations of 0.5 to 16 × 10^4. the corresponding values for the 4^{th} week were from 43.33 to 100.00 % while those of the 5^{th} week ranged from 53.33 to 100.00 %.The LC_{50} values were 1.32 after the 3rd week , 0.68 after 4^{th} week and 0.55 × 10^4 p.p.m. in the 5^{th} week (Table 5).

Data of LT_{50} values (Table 6) indicated a negative relationship between the applied concentration of boric acid and LT_{50} values i.e. the shorter LT_{50} occurred by increasing boric acid concentrations. These values were 4.43, 2.85 and 1.37 weeks by using the concentration of 0.5, 1.0 and 2.0 × 10^4 p.p.m.

These results are in complete concordance with those found by Tisseverasinghe (1974) who reported that the use of boric acid at 1.0, 2.0, 3.0 and 10.0 % against the drywood termite *Cryptotermes domesticus* in wood will be toxic to this termite and the reduction of survival was in a progressive increase as the concentration increase. In the same trend Mostafa (1982) indicated that the boric acid was the most potent compound against workers of *P. hybostoma* from New Valley Governorate with LC_{50} of 84 % and 1 % concentration level after exposure for 3 to 6 days , respectively. Also El-Sebay (1991) indicated that vacuum impregnation of seasoned wood by 4 % of boric acid equivalent of 117 p.p.m. of borone is most effective technique against the wood borers, *Lyctus africanus* and *Sinoxylon sudanicum*, and he reported that the recommended concentration gave 100 % mortality over 3 years of protection. Klotz *et al.,* (1998) evaluated the toxicity of boric acid in different concentrations against the Argentine ant *Linepithema humile* (Mayr) by using a different concentrations of sucrose in water as a liquid bait. They found that at dose range from 0.2 to 1 % (wt: vol.) boric acid, LT_{50} ranged from 5.6 day to 1.4 day in 10 % sucrose water and over a 10 week duration no significant change appeared in out population numbers.

Conclusion The usage of inorganic compounds, Zinc chloride, Copper sulphate (cupric sulfate pentahydrate) , borax (sodium tetraborate decahydrate) and boric acid. These compounds were used as a wood preservative where they work on the alive

internal fauna in the termite and causing anti-feeding due to preventing digestions of food through the midgut. The present work is promising to use different inorganic compounds against drywood termite in some materials where chemicals are harmful such as historical wood articles and mommies.

Table 5. Comparative toxicities of large nymphs *Cryptotermes brevis* treated with inorganic compounds.

Treatments	After (weeks)	LC_{50} p.p.m.	Confidence limits (Po 0.05)	Slope
Zinc chloride	3	4.11×10^4	$3.39 \times 10^4 : 5.06 \times 10^4$	1.306
	4	2.33×10^4	$1.90 \times 10^4 : 2.84 \times 10^4$	1.264
	5	1.67×10^4	$1.37 \times 10^4 : 2.00 \times 10^4$	1.443
Copper sulphate	3	2.50×10^4	$2.05 \times 10^4 : 3.04 \times 10^4$	1.282
	4	1.72×10^4	$1.39 \times 10^4 : 2.08 \times 10^4$	1.335
	5	1.26×10^4	$0.99 \times 10^4 : 1.54 \times 10^4$	1.347
Borax	3	1.99×10^4	$1.60 \times 10^4 : 2.43 \times 10^4$	1.245
	4	1.39×10^4	$1.08 \times 10^4 : 1.71 \times 10^4$	1.252
	5	0.92×10^4	$0.67 \times 10^4 : 1.19 \times 10^4$	1.165
Boric acid	3	1.32×10^4	$1.06 \times 10^4 : 1.60 \times 10^4$	1.432
	4	0.68×10^4	$0.54 \times 10^4 : 0.83 \times 10^4$	1.924
	5	0.55×10^4		2.254

Effect of petroleum oil fractions

2- Efficiency of different mineral oils against drywood terminate

1-$CAPL_I$ treatment

The corrected mortality percentages after 4 weeks for *C. brevis* large nymphs treated with $CAPL_I$ were ranged from 23.33 to 86.67 % while those of the 5th week were from 26.67 to 86.67 opposed to 33.33 to 90.00 % for 6th week but for 7th week they were 36.67 to 93.33 %. (Table 7).

The corrected mortality percentages after 4, 5, 6 and 7 weeks (at which LC50 were estimated) increased by increasing $CAPL_I$ concentrations (Table 7). However as shown in (Table 10) the LC50 values were 3.83, 3.12, 2.43 and 2.05 × 104 p.p.m. for the 4th , 5th, 6th and 7th week, respectively.

Table 6. Comparative mortality of inorganic compounds on large nymphs of Cryptotermes brevis.

Concentrations (p.p.m.)	LT_{50} (weeks)	Confidence limits of LT_{50} at Po 0.05	Slope
Zinc chloride			
1×10^4	5.49	5.03 : 6.04	2.318
2×10^4	3.99	3.66 : 4.34	2.491
4×10^4	2.69	2.43 : 2.94	2.705
8×10^4	1.75	1.47 : 2.00	2.152
Copper sulphate			
0.5×10^4	6.53	5.91 : 7.34	2.185
1×10^4	4.90	4.40 : 5.48	1.845
2×10^4	3.08	2.72 : 3.43	1.956
4×10^4	2.05	1.77 : 2.32	2.192
8×10^4	1.42	1.17 : 1.64	2.290
Borax			
0.5×10^4	6.04	5.44 : 6.82	1.983
1×10^4	4.12	3.73 : 4.58	1.984
2×10^4	2.51	2.19 : 2.82	2.012
4×10^4	1.88	1.59 : 2.15	2.054
8×10^4	1.15	0.84 : 1.42	1.793
Boric acid			
0.5×10^4	4.43	3.45 : 6.25	1.930
1×10^4	2.85	1.95 : 3.76	1.968
2×10^4	1.37		1.856

Data of LT_{50} values were presented in (Table, 11, and Fig11) indicated a negative relationship between the applied concentration of $CAPL_I$ and LT_{50} values i.e. the shorter LT_{50} occurred by increasing $CAPL_I$ concentration . These values were 10.07, 6.33, 4.00, 2.75, 2.73 and 1.39 weeks at the concentrations of 1, 2, 4, 8, 16 and 32 $\times$ 10^4 p.p.m., respectively.

2- Masrona oil treatment:

Data presented in (Table 8), indicated that at concentration of 1 to 32 $\times$ 10^4 p.p.m. of Masrona oil treatment, led to an increasing in the percentages of mortality among the treated large nymphs of *C. brevis* . After 4th week of treatment the mortality percentages ranged from 26.33 to 86.67 % wile those of the 5th week ranged from 30.00 to 90.00 % whereas in 6th week it ranged from 33.33 to 93.33 % but for the 7th week it goes from 36.67 to 93.33 %.

Table 7. Corrected mortality rates for the drywood termite (*Cryptotermes brevis*) large nymphs treated with $CAPL_I$.

Con. p.p.m.	Cumulative mortality % after weeks of treatment													Surviving nymphs reached the adult stage
	1 st	2nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	
0.00	0.0	0.0	3.33	3.33	3.33	3.33	3.33	6.67	6.67	6.67	6.67	6.67	6.67	
1×10^4	6.67	10.0	13.33	23.33	26.67	33.33	36.67	39.29	42.86	49.99	53.57	64.29	64.29	
2×10^4	10.0	16.67	30.0	40.0	43.33	46.67	53.33	53.57	60.71	64.29	71.42	75.00	75.00	
4×10^4	16.67	26.67	36.67	56.67	60.0	63.33	66.67	67.86	71.42	75.00	82.14	85.72	85.72	
8×10^4	23.33	33.33	46.67	66.67	73.33	76.67	83.33	85.72	85.72	89.29	89.29	92.85	92.85	
16×10^4	33.33	46.67	56.67	76.67	80.0	83.33	86.67	89.29	92.85	96.43	100.0			
32×10^4	43.33	50.0	73.33	86.67	86.67	90.0	93.33	92.85	96.43	100.0				

Table 8. Corrected mortality rates for the drywood termite (*Cryptotermes brevis*) large nymphs treated with Masrona oil.

Con. p.p.m.	Cumulative mortality % after weeks of treatment													Surviving nymphs reached the adult stage
	1 st	2nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	
0.00	0.0	0.0	3.33	3.33	3.33	3.33	3.33	6.67	6.67	6.67	6.67	6.67	6.67	
1×10^4	10.0	16.67	23.33	26.33	30.0	33.33	36.67	39.29	49.99	60.71	64.29	67.86	67.86	
2×10^4	13.33	23.33	33.33	43.33	46.67	53.33	56.67	57.14	60.71	64.29	75.00	82.14	82.14	
4×10^4	23.33	33.33	46.67	60.0	66.67	70.0	73.33	75.00	82.14	85.72	85.72	89.29	89.29	
8×10^4	33.33	46.67	63.33	73.33	76.67	80.0	83.33	82.14	85.72	89.29	92.85	96.43	96.43	
16×10^4	43.33	56.67	66.67	80.0	83.33	86.67	90.0	92.85	96.43	96.43	100.0			
32×10^4	53.33	66.67	76.67	86.67	90.0	93.33	93.33	96.43	96.43	100.0				

Table 9. Corrected mortality rates for the drywood termite (*Cryptotermes brevis*) large nymphs treated with $CAPL_{II}$.

Con. p.p.m.	Cumulative mortality % after weeks of treatment													Surviving nymphs reached theadult stage
	1 st	2nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th	13 th	
0.00	0.0	0.0	3.33	3.33	3.33	3.33	3.33	6.67	6.67	6.67	6.67	6.67	6.67	
1×10^4	13.33	16.67	23.33	33.33	36.67	40.0	43.33	42.86	46.43	53.57	60.71	71.42	71.42	
2×10^4	16.67	26.67	36.67	46.67	50.0	53.33	56.67	60.71	64.29	71.42	75.00	82.14	82.14	
4×10^4	26.67	36.67	46.67	63.33	66.67	70.0	73.33	75.00	82.14	85.72	92.85	96.43	96.43	
8×10^4	36.67	46.67	60.0	76.67	83.33	86.67	86.67	89.29	92.85	92.85	96.43	100.0		
16×10^4	46.67	60.0	73.33	83.33	86.67	90.0	93.33	92.85	96.43	96.43	100.0			
32×10^4	56.67	73.33	76.67	86.67	90.0	93.33	93.33	96.43	96.43	100.0				

The LC_{50} values were 3.13, 2.50, 1.96 and 1.69 × 10^4 p.p.m. (Table 10) for the 4th, 5th , 6th and 7th week, respectively. Data of LT_{50} values (Table 11) .indicated a negative relationship between the applied concentration of Masrona oil and LT_{50} values i.e. the shorter LT_{50} occurred by increasing Masrona oil concentrations. These values were 8.71, 5.35, 3.15, 2.00 and 1.43 weeks at the concentration of 1, 2, 4, 8, 16 × 10^4 p.p.m., respectively.

3- $CAPL_{II}$ treatment:

The corrected mortality percentages after 4th week were 33.33, 46.67, 63.33, 76.67, 83.33 and 86.67 % while they were 36.67, 50.00, 66.67, 83.33, 86.67 and 90.0 % in the 5th week, whereas, they were40.00, 53.33, 70.00, 86.67, 90.00 and 93.33 % in the 6th week but in 7th week they were 43.33, 56.67, 73.33, 86.67, 93.33 and 93.33 % (Table, 9).

AS shown in (Table 10) the LC_{50} values were 2.44, 1.97, 1.61 and 1.56 × 10^4 p.p.m. for the 4th, 5th , 6th and 7th week, respectively.

Data of LT_{50} values (Table 11) indicated that a negative relationship between the applied concentration of $CAPL_{II}$ and LT_{50} values. These values were 8.21, 4.83, 2.87, 1.83 and 1.34 weeks at the concentration of 1, 2, 4, 8, 16 × 10^4 p.p.m., respectively.

The results are in agreement with Deong (1928)concluded his finding that there is a positive correlation between the increase in the boiling range of some base oil like solar oil, lubrication paraffin oil, and the increase of insecticidal activity. Also the use of preservative solutions was studied by Nicholes (1972) who stated that preservative chemicals as light hydrocarbon oil has a significant effect on their transport into wood during impregnation and gave a protection against termite infestations. Davidson (1977) showed that the treatment of the southern pine posts with pentachlorophenol in used crank case oil extended the average life of posts against attack by termite. Whereas , Abd-El Nour (1980) mentioned that chemical preservatives proved effective in protecting Sudanese timbers against the sand termite *P. hybostoma* and he stated that brushing and dipping treatment by some chemicals such creosot oil afforded the test timber protection for up to eight years. Giron *et al.,* (1996) tested the efficacy of elemi oil against drywood termites *Cryptotermes* spp. and powder post beetles *Lyctus* spp. At 5.0, 10.0, 15.0 and 20.0 concentration levels. They showed that termites and powder post beetle sustained 88 % and 25 % mortality respectively at 20 % and these results indicated the potential of elemi oil in controlling drywood termites.
Generally, results indicate that, $CAPL_{II}$ is the best treatment for wood preservatives in different kind of row wood articles.

Table 10. Comparative toxicities of large nymphs *Cryptotermes brevis* treated with chemical compounds.

Treatments	After (weeks) (weeks)	LC_{50} p.p.m.	Confidence limits (Po 0.05)	Slope
$CAPL_I$	4	3.83×10^4	$3.06 \times 10^4 : 4.70\times10^4$	1.215
	5	3.12×10^4	$2.44 \times 10^4 : 3.86 \times10^4$	1.195
	6	2.43×10^4	$1.85 \times 10^4 : 3.05 \times10^4$	1.192
	7	2.05×10^4	$1.51 \times 10^4 : 2.60 \times10^4$	1.180
Masrona oil	4	3.13×10^4	$2.45 \times 10^4 : 3.88 \times10^4$	1.200
	5	2.50×10^4	$1.92 \times 10^4 : 3.10 \times10^4$	1.239
	6	1.96×10^4	$1.42 \times 10^4 : 2.52 \times10^4$	1.144
	7	1.69×10^4		0.999
$CAPL_{II}$	4	2.44×10^4	$1.82 \times 10^4 : 3.09 \times10^4$	1.118
	5	1.97×10^4	$1.46 \times 10^4 : 2.51 \times10^4$	1.200
	6	1.61×10^4	$0.57 \times 10^4 : 2.46 \times10^4$	1.140
	7	1.56×10^4	$1.14 \times 10^4 : 1.98 \times10^4$	1.315

Table 11. Comparative mortality of Petroleum oil fractions on large nymphs of *Cryptotermes brevis*.

Concentrations (p.p.m.)	LT_{50} (weeks)	Confidence limits of LT_{50} at Po 0.05	Slope
$CAPL_I$			
1×10^4	10.07	9.15 : 11.29	1.991
2×10^4	6.33	5.78 : 6.45	1.812
4×10^4	4.00	3.59 : 4.41	1.868
8×10^4	2.75	2.43 : 3.05	2.142
16×10^4	2.73	2.29 : 3.12	2.866
32×10^4	1.39	0.90 : 1.74	1.806
Masrona			
1×10^4	8.71	7.42 : 10.73	1.746
2×10^4	5.35	4.85 : 5.87	1.785
4×10^4	3.15		1.063
8×10^4	2.00	1.68 : 2.31	1.832
16×10^4	1.43	1.12 : 1.72	1.725
$CAPL_{II}$			
1×10^4	8.21	7.02 : 9.93	1.578
2×10^4	4.83	4.34 : 5.34	1.689
4×10^4	2.87	2.33 : 3.34	1.995
8×10^4	1.83	1.62 : 2.03	1.919
16×10^4	1.34	1.03 : 1.62	1.735

REFERENCES

1. Abbott, W. W. 1925. Method of computing the effectiveness of an insecticide. J. Econ. Entomol. 18: 265 – 267.
2. Abdel Nur, H. A. 1980. The natural durability of building wood and use of wood preservatives in the Sudan. Sociobiology, 5 (2): 175- 182.
3. Balfas, J. and G. Sumarni . 1995. Durability of Tusam (Pinus merkusii Jungh) and mangium (Acacia mangium Willd.) after furfurylation. Jurnal Penebtian Hasil Hutan 13 (7): 259-265.
4. Davidson, H. L. 1977. Comparison of wood preservatives in Mississippi . USDA Forest Service Research Note. FPL 1 : 16 pp.
5. Deong, E. R. 1928. Specifications for petroleum oils to be used on plants. J. Econ. Entomol., 21 : 697 – 702.
6. El-Sebay, Y. A. 1991. Studies on wood preservatives against certain wood borers attack. J. Agric. Res. Egypt, 69 (2): 127-132.
7. Finney, D. J. 1971. Probit analysis 3rd edition. Cambridge Univ., pp 333
8. Giron, M. Y., C. M. Garcia, M. San Pablo and B. A. Bawagan 1996. Efficacy of elemi (Canarium spp) oil against wood destroying organisms. FPRDI Journal 22 (2) : 49-53.
9. Inoue, Y. 1982. On the damage caused by termites and termite control chemicals in Japan. House and Household Insect Pests (11-12): 1-16.
10. Klotz, J., L. Greenberg and E. C. Venn 1998. Liquid boric acid bait for control of the Argentine ant (Hymenoptera: Formicidae). J. econ. Entomol. 91 (4): 910 – 914.
11. Moein, S. I. and R. M. Farrag. 1997. Efficacy of some organic salts against the drywood termite Cryptotermes brevis Walker. J. Agric. Res. Egypt 95 (3) : 645-651.
12. Mostafa, H. H. 1982. Effect of some non organic chemicals against workers of Psammotermes hybostoma. Assiut J. Agric. 13 (3): 175 – 191.
13. Nicholas, D. D. 1972. Characteristics of preservative solutions which influence their penetration into wood . Forest Product Journal. 22 (5) : 31-36.
14. Salman, A. G. A. and A. A. Sayed. 1990. Construction techniques for the control of the sand termite, Psammotermes hybostoma Desneuk in traditional housing in Egypt. Tropical Pest Management 36 (1): 68 – 70.
15. Sulastiningsih, I. M. 2000. Preventing the termite attack on particleboard Buletin-Penelitian Hasil Hutan 17 (4): 179 – 188.
16. Sun and E. R. Johnson. 1960. Analysis of joint action of insecticides against house flies. J. Econ. Entomol. 53: 887 – 892.
17. Tisseverasinghe, A. E. K. 1974. The threshold level of Boron preservatives against attack by the drywood termite Cryptotermes domesticus Srilanka Forester 12 (2): 89 – 94.

مكافحة النمل الابيض الذى يصيب الخشب الجاف بأستخدام طرق غير تقليدية

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دلت النتائج التى اجريت على استخدام بعض الاملاح المعدنية الغير العضوية مثل كلوريد الزنك – كبريتات النحاس – بوراكس – وحمض البوريك على انه يمكن مكافحة النمل الابيض الذى يصيب الخشب الجاف بالمعاملة بمثل هذه الاملاح والحصول على نسبة مكافحة تصل الى ١٠٠% لجميع هذه المواد عند تركيز ١٦ x ١٠٠٠٠ جزء فى المليون ١٠٠% لحمض البوريك عند تركيز ٢ x ١٠٠٠٠ جزء فى المليون وذلك بعد ستة ايام من المعاملة

كذلك اوضحت نتائج استخدام الزيوت المعدنية على انه يمكن الحصول على نسبة مكافحة تصل الى ١٠٠% فى اليوم العاشر من المعاملة بأستخدام زيوت كابل١ – كابل٢ – وزيت مصرونا بتركيز ٣٢ x ١٠٠٠٠.