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Food Preference of Termite (*Microcerotermes diversus* Silv.) for Forest Trees in Erbil Governorate

ABSTRACT

The current study investigated the sensitivity of different wood species to the termite, *Microcerotermes diversus*, in two different locations. The results showed that both softwood and hardwood of White Willow, *Salix alba*; Melia, *Melia azedarach*; pine, *Pinus brutia* and Mediterranean Cypress, *Cupressus sempervirens* are highly susceptible to the termite invasion under physically infection conditions in Sami Abdulrahman Park, Erbil city, Iraq. Moreover, the sensitivity of the species to the termite invasion was significantly different under natural infection in Grdarasha after 22 weeks from early April to the end of September 2017. In addition, the White Willow (*Salix alba)* species showed more sensitivity to the termite infection in comparison with others species, where the mean of wood green weight, wood dry weight (before infection), wood dry weight (after infection) and specific gravity loss during the period of experiment of the White Willow were 2.2609g, 2.1584g, 1.5983g and 0.5139 respectively. Furthermore, *Cupressus sempervirens* was more resistant in comparison with other wood species to the termite in both locations where green weight of wood 3.010g and Dry weight of wood (after infection) 2.287g, Dry weight of wood (befor infection) 2.877g and Specific gravity 0.685. Generally, this study revealed that there is no definite association between both physical properties and moisture content of softwoods and hardwoods with termite preference.

INTRODUCTION

Termite, Microcerotermes diversus, can broadly be defined as one of the most predominant pests in Erbil governorate that causes considerable damages to household furniture and house foundations. Furthermore, it can attack forest products and other cellulosic origins (Al-Mallah et al., 2008 and Farouk et al., 2011). Mustafa (2004) reported that Microcerotermes feeds on any woods such as, sound or decayed, and lays on or in contact with the ground. The wood species, which suggested for most part of building structures and interior designs, were divided into different groups depending upon the wood density and wood strength (Wong et al. 1983 and Al-Mallah- et al., 2009). Susceptibility and resistance to termite had been measured by Always et al., (1989) to determinate the effect of the termite invasion on local and imported wood in Iraq. Despite its negative effect, which had been mentioned previously, termites can certainly have great economic significance, as a result of the damages that they cause to woodwork in buildings, agricultural crops and forest plantations, due to the essential natural resistance of the native timbers and feeding preferences of the native species of termites (Rasib, 2008). Over past decade, either wood volume or wood weight was considered as effective parameters to evaluate the termites' preference and non-preference. Early

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examples of research into termite laboratory experiment substantially include termite mortality in compulsory laboratory feeding test (Scheffrahn, 1996; Grace, et al., 1996, Yamamoto 1994 and Haverty and Nutting, W.L., 1975).

The aims of this study are: analyzing the susceptibility of some local wood species measuring wood preferences of each softwood and hardwood zones against subterranean termite Microcerotermes diversus.

MATERIALS AND METHODS

RESOURCE OF TERMITE

Basic information was gathered on termite habitat. The researchers notified termite colonies with large numbers of winged individuals in both study sites of Grdarasha and Sami Abdulrahman Park in Erbil.

WOOD SAMPLE

Wood samples with dimension of 20x20x20mm were used in each of the four proposed local tree species per softwood and hardwood, which are the most famed species in Iraq (Table-1), specifically.

Table (1): List of tree species, which includes the scientific name, common English name, the family the species belong and the collection site

No.	Scientific Name	English Name	Family Name	Collection Site
1.	Salix alba	White Willow	Salixacea	Grdarasha
2.	Melia azedarach	Melia	Meliaceae	Sami Abdulrahman Park
3.	Pinus brutia	Brutia Pine	Pinaceae	Sami Abdulrahman Park
4.	Cupressus sempervirens	Mediterranean Cypress	Cupressaceae	Grdarasha

MOISTURE CONTENT

Moisutre content was measured for the wood samples using the equation that wasreported by Panshin et al., (1980) equation as shown below:

$$\text{Moisture content (M.C. \%)} = \frac{\text{Wood green weight} - \text{Oven wood dry weight}}{\text{Oven wood dry weight}} \times 100$$

SPECIFIC GRAVITY

To measure the specific gravity, wood samples were oven dried in 105°Cfor 48 hours, and their weights were calculated. The volume also was measured by calculating the removed water volume after placing the wood samples in water bucket. Thereafter, the density can be achieved by dividing dry weight by volume according to Haygreen's and Bowyerp's (1982). .

$$\text{Specific gravity} = \frac{\text{Sample weight}}{\text{Removed water volume}}$$

INFESTATION DEGREE

The rate of infestation was calculated depending on Abdel-Malak (1995). Additionally, it was categorized as following:

$$\text{Infestation degree} = \frac{\text{No. of infested wood pieces}}{\text{No. of examined wood pieces}}$$

Zero	*No. infestation*	*"O"*
5 <	*Rare*	*"R"*
5 – 10	*Low*	*"L"*
10 – 25	*Moderate*	*"M"*
25>	*High*	*"H"*

EXPERIMENTAL STUDY

The experimental work was carried out on the physical preferences of the underground termite Microcerotermes diversus from early April to the end of September 2017 for two study sites Grdarasha and Sami Abdulrahman Park. Subsequently, five replicates were taken per softwood and hardwood for four species of forest trees.

The temperature and relative humidity mean of the wood samples were 30°C and 47% respectively. At the time of wood burying, wet weight of wood Samples were measured by sensitive digital balance. Afterwards, samples were dried in oven at 105°C for 48 hrs and reweighted after drying time. Wood pieces were buried for 22 weeks underground in order to conduct the bioassay at Sami Abdulrahman Park and Grdarasha field, which were assumed as urban forest according to some of their characteristics such as well-draining, shadding and moisture to perform high subterranean termite activity. Wood samples were layered in the soil to 20-25cm in depth with 10cm of spacing between samples and covered with soil. Wood samples were carefully retrieved and weighed directly to calculate the final wet weight after 22 weeks. The complete randomized design with five replicates for both softwood and hardwood was used to analyze the data and Least Significant Difference (L.S.D) test was used to compare means the means using the $P < 0.05$ as statistical threshold level of significance; data was analyzed by (SAS, 1987). Preference were mostly assessed by measuring wood weight loss, which was calculated according to the amount of loss in wood dry weight (before) and wood dry weight (after) infestation by termite for each softwood and hardwood samples (Beal et al., 1974; Usher and Ocloo, 1979; Rizk and Beal, 1982; Supriana, 1988; Grace, 1997 and Mustafa, 2004).

The confirmations of wood visual rating, wood loss, wood loss ratio, degree of infestation and infestation ratio, the samples rated by an arbitrary (0-5) visual rating scale that were reported by Wong et al., (1983) andMohd and Azlan, (1994) (Table 2).

Table 2: Non-infestation species per softwood and hardwood to M. diversus in 22 weeks under natural infestation condition.

No.	Non-infestation species (softwood and hardwood)	Visual rating **	No. attacked / Total observation	Infestation %
1-	*Salix alba* *	0	0 / 6	0
2-	*Melia azedarach*	0	0 / 6	0
3-	*Pinus brutia*	0	0 / 6	0
4-	*Cupressus sempervirens***	0	0 / 6	0

** Per mean represented (5) replicates per softwood and hardwood*

*** Woods were visually rated as (0= sound, 1= surface nibbles, 2 = light attack, 3 = moderate attack, 4 = heavy attack and 5 = completed destroyed).*

RESULTS AND DISCUSSION

Four local tree species for each softwood and hardwood types were chosen in two different study locations. The first site (Sami Abbdulrahman Park) did not show any infection symptoms with termite; however, the second site (Grdarasha Field) was severely infected with termite. In order to find the termite preference for these trees based on the weight loss when attack by termite, as followed:

NON-DAMAGED WOOD SPECIES BY TERMITE

As it can be seen in table (2) four wood species from each softwood and hardwood were not affected by the workers termite, which visual rating of wood was zero and infestation percentage was 0%. Also, these results agree with Rizk and Beal (1982) study findings in Egypt, which argued that wood species of Salix alba, Melia azedarach, Pinus brutia and Cupressus sempervirens were non-preferable to subterranean termite, Microcerotermes diversus during 22 weeks feeding test. However, natural infection condition is available for the examined wood species within the exposure period 22 weeks. It possibly explains as a proof of changeability in method of termite reinforces performance within confident duration or the existence of chemical component, that not compatible or more resistant preferably high cellulose content (Abdel-Karim et al., 2006). Similarly, the similar data was recorded by Wolcott (1959). Interestingly no infection with termite was recorded in Sami Abdulrahman Park under natural infection conditions, that might due to the residues of morus trees, branches, fallen leaves, tree barks and humus cumulative materials in underground of the park with height about 436m above sea level. These rests for living morus trees on soil surface are naturally attacked by termites and termite defense rely on choices in a place for alive alone in each wood piece as a possible alternative. Then, termite will have to attach or die in these conditions (Pearce, 1997) and (French and Ahmed, 2002). The manner of a food source is also powerful in case, this could be original shrubs or crops. Numbers of termite species (e.g. Macrotermitinae) have the ability of storing food for difficult condition such as food shortage and tough climate conditions. By comparison, plant damages resulted from pests are greater than termites. Pearce (1997) stated that some factors, such as wind, weeding, animal feeding and trampling can strengthen termite attack, as well as examples of different predators of termites.

THE EFFECTS OF WOOD SPECIES

During the research, the stimulated underground termite preference was evaluated by the examining woods for both softwood and hardwood of four wood species based upon of termite damage and wood weight lose according to Grace et al., (1996) and Lewis (2003) as follows:

Wood green weight, wood dry weight (before infection), wood dry weight (after infection) moisture content and specific gravity, as showed in Table (3).

Table (3): Effect of termite Microcerotermes diversus on the Physical properties of local wood

Species	Wood green weight	Wood dry weight (before infection)	Wood dry weight (after Infection)	Moisture content %	Specific gravity	Degree of infestation	Infestation percentage %
Salix alba	2.2609	2.1584	1.5983	4.66301	0.5139	2/3	0
Melia spp.	2.8415	2.7434	2.1323	3.68327	0.65319	1/3	66
Pinus brutia	2.3014	2.2168	1.631	4.21505	0.52781	0/3	33
C. sempervirens	2.9942	2.8755	2.27	4.09246	0.68464	3/3	100
L.S.D. < 0.05	**0.2593**	**0.2531**	**0.2623**	**N.S.**	**0.0603**	**N.S.**	**N.S.**

INTERACTION EFFECT OF LOCATION AND WOOD SPECIES

Salix alba, Melia spp, Pinus brutia and C. sempervirens were the most resistant species to termite, which the results analysis showed that there were statistical significant differences among them for Green weight of wood, Dry weight of wood (befor infection), Dry weight of wood (after infection), Moisture content and Specific gravity showed in (table 4). Interestingly, the Cupressus sp. was more resistant in comparison with other wood species to the termite in both locations which had green weight of wood 3.010g and dry weight of wood (after infection) 2.287g, dry weight of wood (befor infection) 2.877g and Specific gravity 0.685. However the Salix alba with less resistance to termite in Sami Abdulrahman Park, which green weight of wood, dry weight of wood (before infection), dry weight of wood (after infection) and specific gravity were 2.045g, 1.952g, 1.357g and 0.465 respectively, Gosswald (1946) and Asenjo et al., (1995) mentioned that the West Indian Mahogany in Meliaceae family is significantly resistant to the termite and that might due to the high lignin content and the appearance of extractives, such as oils, waxes and resins that this species is rich with (Al-Mallah et al., 2010). Therby, the resistance to the termite in the resistant wood species might be resistant due to development of phenol compounds, lignin and other ingredients, for instance oils, wax and remain materials in examined wood. These may have a capacity of the wood resistance as impervious to termite that contains the chemical compound determinations. And, this has given the ratio of wood resistance sample to destruction infested by termites. However, the extractives also contain the chemical compound determinants which given the ratio of resistance of a wood sample to destruction infested by termites. These data were partly agreement with Wong et al., (1983) who announced that the softwoods Araucaria cunninghamii and Pinus sylvestives to be completely susceptible to subterranean termites replicated wood blocks lost. After four weeks, they recorded that woods were easily degenerate in the face of the toxicity of some resinous extractives against termites and the contents of which may be restricted to overbalance the existence of feeding refreshing chemicals in the wood (Grace, 1997). By contrast, the concept chemical components of defense species were harmful to many insect species. Both Pine and Cypress wood were less preferable by termites than Walnut. Thus, it is suggested that these types of trees could have great economic values and can be useful for wood industry and other purposes, in particular prefabricating, planting and decorating arboriculture in Iraq, they could not be applicable for wood harvesting. This study confirms that C. sempervirens is unsympathetic host for P. hybostoma is associated with Ali et al., (1982). Also, Rizk and Beal (1982) agree with Abdel-karim et al., (2006) who found that Cypress tree, C. sempervirens seemed to be more resistant to the dry wood termite Cryptoterms brevis. The outcome of some physical properties, such as moisture content and specific gravity of trees; namely (Salix alba, Melia azedarach, Pinus brutia and Cupressus sempervirens) to termite feeding appeared that there was no obvious correlation between the wood physical properties and the weight losses in wood sample, due to termite's workers feeding. The results of L.S.D. test recorded non-significant values according to the wood types, tree species, and physical properties of the woods. These results reflect those of Al-Mallah et al., (2009) who reported that there is not precise correlation between physical properties of wood and amount of wood loss in termite feeding preferences to the tested woods. On the other hand, Behr et al., (1972) in their research supporting the correlation between the amount of termite feeding by (percentage wood weight loss) and both wood hardness and density. Rudman and Gay (1967) established that three features can determine sensitivity of woods to termite attack. These are density, nature of the wood substance and nature of the extraneous materials, extractives and nutrients. The variation in resistance is an ascribed to a natural variation in the amount of deterrent extractives to an ageing of the extractives and to lesser extent of density factor that recorded by Always, et al., (1989) and Scheffrahn (1991).

Table 4: Interaction effect of location and wood Species

Location	Wood Species	Green Weight of Wood	Dry Weight of Wood befor	Dry Weight of Wood after	Moisture Content %	Specific Gravity
Sami Abdulrahman Park	1- Salix alba	2.045	1.952	1.357	4.809	0.465
	2- Melia spp.	2.727	2.639	2.041	3.318	0.628
	1- Pinus brutia	2.316	2.183	1.441	6.803	0.520
	2- Cupressus sempervirens	3.010	2.874	2.287	4.705	0.684
Grdarasha	1- Salix alba	2.477	2.365	1.840	4.517	0.563
	2- Melia spp.	2.956	2.848	2.224	4.049	0.678
	1- Pinus brutia	2.286	2.251	1.821	1.627	0.536
	2- Cupressus sempervirens	2.978	2.877	2.253	3.480	0.685
L.S.D. < 0.05		0.3673	0.3585	0.3716	4.9635	0.0854

CONCLUSION

In summation, the main goals of the present research were: Firstly to determine the susceptibility of some local forest wood species to the termite. Secondly to measure wood preferences of each softwood and hardwood zones against subterranean termite M. diversus. In general, the results of this investigation showed that termite's effect on woods depends on a number of determinants. This experiment has confirmed that high cellulose content can obviously be the main factor of termite damage on any wood types. Further, this research study has also found that termite damages to woods can depend mainly on to what extend the woods are soft or hard. The last major finding of this paper is that the termite's resistances rely up on some circumstances, such as hardness and chemical component of woods.

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التفضيل الغذائي للنمل الابيض *Microcerotermes diversus* Silv. لأشجار الغابات في محافظة اربيل

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المستخلص

درست حساسية اربعة أنواع من الاخشاب المحلية لاشجار الغابات لأرضة القاطنة تحت سطح الأرض *Microcerotermes diversus*. أظهرت النتائج أن الأخشاب الرخوة والصلدة لأنواع الأشجار المدروسة وهي الصفات السبحبح الأبيض والصنوبر البروتي والسرو المتوسط والسروالعادي كانت غير مفضلة من قبل الأرضة تحت ظروف العدوى الطبيعية في الحديقة النباتية (سامي عبد الرحمن) في محافظة اربيل / العراق فيما لوحظ وجود فروقات معنوية ما بين الأنواع المدروسة للأخشاب في ظروف العدوى الأصطناعية في حقل (كردة رقش) بعد 22 أسبوع من بداية نيسان الى الاواخر ايلول 2017من الإصابة بينت الدراسة ان الصفصاف الأبيض كان من اكثر الأنواع إصابة بالحشرة الأرضة مقارنة ببقية الأنواع الخشبية وبمتوسط عام بلغ(2.2609غم ، 2.1584غم ، 1.5983غم، 0.5139) للخشب الرطب والخشب الجاف قبل وبعد الأصابة والوزن النوعي على الترتيب، على ذلك خلال فترة التجربة وفيما أظهر السرو العادي اكثر مقاومة لنمل الأرضة بمتوسط في كلا الموقعين بلغ (وزن خشب الرطب3.010غم و وزن خشب الجاف (بعد الاصابة) 2.287غم، وزن خشب الجاف (قبل الاصابة) 2.877غم و وزن النوعى 0.685).

الكلمات المفتاحية: النمل الابيض، *Microcerotermes diversus* ، الخشب، التفضيلات.