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EVALUATION OF BOTANICAL EXTRACTS AGAINST TERMITES INFESTING TASAR FOOD PLANTS

Shreyansh, H.S. Gadad*, Ampi Bhagat, Tanjila Haque and Kutala Sathyanarayana
Central Tasar Research and Training Institute, Ranchi – 835303, Jharkhand, India
*Corresponding author: hsgadad@gmail.com

ABSTRACT

Termites are gaining major pest status in tasar ecosystem in recent years and being observed in all the major tasar growing regions. *Odontoterme sparvidens, Odontotermes obesus, Odontotermes proformosanus, Microtermes obesi* (Hols), *Coptotermes heimi* (Wasm), *Odontotermes latiguloides, Odontotermes ganpati, Odontotermes redemanni* are the common species of termites damaging the tasar food plants. Therefore, an urgent need to develop certain eco-friendly management practices which are safe to silkworm. Hence, efforts have been made to evaluate the anti-termite activity of botanical extracts. In this study we have evaluated the toxicity of 6 different botanicals extracts against termites infesting tasar host plants. Bioassay results revealed that all botanicals extracted using n-hexane found effective including the solvent alone. Effectiveness of all the extracts might be due to toxic effect of n-hexane since it has been observed 100% mortality when n-Hexane used alone, whereas mortality in control was only 10%. Further extracts isolated using methanols were tested and in that also toxicity of methanol was evident (90%). Due to the toxic effects of n-hexane and methanol we have further isolated the selected botanicals using distilled water and conducted bioassay of these extracts against termites. Results indicated that among the tested botanicals lemongrass (93.00%), *Vitex negundo* (87.00%) and Eucalyptus (73.00%) found superior. Whereas other botanicals found less effective by recording lower per cent mortality. Hence outcome of the experiment suggests that these botanicals are having anti-termite activity further they can be utilized for field application for effective and eco-friendly management of termites in tasar sericulture.

Keywords **:** Botanicals, Anti-termite, Bioassay, % Mortality

Introduction

The insect which produce the traditional tasar silk is known as *Antheraea mylitta*. It exists in the form of nearly 44 ecorace distributed over different states and tasar producing areas in India (Singh and Srivastava, 1997, Srivastava, 2002 and Srivastava *et al.* 2003). They are mainly reared on the tree species such as *Terminalia arjuna* (Arjun), *Terminalia tomentosa* (Asan) and *Shorea robusta* (Sal) which are also known to be the primary food plants of tasar silkworm. *Terminalia* sp. is generally used in block plantations while *Shorea* plants are wild and nature grown. Secondary food plants of tasar silkworm are *Anogeisus latifola, Terminalia myriocarpa, Lagerstroemia indica, Lagerstroemia parviflora, Lagerstroemia speciosa* (Suryanarayana *et al.*, 2005; Deka *et al.*, 2015; Gargi *et al.,* 2014). Primary tasar food plants are attacked by many polyphagous insects' pests and damage various plant parts during different growth and developmental stages (Jolly *et al*., 1974). The magnitude of damage caused by these pests varies depending upon their nature of damage. Some pests eats the entire leaf, other suck their sap, while some others feed on the bark of the trees. Some pests bore into the stem and branches and cause severe damage to both young and grown up plants. Root feeders cause maximum damage to young saplings by devouring them. These activities of various pests adversely affect quality and quantity production of leaf. To prevent plant damage, it is utmost important to manage their population below economic threshold level, for which a forehand knowledge of various pests, their life cycle, living behavior and nature of damage caused by them is a must(Richards and Davies, 1997).

In addition to earlier reported pests of tasar food plants, in recent years incidence of termites is increasing in major tasar growing regions. Termite infestation is detrimental for many forest plant species including tasar host plants (Mandal *et al*., 2010). Among the sericulture plants commonly damaged by termites are Mulberry, Arjun, Asan, Sal, Oak, Som and Soalu plants. The species of termites commonly served damaging these plants are *Odontotermes parvidens,Odontotermes obesus, Odontotermes proformosanus, Microtermes obesi* (Hols), *Coptoterme sheimi* (Wasm), *Odontotermes latiguloides, Odontotermes ganpati, Odontotermes redemanni*), (Rathore *et al.* 2018; Baig *et al.,* 2018 and Kumar *et al.,* 2018). Termite infests taproots of especially young host plants immediately below the soil, this intern results in damage to the central root system and creation of cavities, which then becomes filled with soil. Their infestation reduces survivability and vigor of the host plants, which in turn, affect the cocoon productivity in tropical tasar silkworm (Rathore *et al.,* 2018). Termites have also been reported to damage various sericultural infrastructures like furniture's and sheds in rearing field. This results directly on economic loss and has a negative impact on income of marginal farmers due to reduced silkworm brushing capacity and cocoon yield. Hence there is an urgent need to develop certain eco-friendly management practices which are safe to silkworm and also eco-friendly. With this background during present study, efforts have been made to evaluate the botanical extracts to know their anti-termite activity.

Material and Methods

The experiment was conducted at Central Tasar Research and Training Institute, Ranchi (Jharkhand). Selected botanicals were isolated and evaluated using three different solvents (Methanol, Hexane and Water) against termites infesting tasar food plants (T*erminalia arjuna* and *Terminalia tomentosa*) in laboratory condition.

Treatment details

Based on the literature we have selected six botanicals (Table 1) to see their efficacy against termite in laboratory condition. Selected botanicals were collected and dried under room temperature and leaves were grinded to use for extraction.

Botanicals extraction: the selected botanicals were isolated using three different solvents viz., N-hexane, methanol and distilled water. Reason for using different solvents is that some plants compounds doesn't have affinity to dissolve in polar solvent and can easily dissolve in non-polar solvent and vice versa. Method followed for extraction was soxhlet extraction method. During the extraction 30 g of dried, grinded, and finely powdered botanicals is placed inside porous bag made up of a muslin cloth. The extraction solvents (methanol, hexane and water) were poured (150 ml) into the bottom flask, followed by the thimble into the extraction chamber. The solvent is then heated from the bottom flask at 64-65°C, in the case of hexane and methanol and for water 100°C temperature was used. Due to heating solvents evaporates, and passes through the condenser where it condenses and flow down to the extraction chamber and extracts the botanicals by coming in contact. Consequently, when the level of solvent in the extraction chamber reaches the top of the siphon, the solvent and the extracted plant material flow back to the flask, the entire process continues repeatedly for 4-6 hours until the botanicals completely extracted, a point when a solvent flowing from extraction chamber does not leave any residue behind.(Abubakar, and Haque 2020)

No choice bioassays

Standard filter paper method as followed by Acda *et al.*, 2014 and Bakaruddin *et al.* 2018 was used because termites feed on cellulosic compound and filter paper can easily absorb the botanical extracts. Bioassays were performed with three replications for each botanical and control. Filter paper were immersed for 10-30 sec in botanical extracts and dried at room temperature for 10 to 15 min. Then, these treated filter papers were placed in the hollow plastic container. Control is prepared by using distilled water-soaked filter paper. Ten healthy and active termites were placed on each of the treated replications and these replications are placed in dark place at room temperature. The mortality of termite was recorded after 24 hours of exposure in each botanical extract. All the dead and inactive termites were removed from the plastic container from each replication to record the % mortality by using camel hair brush. Percentage of mortality has been calculated by Abbott equation.

$$\text{Percent mortality} = \frac{\text{No. of dead termite}}{\text{Total No. of termite}} \times 100$$

Results

n-Hexane Extracts

Bioassay results revealed that among the hexane extracts agave shown excellent anti termite activity by recording highest mortality of 91.72 % and it was on par with eucalyptus (91.18%), lantana (90.88%), lemon grass (90.00%), neem (87.19%) and vitex (86.67%). Whereas in control only 10% mortality was recorded Due to effectiveness in all treatments we have also tested the toxicity of solvent (n-Hexane) alone and it was found that n-hexane alone showed 100% mortality (Table 2).

Methanol Extract

Similarly, bioassay has been carried out using methanol extracts and contrasting results have been observed. Among the different extracts tested Lemon Grass leaf extract was found superior over other treatments by recording highest mortality of 85.58% and it was on par with *Eucalyptus* (84.92%) and *Lantana* (82.78%).While remaining treatments found moderately effective, whereas agave showed least effectiveness against termites by recording 21.79 % mortality. Whereas in control observed mortality was only 10%. Further toxicity of methanol was also studied and it was evident that methanol was highly toxic to termites and observed mortality was 90% (Table 2).

Water Extracts

Considering the toxicity caused by n-hexane and methanol we have further tested the anti-termite activity of the selected botanicals isolated by distilled water in order to find out whether the selected botanicals are having any toxicity over termites or not. To understand this similar bioassay method was followed. Bioassay results revealed that among the water extracts Lemon grass shown excellent anti-termite activity by recording 93% mortality and it was on par with Vitex (87%) and Eucalyptus (73%). Further Lantana (60%) and neem (43%) extracts were found to be moderately effective. Whereas agave found least effective among all the tested botanicals by recording 30% mortality which was nearest to control (10%)with respect to per cent mortality (Table 2).

Discussion

Overall results of the present study revealed that toxic effects of the botanicals isolated using hexane and methanol were not clear due to solvents toxicity. However, results of water extracts showed some of the tested botanicals are having good anti-termite activity. Hence they can be utilised for eco-friendly management of termites. Since highly effective chemical treatments have been available for many years to prevent subterranean termite attacks and to control infestations. The use of termiticides for control of termites has generated a number of biological and environmental hazards in water, soil, air, and food. In addition to these dilemmas chemical treatments may also harmful for silkworm. Present study was designed to evaluate botanical extracts against termites infesting tasar host plants. Results obtained from the bioassay revealed that lemongrass extracts of all three solvents found superior over other botanicals. Similarly extracts of vitex isolated using water and n-hexane showed good anti-termite activity. Further eucalyptus and lantana leaf extracts also did exceedingly well in all three solvents by recording comparatively higher mortality (Fig. 1). These results are supported by the findings of Ekhuemel *et al.,* 2017, as they reported that crude extracts of eucalyptus leaves and bark are effective against wood termites. Further findings of Verma and Verma, 2006, Yuan and Hu, 2012, Ding, Wei, and Xing Ping Hu, 2010 are in line with the present findings. They have also reported that lantana leaf extracts act as excellent repellent and moderate toxic and anti feedant activities against termites. Findings of Majeed *et al*., 2020 about lemon grass are in line with the present study. However, toxicity of n-hexane and methanol over termites indicates that anti-termite activity of the selected botanicals might have been influenced by the toxic effects of solvents since effectiveness of any plant extract mainly depends on concentrations and types of extraction solvents (Obinna *et al.*, 2013). High mortality in n-hexane and methanol might be also contributed by starvation as it was observed that there was no feeding on filter paper (due to lack of moisture) was noticed when solvents (n-hexane and methanol) alone used. Nevertheless, bioassay results of extracts isolated using water clearly suggests that botanicals like lemongrass, vitex, eucalyptus and to some extent lantana are good candidates to use against termites for eco-friendly management.

Table 1 : Different selected plants for botanical extraction

Botanicals Names	Common Names	Family	Plant Parts Extracted
Agave	Century Plant	Asparagaceae	Leaves
Eucalyptus globulus	Eucalyptus	Myrtaceae	Leaves
Lantana camara	Lantana	Verbenaceae	Leaves
Cymbopogon citratus	Lemon Grass	Poaceae	Leaves
Azadirachta indica	Neem	Meliaceae	Leaves
Vitex negundo	Sindwar	Lamiaceae	Leaves

Table 2 : Comparative mortality activity of Hexane and Methanol solvents botanical extracts of plants against the termites.

Botanicals	Methanol	Hexane	Water
Agave	21.79 $(27.61)^{D}$	91.72 $(74.02)^{B}$	30.00 $(32.99)^{EF}$
Eucalyptus	84.92 $(71.17)^{A}$	91.18 $(75.85)^{B}$	73.00 $(59.68)^{BC}$
Lantana	82.78 $(65.47)^{AB}$	90.88 $(72.66)^{B}$	60.00 $(50.83)^{CD}$
Lemon Grass	85.58 $(71.62)^{A}$	90.00 $(74.97)^{B}$	93.00 $(77.68)^{A}$
Neem	65.52 $(54.09)^{BC}$	87.19 $(69.44)^{B}$	43.00 $(41.14)^{DE}$
Vitex	50.00 $(44.98)^{C}$	86.67 $(68.83)^{B}$	87.00 $(72.26)^{AB}$
Solvents	90.00 $(71.54)^{A}$	100.00 $(89.96)^{A}$	10.00 $(18.43)^{F}$
Control	10.00 $(18.43)^{D}$	10.00 $(18.43)^{C}$	10.00 $(18.43)^{F}$
SEM	**5.13**	**3.54**	**5.11**
CD	**15.37**	**10.61**	**15.50**

Values in the parenthesis are arcsine transformed values and means followed same letter are not statistically significant

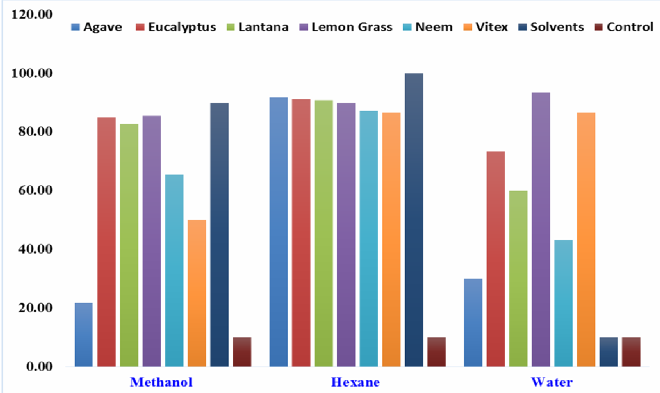

Fig. 1 : Percent mean mortality of botanicals extracts isolated using different solvents

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