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ADVANCES IN WOOD PRESERVATIVES BASED ON PLANT SOURCES

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ABSTRACT

Termites not only digest all types of cellulosic materials in buildings but may penetrate through cement and mortar also. As far as wood is concerned, out of total wood available for use in one year, one third is destroyed by bio-degradation, in which termite attack is a major factor. Therefore protection of wood is done by using preservatives which are based on toxic chernicals. The chemicals though are highly effective but due to toxic character may be hazardous to enviroment and it is dangerous to use inside the buildings.

Bark, seeds, flowers and leaves of various plants and trees were extracted to study their termite repellancy. A surface coating based on extratives is developed in ammonical medium which is highly effective to resist termite attack on wood and other building materials. The coating may be used as a primer coat and the surface can be painted as usual.

Introduction

Wood is used for construction purposes from time immemorial. It is estimated that world wide ,one third of the total wood is used in building construction. Further out of total quantity of wood which is in use, one third is destroyed by bio-degradation in which maximum is eaten away by termites [1]. To protect wood from insect and termite attack, the preservatives which were conventionally used were generally based on arsenic, copper and sodium pentachlorophenate. Sometimes it has been seen that pest control operators treat the wooden units in the dwellings with oil based synthetic pesticides solution which they generally use for soil treatment. These chemicals are highly toxic and environmentally stable and it is dangerous to use them inside the houses. Therefore a search is done globally to find out alternative to these chemicals to control termite attack on wood . The extractives of plant sources have given encouraging results to control termite attack on wood. The paper is a review of research and development work carried out in this area.

Preservatives from Plant Sources

Plants are richest source of bio-active organic chemicals on earth. They store secondary metabolites such as alkoloids, terpenoids, polyacetylenes, unsaturated isobutylamide and rotenoids, etc. which may act as toxicant, repellent and modifiers [2]. Plant toxicants are frequently lethal to insects upon contact or their vapours may kill the insects by fumigation, while repellent or deterrent causing insect

to avoid contact with target species. The behaviour modifiers alter normal pattern of insect activity and usually act on insect sensory nervous system.

Pine wood has since long been known to be termite resistant and attempts have been made to identify, isolate and characterize termite - repellent from it. Moore [3] has reported that certain species of termites do not attack pine timber and that termites will abandon an area in which pine is planted. He attributed termite repellency of pine wood to the presence of terpenes. Arther et al[4] gave the composition of the essential oil from the wood of *P. edulis* and *P. albicaulis*. Eugene et al [5] gave the average composition of *P. ponderosa* needles as: 11.3% 2-pinene, 8% 3-carene, 5% myrcene, 18% limonene, 22% B-phellandrene and 6.4% methyl chavicol. Robert [6] has reported the extraction of terpenes of the bark oil of *P.radiata*. Zaheer et al [7] reported the results of the extraction and chemical characterisation of terpenes of *P. roxburghii* and their repellent effect on termite species *O. obesus*. The crude extract was found to have low repellent activity due to the low concentration of repellent chemicals. Some of the fraction obtained by TLC separation were found to have better repellent activity. He also studied the extract from both stem and leaves of *P. roxburgii* and found extracts from leaves possess better repellent properties. The extraction of similar terpenes from *Cedrus deodara* has been reported by Naqvi [8]. Rudmam [9] found that callitric acid was termite repellent. He reported that a group of neutral extractives namely Cudesmol and Azulene impart decay-resistance to cypress pine. Hills and Inoue [10] and Coutts [11] isolated and characterised polyphenols from pine heartwood. Stilbene, a pinosylvin monoethyl ether compound was isolated.

Tannins are another group of extractives found both in wood and bark. Pine bark are generally known to have high tannin content. Rudman [9] and Rowe and Conner [12] showed that tannin like compounds are detrimental to termites. Besides tannins, the bark also contains phenolic compounds which further contribute to the termiticidal properties of the bark. Steller [13] studied the antitermitic properties of selected bark extractives and found termite mortality occur with Acetone: Hexane: Water bark extracts obtained from the species *Quercus pinus*, *Pinus strobus*, Carya ovata Mill, and *Sassafras ablidum*. Harun and Labosky [14] conducted screening trials to determine antitermitic properties of bark extractives obtained from five north-eastern trees. The species selected were : red pine (*Pinus resinosa*), white pine (*P.strobus)*, Shagbark hickory (*Carya ovata*),red oak (Quercus rubra), and red mapple (*Acer rubrum*). The extraction was made with acetone:hexane:water (54:44:2 v/v) mixture in Soxhlet extractor. The eastern subterranian termite, *R.flavipes* was used for antitermitic trials with cellulose paper pad treated at 0.07 gm/ml bark extract. The A:H:W bark extract from shagbark,red oak, and white pine exhibited complete mortality after the four week trial period. Results also

revealed that the bark extracts which exhibited the lowest pad weight loss, the average weight loss ranging from 4 to 17%. The red maple bark extracts showed lowest antitermitic activity. Geranyl linolool isolated from pine wood showed termiticidal activity [15]. Bark extracts from quercus, pinus, sarfras, jugans ragia and carya also showed antitermitic propteries[2].Nagnan and Clement [16] found that terpenes extracted from *Pinus pinaster* were toxic for termites of the species *Reticulitermes*.

Termite repellent from bark other than those of pinewood have also been isolated and characterized. Bultman and Parish [17] evaluated some wood extractives and related compounds as antitermite agents. Rowe and Conner [12] reported that oak bark contains the chemical components D-Catechin, D-gallocatechin, Leucopelargonidin, leucocyanidin, leucodelphinidin, gallic acid and condensed tannins. These compounds are said to have antitermitic properties. They also reported components of red maple bark as tannins, glucose, B- sitosterol, D-Catechin, pyrocyanidin, pyragallol, catechin and gallic acid. Juglone and some other napthaquinone type antitermitic compounds have been isolated from shagbark hickory bark extracts.

A study conducted in Australia by Yagaki and Hills [18] on white cypress pine (*Callitris columellaris*) showed that the petroleum ether extracts from white cypress heartwood affect termites. It made up 4.2% of the dried wood and consisted of 53.1% volatile neutrals.The non-volatile neutral residue showed no signs of repellency or toxicity. 1-Citronellic acid was the major component of the acid fraction. The volatile neutral fraction consisted of gualol, B-endoenol and 5-sesquiterpene lactones isolated for the first from *C.columellaris* heartwood.

Itoh et al [19] studied the effect of trimethylnaphthalenes isolated from cypress on termites. 1 mg of compound in acetone was tested for termite-repellency in laboratory. Rowell et al [20]. reported investigations on biological resistance of southern pine and aspen flake-boards made from acetylated flakes. Ibata Y. and Ando Y. [21] analysed essential oils obtained from cypress and ceder for termite repellency. Building lumber and furniture treated with wash containing 0.1 to 0.3% ceder and cypress leaf essential oil showed termite repellency up to 7-8 years. The anti-termitic activity is in the neutral extractive fraction isolated from eastern cedar , *Juniperus virginiana*, containing sesquiterpene alcohol widdrol exhibited some toxic activity against subterranean termites *Coptotermes formosanus*, but less than that of widdrol [22].Yoga et al [23] investigated the cause of termite activity in the wood of *Sciadopitys verticillata* belonging to the family Taxodiaceae. The termite repellent substances of the wood were present in the n-hexane solubles of the steam distillates of the wood meal. The hexane soluble were fractionated in the usual way into acid,phenols and neutrals. The neutral were dissolved in methyl alcohol residue. Later on an alumina/column

was eluted with various solvents having different polarities to afford six fractions,F-1 to F-6. Among these the most active fraction was found to be F-3 from which isoeuganol monomethyl ether was isolated and confirmed as the active compound in a yield of 0.21% of wood. A crystalline compound having less activity was identified as cedral, the yield of which was 0.6% of wood. These two compounds accounted for entire termite-repellent-activity.

Ivbijaro, Umeh and Mutsaers [24] studied the aqueous extracts of seeds of *Piper* guineense, *Azadirachta indica* and *Parkia clappertoniana* against termites *Macrotermes nigeriensis*. It was respected that they caused 90% mortality with *A. indica*, and *P. clappertoniana* within 3 hour of typical application. Azadirachtin, and possibly other neem oil components showed some toxicity, long-term repllency, and feeding deterrent activity towards termite *Coptotermes formosanus* [25]. Giridhar and Vasudevan [26] investigated antitermitic properties of *Calotropis* latex.They tested it to control termite attack in *Cedrus deodara* and *Mangifera indica*.At higher concentration latex could very well be used in termite control.

Serit et al [27] studied antifeedent properties of extract of seeds of *Citrus natsudaidai*. It was reported that methonol extract of the above seeds showed significant deterrent action . French et al [28] extracted bark and heartwood of white cypress pine (*Callitris columellaris* F. Muell.).Termites species taken for studied were *Coptotermes acinaciformis* Froggatt, *Nasutitermes exitiosus* and *Mastotermes darwiniensis* Froggatt. The bio assays indicate that the petroleum ether soluble extractive from the heartwood was more toxic to *M.darwiniensis* than the diethyl ether or methonol soluble extractive . In addition , acid and neutral fractions were found to be toxic to both *N.exitiosus* and *C. acinaciformis*. Four kinds of volatile oils from the leaves,flower, fruit and bark of *Litsea cubeba* pres oil were obtained by steam distillation. The oils of the bark and leave are found to be most effective while the oil of fruit is next and the oil of flower the least effective [29]. A formulation containing red pepper extracts, nonylic acid and vanilyamide has been reported to have 100 % control of termite at 5 p.p.m level [30].

Work done at CBRI

A systematic research work is started in this Institute in the last 2-3 years to survey, extract and screen the leaves,bark, flowers, seeds and roots of such for their termite - resistance. A number of plant and trees of Himalayan region and other parts of India have been studied. A few of them gave encouraging results. Based on the work carried in this direction , termite -resistance surface incorporating plant extractives is developed recently. The coating can be applied on cellulosic and masonary surfaces and is highly effective to control termites. It is non-toxic also. The surface treated with coating can be painted in normal way. An Indian - patent is recently filled for the coating.

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