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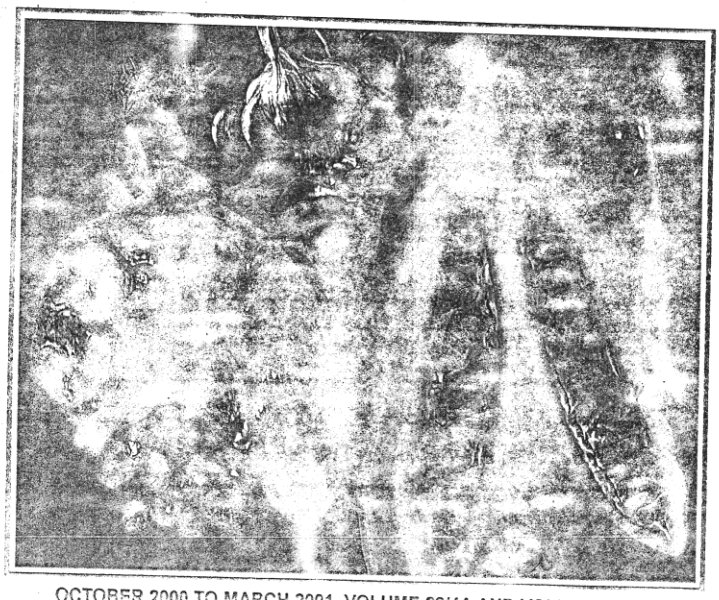

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Termite control with medicinal plant products

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Abstract

Termites are structurally most closely related to cockroaches but are social insects comprising the order Isopetra. They are serious biodegrading agents affecting buildings and other human dwellings. The use of toxic synthetic pesticides in controlling termites is now a global concern. In order to minimize their use, the attention of scientists are now focussed on integrated termite management (ITM). Use of medicinal plant extractives having termite-resistant properties is a promising alternative.

The plants are storehouse of secondary metabolites such as alkaloids, terpenoids, steroids, polyacetylenes, unsaturated isobutylamides and retenoids. They may act as toxicants, repellants and/or Behaviour modifiers. Many plants have evolved a wide range of defensive mechanism to protect themselves from termites. Therefore, a large number of formulations using plant extracts have been developed around the world to control termites in the recent past. The paper gives detailed survey of literature on research carried out in this direction.

The stem bark, leaves, seeds and flowers of many plants of Himalayan region were extracted in polar and non-polar solvents. The extracts were studied for their behavior against termites and active compounds present in such extracts were identified. Processes developed for the preparation of plant extracts having anti-termite properties and termite-resistant formulations prepared from such extracts are detailed in this paper.

Termites are social insects and live in small to large colonies. They are soft-bodied insects which range in colour from dull white to light or dark brown, and belong to the insectan order Isoptera [15]. It lives mostly in underground soil, in wood or in earthen mounds or carton nests above ground. Their food consists principally of wood – cellulose and so they freely attack all woody matter, both dead and alive, as well as roots. They also feed on fungi, regurgitated liquid food, ejected faeces and certain exudation of the colony.

Plants are the richest sources of renewable bioactive organic chemicals. They store secondary metabolites such as alkaloids, terpenoids, polyacetylenes, unsaturated isobutylamides and rotenoids, etc. [4]. Plant toxicants are frequently lethal to insects upon contact or their vapors may kill the insects by fumigation, while repellents or deterrents cause insect to avoid contact with the target species. The behavior modifiers alter normal pattern of insect activity and usually act on insect sensory nervous system.

Certain species of termites do not attack on pine timber and the termites will abandon an area in which pine is planted [9]. Hillis and Inoue Several groups have isolated and characterized antitermitic polyphenols from heartwood of pine. Itoh *et al.* [6] studied the effect of trimethyl naphathalenes isolated from Cypress on termites. One milligram of compound in solvent was tested for termite repellency in laboratory. Yagaki and Hillis [20] reported that the petroleum ether extracts of heartwood of *Callitris columellaris* affect termites. The chemical components of oak bark are D-catechin, D-gallocatechin, leucopelargonidine, leucocyanidin, leucodelphinidin, gallic acid and condensed tannins. These components showed termiticidal activity [11]. Some wood extractives and related components showed antitermitic activity when tested in laboratory [1]. The termite repellent substances were extracted in n-hexane from the wood of *Sciadopitys verticillta*. The hexane extracts was fractionated by usual methods into acid, phenolic and neutrals. The neutrals on alumina/column chromatography gave six fractions F-1 to F-6. Among these, the most active fraction was found in F-3 [19]. Zaheer *et al.* [21] reported that terpenes isolated from *Pinus roxburghii* shows termite repellent activity.

Santosh and Vasudevan [12] reported that latex of *Calotropis* showed termite-repellent activity at higher concentration. The terpenes emitted by *Pinus pinaster* were toxins for termite of the genus *Reticulitermes*. The most toxic component was geranyl linalool [10]. Serit *et al.* [13] isolated termite antifeedants, obacunone, nomilin and limonin from precipitated layer of methanol extract of *Citrus natusdaidai* seeds. Grace and Yates [3] investigated that azadirachtin and possibly other neem oil components showed some toxicity, long-term repellency and feeding deterrent activity towards termite. Ivbijaro *et al.* [7] reported that aqueous extracts (5%) of the seeds of *Parkia clappertoniana, Azadirachta indica*, A Juss and *Piper guineense* Schum and Thonn caused 90% mortality of the worker cast with *P. guineense* and 86% mortality with *A. indica* and *P. clappertoniana*, respectively within 3 hours of topical application. Lin and Yin [8] isolated four kinds of volatile oils from the leaves, flowers, fruits and bark of *Litsea cubeba* and evaluated them for their antitermitic activity. The results indicated that oil of bark and leaves were found to be most effective while the oil of fruit is next and the oil of flowers the

least effective .

Work done at CBRI

A systematic research work was started in this Institute during the last 5 – 6 years to survey, extract and screen the leaves, bark, flowers, seeds and roots for their termite-resistance. A number of plants 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 coatings incorporating plant extractives have been developed recently. The coatings can be applied on cellulosic and masonry surfaces and are highly effective to control termites. They are also non-toxic. The surface treated with coating can be painted in normal way. Two Indian patents have recently been filed for the coatings [16,17].

Out of the above two termite resistant surface coatings, one is based on family Rutaceae plant *Zanthoxylum alatum* [18]. The plant grows along the foot of Himalayan hills up to an altitude of about 2000 m, usually in hot dry places. The leaves of *Z. alatum* were extracted in a acetone by using soxhlet apparatus. The residue was further concentrated and weighed (20g) and subjected to TLC and IR characterized. The best solvent found for TLC was toluene: acetone (80:20). Iodine vapor was used to detect spots on the chromatographic plates and the R_f value of the five active spots so obtained were determined as 0.76, 0.53, 0.48, 0.35 and 0.28, respectively. These fractions were further separated by column chromatography by increasing the solvent polarity. For each fraction, the solvent is removed under reduced pressure and the residue was left in refrigerator overnight; differently colour solid masses were obtained at the bottom. They were removed by filtration and crystallization with suitable solvent.

For IR studies, the IR spectra were carried out using the Hitachi 323 spectrophotometer. Following characteristic peaks indicated in fraction A, IR spectrum revealed the presence of an unsaturated carbonyl group (2700-3500 br, 1690 and 950 cm^{-1}) and a vinyl group (1660, 1450, 1015 and 910 cm^{-1}), in fraction B; 3500, 1660, 1555 cm^{-1} (-NHCO), 1245 cm^{-1} (C=S), 1620 cm^{-1} (aromatic moiety), and in fraction C; 3300-3500 cm^{-1} (NH), 1600 cm^{-1} (aromatic), 1350 cm^{-1} (N-O streching of NO_2) and 800 cm^{-1} (-Cl), in fraction D; 1665 cm^{-1} (C=O, cyclic amide), 1725 cm^{-1} (C=O, ester), in fractioin E; 2100 cm^{-1} (-CN), 3610 cm^{-1} (-OH, phenolic). The mortality and repellent activity of the compounds were determined by percentage of mortality and repellency (Sighamony, 1984). The active workers of termite species *Microcerotermes beesoni* were taken for the study. Observations were taken in triplicate and results presented in table 1 [18].

Table – 1. Termite mortality and repellent activity in 24 hours

S. No.	Solution	% Mortality	% Repellency
1.	Extract	46.60	92.40
2.	Fraction A	26.60	25.38
3.	Fraction B	48.00	85.60
4.	Fraction C	66.00	88.96
5.	Fraction D	72.00	93.60
6.	Fraction E	64.00	74.90
7.	Control	40.00	50.00

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