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Review

Biological alternatives for termite control: A review

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ABSTRACT

Termites are a serious menace to both plants and structures. They are the most problematic pest threatening agriculture and the urban environment. They cause significant losses to annual and perennial crops and damage to wooden components in buildings, especially in the semi-arid and sub-humid tropics. Chemical control has been a successful method of preventing termite attack, but the effects of these chemicals are of concern as they create problems for our health and the environment. Biological methods could be suitable alternatives in this regard. The present paper reviews the various methods (physical, chemical, and biological) for termite control. Recent advances and past research done on termite control emphasizing biological methods are reviewed. Biological methods described include botanicals (essential oil, seed, bark, leaf, fruit, root, wood, resin), as well as fungal, bacterial, and nematode approaches. The relationship between chemical structure of active components responsible for termite control and termiticidal activity is discussed. The plants reviewed show good insecticidal properties against termites. These botanicals can be used for termite control singly and in combination. The active component from biomass can be extracted to prepare efficacious and potent biocidal formulations.

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1. Introduction

Termites are the most problematic pests in the plant kingdom and buildings. There are over 2800 described species of termites, with about 185 considered to be pests. They cause over 3 billion dollars worth of damage to wooden structures annually throughout the U.S. (Lewis, 1997). Termites that belong to the families Hodotermitidae (*Anacanthotermes* and *Hodotermes*), Kalotermitidae (*Neotermes*), Rhinotermitidae (*Coptotermes, Heterotermes,* and *Psammotermes*), and Termitidae (Amitermes, Ancistrotermes, Cornitermes, Macrotermes, Microcerotermes, Microtermes, Odontotermes, Procornitermes, and *Syntermes*) cause great loss in agriculture (UNEP Report, 2000). Out of 300 species of termites known so far from India, about 35 species have been reported damaging agricultural crops and buildings. The major mound-building species in India are *Odontotermes obesus, Odontotermes redemanni, and Odontotermes wallonensis,* and the subterranean species are *Heterotermes indicola*, *Coptotermes ceylonicus*, *C. heimi*, *Odontotermes horni*, *Microtermes obese, Trinervitermes biformis,* and *Microcerotermes beesoni* (Rajagopal, 2002). Synthetic pesticides remain the primary method used to prevent termite attack on wooden structures. However, the persistent use of chemical termiticides is at present of environmental concern and has resulted in the need to search for plant-derived compounds as an alternative for termite control.

2. Economic losses caused by termites

Termites are of the greatest importance in recycling woody and other plant material. Their tunneling efforts help to aerate soil. Termites are an important part of the community of decomposers. They are able to decompose cellulose, the main component of wood. They are abundant in tropical and subtropical environments, where they help in breaking down and recycling one third of the annual production of dead wood. But they become economic pests when they start destroying wood and wooden products of human homes, building materials, forests, and other commercial products (Meyer, 2005). Control and repair costs due to Formosan subterranean termites in New Orleans, for example, have been estimated at 300 million dollars annually (Suszkiw, 1998). Termites damage about 10–30 percent of harvested kernels of groundnut in Mali, Burkina-Faso, Niger, and Nigeria (Umeh et al., 1999). In India, they are responsible for the loss of 15–25% of maize yield and about 1478 million Rupees (Joshi et al., 2005). Crop losses in other countries are shown in Table 1.

3. Biology of termites

Termites (soft bodied, pale in color, with mouth parts for biting and chewing and utilizing cellulose as a food source) belong to the group of insects called Isoptera. They are closely related to cockroaches (Meyer, 2005) and are long-lived social insects. Termites living in large colonies depend entirely on wood, either living or dead, or the woody tissue of plants, intact or partially decayed.

Their colony consists of reproductive forms, sterile workers, soldiers, and immature individuals. The reproductives are of two types, primary and supplementary. The primary reproductives, the king and queen, are pigmented and fully developed winged adults. Their role is egg production and distribution by colonizing flights. The queen lays about 3000 eggs a day through its enlarged abdomen (Thompson, 2000). It lives up to 25 years. The eggs are yellowish-white and hatch after 50–60 days of incubation. The colony reaches its maximum size in approximately 4–5 years and it may include 60,000 to 200,000 workers. In most termite colonies there is only one pair of primary reproductives, but when they die they are usually replaced by numerous supplementary reproductives, which are with or without wing pads and are slightly larger and more pigmented then workers. The sterile castes, the workers and the soldiers, are wingless and usually lack eyes (Myles, 2005). Worker and soldier termites are 6 mm long and pale cream in color; however, the heads of soldiers are much enlarged (almost half their body length) with noticeable black jaws. Workers construct the distinctive shelter tubes and collect food to feed the young and other members of the colony. Soldier termites are responsible for guarding the colony and its occupants.

Table 1
Crop losses, building damage and economic losses caused by termites worldwide.

Country	Crop losses (%)	Building damage (%)	Economic losses/annum (Million US $)	Reference/Source
Australia	–	–	>95.24	www.chem.unep.ch/pops/termites
Brazil	–	42.7	–	Milano and Fontes, 2002
China	–	80–90	248.68–292.79	Zhong and Liug, 2002
Europe	–	–	313	www.chem.unep.ch/pops/termites
India	15–25 (Maize crop)	–	35.12	Joshi et al., 2005
Japan	–	–	800	www.chem.unep.ch/pops/termites
Malaysia	–	70 – Residential 20 – Industrial 10 – Commercial	8–10	Lee, 2002
Southern Africa	3–100	–	–	Mitchell, 2002
Spain	–	53.2	–	Gaju et al., 2002
United States	–	–	>1000	www.chem.unep.ch/pops/termites