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## Anti-termite properties of four selected species of Zingiberaceae rhizome extracts

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### Abstract

Termites are a group of eusocial Isoptera insects. They cause serious damage to wood, plants, crops and forest plantation. Control of termites is a major concern. In the present study, rhizome extracts from four different varieties belonging to Zingiberaceae family were selected and checked for their insecticidal potential. Aqueous, ethanolic and petroleum ether extracts of *Hedychium coronarium*, *Maranta arundinaceae*, *Alpinia galanga* and *Acorus calamus* rhizomes were prepared and tested. Different concentrations of the filtrate ranging from 1-5% were tested against termites and observed for 6 hours of exposure. The insecticidal effect was analyzed by observing and recording the death rate of termites. 1% ethanolic and petroleum ether extracts of *Hedychium coronarium*, *Maranta arundinaceae* and *Acorus calamus* caused around 30% and 50% mortality at 2 hour exposure and extract concentrations of the same rhizomes at 2%-5% caused 50-100% mortality in termites at various exposure periods. Whereas *Alpinia galanga* was most effective as an anti-termite agent, as 1% ethanolic and petroleum ether extracts of *Alpinia galanga* resulted in 90% mortality at 2 hour exposure and 2%-5% extract concentrations of *Alpinia galanga* caused mortality at the rate of 95-100% at various exposure periods, i.e., dose dependent mortality was observed when both ethanolic and petroleum ether extracts of all four plants were used.

**Keywords:** Termite, Zingiberaceae, Rhizome, *Hedychium coronarium*, *Maranta arundinaceae*, *Alpinia galanga*, *Acorus calamus*.

### 1. Introduction

India is blessed with a wide variety of flora and fauna due to its climate. It also has rich forest cover. The forests and hills of the country are a treasure house of about 700 medicinal plants. Many plants are used for traditional and folk medicinal practices and have been exploited commercially for their active enzymes. Plant extracts have been used locally in herbal preparations to cure ailments even before the advent of orthodox medicine in many developing countries.

The productivity of forests and agricultural crops are generally affected by frequent outbreak of pests which causes lot of economic loss. One among the common pests that affect the crop plants are termites. Termites belong to order Isoptera. They live in huge mounds, in colonies and feed on cellulose material and on almost anything which contains carbohydrate. They are the most popular and most efficient among insects capable of decomposing lignocellulose. Termites vary in size from 1-15mm in length and their color from white to tan. They are known to cause tremendous loss to finish and unfinished wooden structures in buildings. They are one of the major agents that cause damage to fibers, cellulose, sheets, papers, clothes, woolens and mats.

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Termite infestation of green standing foliage and cereals stored in godowns is yet another problem. Termites infest many commercially important plants<sup>[1, 2, 3]</sup> and are major cause of increasing economic loss, especially in semi-arid and semi-humid tropics. The damage starts from seed to leaves, plant droops down which later wither and dry. They attack and weaken the stem which causes the plant to collapse and the plants are easily uprooted.

Many termiticides have been used for controlling termites. However chemical pesticides get accumulated in plants and there is a problem of biomagnification. This can cause serious health problems to humans, livestock and also affect the environment. The insecticidal and acaricidal properties of a number of plants have been discovered long ago, and some of the plants can compete with methods of synthetic control<sup>[4]</sup>. Rhizome extracts are being used as effective insecticidal agents. The plant uses the rhizome to store starch, proteins and other nutrients. Traditionally, extracts derived from rhizomes were used in the treatment of respiratory disorders, fever, gastro intestinal disorders, chest and lung related problems, as hypotensive, antispasmodic, CNS depressant, analgesic and as an antidote to snake venom. Few also possess anti-inflammatory, antimicrobial, antioxidant, antifungal, pediculicidal and cytotoxic activity. The anti-termite properties of rhizomes of *Hedychium coronarium*, *Maranta arundinacea*, *Alpinia galanga* and *Acorus calamus* belonging to Zingiberaceae family were analyzed in the present study.

## 2. Materials and Methods

### 2.1 Collection of Plant Material

The study was carried out between January to April 2015. Anti-termite activity was evaluated at different concentrations and different exposure periods. Phytochemical profiling of each rhizome was done to check the secondary metabolites present in the rhizomes<sup>[5]</sup>.

*H.coronarium*, *M.arundinaceae*, *A.galanga* and *A.calamus* belonging to Zingiberaceae family were selected for the current study. The plants were procured from Foundation for Revitalisation of Local Health Traditions (FRLHT), Yelahanka, Bengaluru, Karnataka, India. The plants were identified and authenticated at the Life Sciences Research Laboratory, Kristu Jayanti College, Bengaluru, India.

### 2.2 Collection of Termites

The termites were collected from Kristu Jayanti College campus and areas in and around, K. Narayanapura, Bengaluru, Karnataka, India. The termite species were identified and authenticated

as *Odentotermes* at the Entomology Department of Gandhi Krishi Vignan Kendra, Bengaluru, India.

### 2.3 Preparation of rhizome extract

The rhizomes were separated from the plant and washed to remove the debris. Then the rhizomes were cut into small pieces of 20-30mm and shade dried. 10 gm of *H.coronarium*, *M.arundinaceae*, *A.galanga* and *A.calamus* rhizomes were soaked individually in 50ml of solvents such as water, ethanol and petroleum ether for cold extraction. The preparation was left for 48 hours and then filtered using Whatman No 1 filter paper. The filtrate was concentrated by placing in a water bath at 50°C. The extract was re-constituted with respective solvents and different concentrations of the extracts were prepared ranging from 1-5%. The anti-termite activity was tested by placing circular filter paper onto different petridishes to which 1ml of the aqueous, ethanolic and petroleum ether extracts of *H.coronarium*, *M.arundinaceae*, *A.galanga* and *A.calamus* were added and then the chambers were saturated. 10 termites were added into each of the saturated chambers and then observed for anti-termite activity for 2 hours, 4 hours and 6 hours respectively. Triplicates were maintained for each of the extract. The petridishes with filter papers treated with the respective solvent (without rhizome extract) in different percentages as experimental samples served as control in each experiment. 10 termites were introduced into such chambers to check for anti-termite activity of the solvent alone.

The mortality rate (%) was calculated using the formula:

$$\text{Mortality rate (\%)} = \frac{\text{Number of termites died}}{\text{Number of termites added}} \times 100$$

## 3. Results and Discussion

The extracts of all the rhizomes showed anti-termite activity. Different concentration of aqueous extract of *H.coronarium*, *M.arundinaceae*, *A.galanga* and *A.calamus* did not have any effect on termites even after 2, 4 and 6 hours exposure period. It may be due to the fact that the secondary metabolite content was very less to be effective in controlling termites. However the ethanolic and petroleum ether extracts of *H.coronarium*, *M.arundinaceae*, *A.galanga* and *A.calamus* exhibited anti-termite activity (Table 1).

The ethanolic and petroleum ether extracts of the various rhizomes exhibited anti-termite activity. 1% ethanolic and petroleum ether extracts of *H.coronarium*, showed the least mortality rate of 30% and 50% after 2 hours of exposure and highest mortality was recorded at 4% and 5% concentration

and at 4 and 5 hours of exposure and extract concentrations of 2%-5% caused mortality in termites ranging from 85-100%. Successive hexane, chloroform and methanol extracts of the rhizome of *H.coronarium*

*Koen.* showed analgesic and anti-inflammatory activities in animal model in the previous studies by Sangeetha Shrotriya *et al.*, 2007 [6].

**Table 1:** Anti-termite activity of *H.coronarium*, *M.arundinaceae*, *A.galanga* and *A.calamus* ethanolic and petroleum ether extracts

| Nature of the extract | Mortality rate (%) |                             |     |     |                             |     |     |                        |     |     |                       |     |     |
|-----------------------|--------------------|-----------------------------|-----|-----|-----------------------------|-----|-----|------------------------|-----|-----|-----------------------|-----|-----|
|                       | Con (%)            | <i>Hedychium coronarium</i> |     |     | <i>Maranta arundinaceae</i> |     |     | <i>Alpinia galanga</i> |     |     | <i>Acorus calamus</i> |     |     |
|                       |                    | Exposure Time (hrs)         |     |     |                             |     |     |                        |     |     |                       |     |     |
|                       |                    | 2                           | 4   | 6   | 2                           | 4   | 6   | 2                      | 4   | 6   | 2                     | 4   | 6   |
| Ethanolic             | 1                  | 30                          | 70  | 90  | 50                          | 60  | 90  | 90                     | 90  | 100 | 30                    | 50  | 60  |
| Petroleum ether       |                    | 50                          | 70  | 85  | 35                          | 50  | 70  | 90                     | 100 | 100 | 50                    | 70  | 75  |
| Ethanolic             | 2                  | 85                          | 90  | 100 | 70                          | 100 | 100 | 90                     | 100 | 100 | 50                    | 55  | 60  |
| Petroleum ether       |                    | 70                          | 75  | 90  | 80                          | 90  | 100 | 95                     | 90  | 100 | 70                    | 80  | 90  |
| Ethanolic             | 3                  | 90                          | 100 | 100 | 90                          | 90  | 100 | 90                     | 100 | 100 | 65                    | 70  | 85  |
| Petroleum ether       |                    | 90                          | 95  | 100 | 95                          | 100 | 100 | 90                     | 100 | 100 | 90                    | 95  | 100 |
| Ethanolic             | 4                  | 95                          | 100 | 100 | 90                          | 95  | 100 | 95                     | 100 | 100 | 95                    | 95  | 100 |
| Petroleum ether       |                    | 100                         | 100 | 100 | 100                         | 100 | 100 | 95                     | 100 | 100 | 95                    | 100 | 100 |
| Ethanolic             | 5                  | 90                          | 100 | 100 | 90                          | 100 | 100 | 100                    | 100 | 100 | 90                    | 100 | 100 |
| Petroleum ether       |                    | 90                          | 100 | 100 | 100                         | 100 | 100 | 100                    | 100 | 100 | 100                   | 100 | 100 |

The anti-cancerous, anti-oxidant anti-hypertensive, diuretic, leishmani, head ache, lancinating pain, activities of *H.coronarium*, have also been analysed earlier by Taillor Chandra Shekar *et al.*, 2015 [7]. 1% ethanolic extract and petroleum ether extract of *M.arundinaceae* showed the least mortality rate of 50% and 35% respectively after 2 hours of exposure and highest mortality was seen in 5% concentration and 4 hours of exposure.

At minimum concentration of 1%, *A.galanga* ethanolic and petroleum ether extracts were effective as an anti-termite agent as it resulted in 90% mortality at 2 hour exposure and extract concentrations of 2%-5% caused mortality at the rate of 95-100% at various exposure periods. Ethanolic and petroleum ether extract of *A.galanga* showed a high mortality rate at all percentages at minimum hours of exposure. Similarly dual choice bioassays were used to evaluate the antifeedent property of essential oil and methanolic

extract of *A.galanga* against two species of termites, *Coptotermes gestroi* and *Coptermes curvignathus* and mean consumption of paper disc treated with the extracts were observed by Abdullah F *et al.*, 2015 [8]. With regard to *A.calamus*, minimum concentration of 1% ethanolic and petroleum ether extracts caused 30% and 50% mortality at 2 hour exposure and extract concentrations of 2%-5% caused mortality in termites at the rate of 50-100% at various exposure periods. At 6 hours exposure to 1% extract of ethanol and petroleum ether of *A.calamus* there was 60% and 75% mortality of termites. Highest mortality rate was observed in 4% ethanolic extract and 3% petroleum ether extract of *A.calamus* at 6 hours exposure period. Asha Devi S *et al.*, 2009 [9] studied the antimicrobial property of *A.calamus* using different solvents like petroleum ether, chloroform, hexane and ethyl acetate revealed that *A.calamus* leaf and rhizome extract with ethyl acetate exhibited a strong antifungal activity. The present study revealed that ethanolic and petroleum

ether extracts of *A. calamus* also possessed anti termite activity.

It is presumed that the anti-termite effect of rhizome extracts may be due to the secondary metabolite present in different rhizome. Hence the rhizome extracts were screened for the presence of possible

active phytochemical compounds. The analysis recorded the presence of major phytochemical compounds as proteins, carbohydrates, oils, saponins, terpenoids, alkaloids, steroids, flavonoids and cardiac glycosides in different rhizomes (Table 2).

**Table 2:** Phytochemical analysis of various rhizome extracts

| Phytochemical constituent | Biochemical Assay     | <i>Hedychium coronarium</i> | <i>Maranta arundinaceae</i> | <i>Alpinia galangal</i> | <i>Acorus calamus</i> |
|---------------------------|-----------------------|-----------------------------|-----------------------------|-------------------------|-----------------------|
| Alkaloids                 | Hager's Test          | -                           | +                           | -                       | +                     |
|                           | Benedict's Test       | +                           | +                           | +                       | +                     |
| Carbohydrate              | Fehling's Test        | +                           | +                           | +                       | +                     |
|                           | Xanthoproteic Test    | +                           | +                           | +                       | +                     |
| Proteins                  | Alkaline reagent Test | -                           | +                           | -                       | +                     |
| Flavonoids                | Lead acetate Test     | +                           | +                           | +                       | +                     |
|                           | Ferric chloride Test  | +                           | +                           | +                       | +                     |
| Tannins                   | Lead acetate Test     | -                           | +                           | +                       | +                     |
| Steroids                  | Salkowski's Test      | +                           | +                           | +                       | +                     |
| Terpenoids                | Salkowski's Test      | +                           | +                           | +                       | +                     |
| Saponins                  | Froth Test            | -                           | +                           | -                       | +                     |
| Cardiac glycosides        | Keller Killiani Test  | -                           | +                           | -                       | -                     |
| Oils                      |                       | +                           | +                           | +                       | +                     |

Key: + = Present, - = Absent.

Qualitative phytochemical analysis of *H. coronarium* showed the presence of carbohydrates, proteins, steroids, terpenoids, phenolic compound and oil but did not show the presence of alkaloids, flavonoids, tannins, saponins and cardiac glycosides. Earlier Lemino Singh KH *et al.*, 2013 [10] studied the phytochemical components of the methanolic extract of *H. coronarium* and *H. rubrum* also showed the presence of similar groups of compounds and tested negative for the presence of alkaloids. *M. arundinaceae* and *A. calamus* showed the presence of all phytochemical compounds but these components may be present in low concentration in both the rhizomes, hence least mortality rate was observed by *M. arundinaceae* and *A. calamus*. *A. calamus* tested negative for cardiac glycosides. The biologically active constituent of the *A. calamus* rhizome was separated and identified previously by Yingjuan Yao *et al.*, 2010 [11] where the results showed that the ethanolic extract of *A. calamus* had strong repellency and contact effect to *S. zeamais* and the active constituent of the *A. calamus* was characterized as (Z)-asarone by spectroscopic analysis. 1'S-1'-acetoxychavicol acetate

(ACE) was isolated earlier from the rhizomes of *A. galanga* by Ying Ye *et al.*, 2006 [12]. Matsuda H *et al.*, 2003 [13] isolated nine known phenylpropanoids and phydroxybenzaldehyde (1'S-1'-acetoxychavicol acetate and 1'S-1'-acetoxyeuginol acetate) from the rhizome of *A. galanga*. *A. galanga* and *H. coronarium* tested positive for few major phytochemicals whereas *M. arundinaceae* and *A. calamus* were found to possess maximum phytochemicals compared to the other species as evident from the results of the present study.

#### 4. Conclusion

Many plants and their parts are effective as insecticidal agents after adequate processing. Species belonging to Zingiberaceae have been shown anti-termite activity. *H. coronarium* and *M. arundinaceae* showed moderate mortality rate of termites, *A. calamus* expressed least mortality rate and *A. galanga* showed highest mortality even at lowest (1%) and 2 hours of exposure. Aqueous extract of all rhizomes did not exhibit anti-termite activity. Phytochemical profiling revealed the presence of major phytochemical compounds like carbohydrates,

proteins, alkaloids, flavonoids, steroids, terpenoids, saponins, oil and phenolic compounds in the rhizomes.

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