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Sowmya Sri N
Department of Life Science,
Kristu Jayanti College,
Bangalore-77, Karnataka,
India

Calistus Jude AL
Department of Life Science,
Kristu Jayanti College,
Bangalore-77, Karnataka,
India

Deepa M A
Department of Life Science,
Kristu Jayanti College,
Bangalore-77, Karnataka,
India

Corresponding Author:
Sowmya Sri N
Department of Life Science,
Kristu Jayanti College,
Bangalore-77, Karnataka,
India.

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

Author: Sowmya Sri N, Calistus Jude AL and Deepa MA

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.

Termite infestation of green standing foliages and cereals stored in godowns is yet another problem. Termites infest many commercially important plants [1, 2, 3] 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 [4]. 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 [5].

H.coronarium, M.arundinaceae, A.galanga and A.calamus belonging to Zingeberaceae 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	Con (%)	Mortality rate (%)											
		Hedychium coronarium			*Maranta arundinaceae*			*Alpinia galanga*			*Acorus calamus*		
		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 ealier 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 pocessed 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).

Tabel 2: Phytochemical analysis of various rhizome extracts

Phytochemical constituent	Biochemical Assay	*Hedychium coronarium*	*Maranta arundinaceae*	*Alpinia galangal*	*Acorus calamus*
Alkaloids	Hager's Test	-	+	-	+
Carbohydrate	Benedict's Test	+	+	+	+
	Fehling's Test	+	+	+	+
Proteins	Xanthoproteic Test	+	+	+	+
Flavonoids	Alkaline reagent Test	-	+	-	+
Phenolic compounds	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 poccess 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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6. References

1. Sahay NS, Prajapati CJ, Panara KA, Patel JD, Singh PK. Anti-termite potential of plants selected from the SRISTI database of Grassroots Innovations, *Journal of Biopesticides*. 2014; 7(Supp.): 164-169.
2. Salihah Z, Satar A, Khatoon R. Termite damage to sugarcane crop at Mardan area, Annual Tech. Rep., NIFA, Tarnab, Peshawar, Pakistan. 1986; 126-129.
3. Sattar A, Salihah Z. Detection and control of subterranean termites, Technologies for Sustainable Agriculture. Proceedings Natl Workshop (Technologies for Sustainable Agriculture) Sept. 2001; 24-26 NIAB, Faisalabad, Pakistan, 195-198.
4. Sahayaraj K, Paulraj MG. Impacts of some plant products on the behavioural bioassay of *Tribolium castaneum* Herbst in groundnut kernels, International Arachis Newsletter. 2000; 2(5): 12-17.
5. Audu SA, Muhammed L, Kaita HA. Phytochemical screening of the leaves of *Lophira lanceolata*. *Life Science Journal*, 2007;4(4): 75-79.
6. Sangeeta Shrotriya, Mohammad S Ali, Achinto Saha, Sitesh C Bachar, Md. S Islam. Anti-Inflammatory and analgesic effects of *Hedychium coronarium Koen*, *Pakistan Journal of Pharmaceutical Sciences*. 2007; 20(1): 42-47.
7. Shekar TC, Goyal A. A comprehensive review on *Hedychium coronaroium* J Koenig. (Dolanchampa/Kapurkachri), *International Journal of Research in Ayurveda and Pharmacy*. 2015; 6(1): 98-100.
8. Abdullah F, Subramanian P, Ibrahim H, Abdul Malek SN, Lee GS, Hong SL. Chemical composition, antifeedant, repellent, and toxicity activities of the rhizomes of galangal, *Alpinia galanga* against Asian Subterranean termites, *Coptotermes gestroi*and *Coptotermes curvignathus* (Isoptera: Rhinotermitidae), *Journal of Insect Science*, 2015; 15(1): 1-7.
9. Asha DS, Ganjewala D. Antimicrobial activity of *Acorus calamus (L.)* rhizome and leaf extract, *Acta Biologica Szegediensis*. 2009; 53(1): 45-49.
10. Lemino Kh, Ranjit SL, Grihanjali DP, Romabati DN, Somarjit SL, Bag GC. Comparative study of phytochemical constituents and total phenolic content in the extracts of three different species of genus *Hedychium*. *International Journal of PharmTech Research*. 2013; 5(2): 601-606.
11. Yingjuan Yao, Cai Wan-Lun, Yang Chang-Ju, Zhang Hong- Yu, HUA Hong-Xia. Isolation and characterization of insecticidal constituent acorone from *Acorus calamus* L (Araceae), *Acta Entomologica Sinica Insect science*. 2010; 53(9): 985-992.
12. Ying Ye, BaoAn Li. 1′*S*-1′-Acetoxychavicol acetate isolated from *Alpinia galanga* inhibits human immunodeficiency virus type 1 replication by blocking Rev transport. *Journal of General Virology*. 2006; 87 (7): 2047-2053.
13. Matsuda H, Morikawa T, Managi H, Yoshikawa M. The Pharmacological Activities of *Alpinia* galangal, A Review Bioorganic & Medicinal Chemistry Letters 2003; 13(19): 3197-3202.
14. Anantharaju T, Kaur G, *et al*., Sampling and identification of termites in Northeastern Puducherry. *Journal of Entomology and Zoology Studies.* 2014; 225-230.
15. Davies RG, Eggleton P, Dibog L, Lawton JH, Bignell DE., Brauman A, *et al*., Successional response of a tropical forest termite assemblage to experimental habitat perturbation. *Journal of Applied Ecology*. 1999; 36(6): 946-962.
16. Eggleton P, Bignell DE, Sands WA, Mawdsley NA, Lawton JH, Wood TG. *et al*. The Diversity, abundance and biomass of termites under differing levels of disturbance in the Mbalmayo Forest Reserve, Southern Cameroon. Philosophical Transactions of the Royal Society of London, Ser. B. Biological sciences. 1996; 351: 51-68.
17. Isman M. Plant essential oils for pest and disease management, Crop Protection. 2000; 19(8-10): 603-608.
18. Jayashree S, Rathinamala J, Lakshmanaperumalswamy P. Anti-termite properties of root and leaf powder of Vetiver grass. *Journal of Environmental Biology*. 2013; 35: 193-196.

19. Nishaa S. Phytochemical Screening and GC-MS Analysis of Ethanolic Extract of Rhizomes of *Maranta arundinacea L. Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2013; 4(2): 52-59.
20. Chintan VP, Aditee JJ, Balubhai AG. Antifungal activity of crude extracts of *Hedychium coronarium. International Journal of Research in Ayurveda and Pharmacy*. 2014; 4(1): 4-6.
21. Ramesh VK, Garia M, Singh P, Jha KK, Khosa RL. *Alpinia galanga* – An Important Medicinal Plant: A review, *Der Pharmacia Sinica*. 2011; 2 (1): 142-154.
22. Rao MR, Singh MP, Day R. Insect pest problem in tropical agroforestry systems, contributory factors and strategies for management, Agro System. 2000;50:243-277.
23. Sani AA, Ilyas M, Haruna AK. Phytochemical screening of the leaves of *Lopira lanceolata. Life Science Journal*. 2007; 4(4): 75-78.
24. Upadhyay RK. *et.al*. Effects of plant latex based anti-termite formulations on Indian white termite *Odontotermes obesus* (Isoptera: Odontotermitidae) in sub-tropical high infestation areas. *Open Journal of Animal Sciences*. 2013; 3: 281-294.
25. Xin Chao Liu, Li Gang Zhou, Zhi Long Liu and Shu Shan Du. Identification of Insecticidal Constituents of the Essential Oil of *Acorus calamus* Rhizomes against *Liposcelis bostrychophila* Badonnel., Molecules. 2013;18(5):5684-5696.

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