

Anti-termite potential of plants selected from the SRISTI database of Grassroots Innovations

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ABSTRACT

Grassroots innovations and traditional knowledge are precious resource which provides solutions for various kinds of problems and local needs. A review of SRISTI database suggest that large number of grassroots practices are being used by the farmers in the field conditions to control the termite (*Odontotermes obesus* Rambur) attack. In this study, five plant species being used by grassroots innovators in different forms of preparation for termite control in field conditions were selected for efficacy evaluation. Herbal formulations were developed from the aqueous extracts of twig of *Aristolochia bracteata* Retz. (Aristolochiaceae), twig of *Solanum surattense* Burm.f. (Solanaceae), leaves of *Calotropis procera* Ait. f. (Asclepiadaceae), milky latex of *Euphorbia tirucalli* L. (Euphorbiaceae) and oil of *Ricinus communis* L. (Euphorbiaceae). Primary screening of the individual extracts, oil and milky latex at 10% concentration shows that *C. procera*, *A. bracteata*, *R. communis* (oil) and *E. tirucalli* (latex) are having significant effects and caused 100% mortality. However, *S. surattense* caused 88.89% mortality. Compared to the individual treatments, mixture of extracts of *C. procera*, *A. bracteata*, *S. surattense*, oil of *R. communis* and milky latex of *E. tirucalli* showed better results in terms of mortality and hence should be preferred for termite control. The results obtained from the experiments are encouraging and proves efficacy of the plants in control of termite. The formulations based on the above plants could be green alternative for the termite control.

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INTRODUCTION

Termites are one of the most agriculturally important insects and are known to cause enormous economic losses to many crop plants and tree species, buildings, etc. It has the competence to infest at various stages of plant growth (Mitchell, 2002) and cause severe losses in sugarcane, maize, wheat, fruits etc. (Salihah *et al.*, 1986; Sattar and Salihah, 2001) and caused 50-100% yield losses in different crops (Rao *et al.*, 2000; Sekamatte *et al.*, 2001).

Harmful chemical pesticides are extensively applied for controlling the termite attack (UNEP, 2000; Venkateswara *et al.*, 2005) which has serious deleterious impacts on non-targeted biotic and abiotic factors of environment (Dennis, 1981, Pimental, 1995). Thus it is necessary to focus on plant-based pesticides to control the termites. Researchers have screened extracts, latex, quinones, etc. of many plant species such as *Diospyros*

sylvatica (Ganapathy *et al.*, 2004); *Calotropis procera* (Upadhyay, 2013); *Ipomea fistulosa*; *Maesa lanceolata*, *Chenopodium spp*, *Azadirachta indica*, *Croton macrostachyus*, *Tagetes minuta*, *Datura stramonium*, *Vernonia amygdalina*, *Phytolacca dodecandra*, *Nicotiana tobaccum*, *Shinus mole* and *Ficus vasta* (Ahmed and Girma, 2013; Gold *et al.*, 1991) against *Odontotermes obesus* (Rambur). *Ipomea carnea*, *Cleome viscosa* and *Pavonia glechomifolia* has been tested against tea termites (*Microcerotermes beelsoni* Snyder and *Microtermes obesi* Holmgren) (Singha *et al.* (2012).

Efficacy of various plants and their extracts have been examined in *in vitro* and field conditions but still there is a need to develop suitable efficacious botanical based formulations to tackle the losses caused by termites. Many of the farmers are using various plant-based preparations (neem, wild tobacco, dried chillies, *Calotropis* and wood ashes) to control and repel termites in crop fields

(Dokurugu *et al.*, 2012; Nwilene *et al.*, 2008; UNEP, 2000). The review of literature advocates that still lot of efforts are required to find out new plants and developed suitable and effective anti-termite herbal formulations. The one possible method is thorough screening of already available ecofriendly solutions traditionally being used by the local people, select the promising ones and develop the effective formulations. Society for Research and Initiative for Sustainable Technologies and Institutions (SRISTI) in co-ordination with National Innovation Foundation India (NIF) has scouted and documented large number of herbal grassroots agriculture practices/solutions. Many grassroots innovators have developed effective alternative ecofriendly methods and/or formulations for termite control in the field crops. The name of few grassroots innovators and the plant(s) used by them to control termites are listed in Table 1 (SRISTI database-www.sristi.org). In this study, the plants claimed to be effective against termites were selected for evaluation under lab conditions. The main aim of this study was to find out the effective doses and develop appropriate mixtures/formulations using different combinations of extracts of plants, for controlling termites.

MATERIALS AND METHODS

Preparation of extracts and Mixtures

Plants and/or their parts were collected from different locations of Gujarat, brought to laboratory, cleaned and dried under shade conditions. Aqueous extracts of *A. bracteata* twig (AB), *S. surattense* twig (SS) and *C. procera* leaves (CP) were prepared by taking 5 to 40g of samples in the same quantity of water (300 ml). The samples were heated at 100°C for 3 hours, till the final volume was 100ml (un-concentrated final extract - UFE) and was used as such for the development of four mixtures. The ratio of plant sample and water used for *A. bracteata* was 1:100 to 1:12.5; while as for *C. procera* (CP) and *S. surattense* (SS) it was 1:80 to 1:10. Per cent extraction of each plant sample was calculated by evaporating the above extracts up to dryness. Milky latex was collected by plucking the fresh stems of *E. tirucalli* and the oozes were taped in a clean glass vial. The oil of *R. communis* was procured from the local market.

Primary screening for anti-termite activity was carried out with 10% aqueous solution of the plant extracts (UFE) and potential ones were selected for

dose standardization using 3 different concentrations (100, 200 and 300 µl per wooden strip). Based on the outcomes of dose standardization experiments, four mixtures were prepared as mentioned below: Mixture 1: Equal quantities of CP, AB, SS, ET latex and RC oil. Mixture 2: Equal quantities of CP, AB and SS. Mixture 3: Equal quantities of AB, SS and ET latex. Mixture 4: Equal quantities of AB, SS and RC oil. The individual extracts and the mixtures prepared were evaluated for their efficacy against the termites at different concentrations.

Bioassay

Strips (3.5 L x 0.5 W cm) were prepared from 3 ply corrugated boxes and were treated with above prepared experimental solutions. The strips were treated with 300µl of 10% extracts (UFE) for primary screening; 100 µl, 200 µl and 300µl of the extract for dose standardization and 100µl, 150µl and 200µl of extract mixtures for combination experiments (Fig 1). The loaded strips were placed in 5 (L) x 1 (W) cm glass vials to test their efficacy. Termites were collected from the affected field areas, placed inside the experimental glass vials with the help of a hard paint brush and mouth was wrapped with perforated aluminum foil. Perforation in the foil was done with a paper pin to allow the air flow. The experimental vials were kept in a growth room at 28±2°C temperature and normal fluorescent light during the day (tube light of 30W). Observations were done at the interval of 12 hours and motility and mortality of termites were recorded at 48 hrs after treatment. Each treatment contained 3 termites and three replicates of all the treatments were maintained. The control sets were treated only with 300 µl of water.

RESULTS AND DISCUSSION

Standardization and quantification of the plant extract: The percentage of extracts varies when the quantities of material used were changed, keeping water quantity same. A variation in % extract and their activity has also been reported by many workers (Dorta *et al.*, 2012; Koul and Koul, 2007; Mingarro *et al.*, 2003; Owoseni and Sangoyomi, 2014; Tatiya *et al.*, 2011). The solvent volume was kept constant and quantity of plant materials were increased from 5 to 40g in order to standardize the optimum ratio for achieving higher yield (Fig 2).

Table 1. Grassroots innovators using the plants to control termite infestations in their crop and agriculture field.

Name of Plants	Grassroots Innovators (www.sristi.org)
<i>C. procera</i>	Narayanbhai Paragbhai Sarvaliya, Surendranagar; Manubhai Mavjibhai Thakor, Sanand; Balabhai Dudhabhai Makawana, Bhavnagar; Naranbhai Jivanbhai Patel, Surendranagar; Prabhatsinh Bharatsinh Patel, Dahod; Jigarbhai Hareshbhai Trivedi, Bhavnagar; Ranchhodbhai Patel, Mehsana; Punabhai Rajabhai Raval, Patan; Dinubhai Shakrabhai Patel, SK Nagar; Shaileshkumar Revabhai Patel, Mahesana; Ranchhodbhai Abhabhai Chaudhari, Patan; Champakbhai Fetehsinh Rathod, Gandhinagar; Laxmanbhai Tribhovanbhai Barot, Banaskantha; Lalabhai Madhabhai Bharvad; Vitthalbhai Chhitabhai Vasava, Thikariya-Sejapur, Vadodara; Babubhai Sardarbhai Rajasthan; Ishvarbhai Hirabhai Solanki, Ahmedabad.
<i>A. bracteata</i>	Manubhai Khumabhai Damor, Sabarkantha.
Castor oil	Umedbhai Keshubhai Patel, Patan; Vitthalbhai Manubhai Rathor, Chota Udaipur; Mahenrabhai Kalubhai Satani, Bhavnagar; Narayanbhai Vitthalbhai Patel, Kheda; Madhavbhai Bhopabhai Solanki, Rajkot; Rameshbhai Devabhai Vanakar, Kheda; Raghubhai Chothabhai Malakiya, Surendranagar; Karshanbhai Bhagvanbhai Gajera, Junagadh; Vechanbhai Revalabhai Rathva, Vadodara; Ajmal Narayanlal Damor, Rajasthan; Mandubhai Ramjibhai Bariya, Panchmahal; Bhikhabhai Dalabhai Rathva, Panchmahal.
<i>S. surattense</i>	Nathubhai Becharbhai Patel, Himatnagar
<i>E. tirucalli</i>	Shri Laljibhai Chaudhari, Palanpur; Sukhajibhai Sodha, Kheda; Shivarambhai Vhora, Palanpur; Laxmanbhai Tribhovanbhai Barot, Banskantha; Babubhai, Sardarbhai Malivad, Dungarpur; Amratbhai Kalabhai Zala, Kheda.

Fig.1. Shows complete process of efficacy evaluation trials.

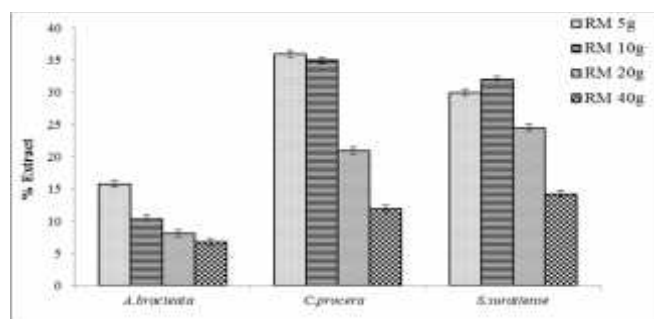
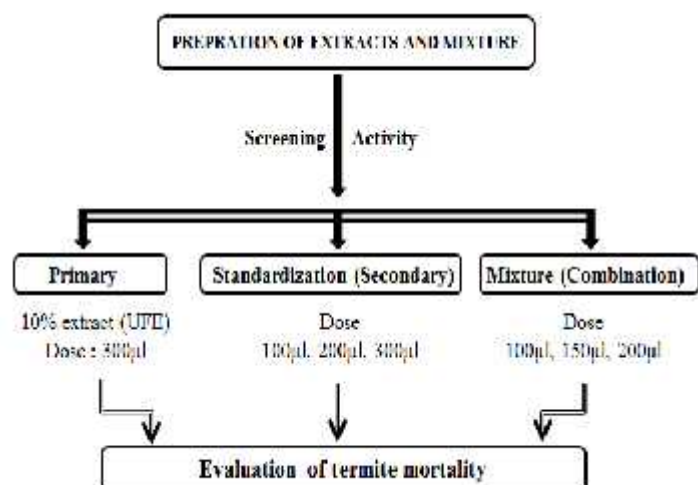


Fig. 2. Shows % extract obtained during standardization process. Four different weights (5, 10, 20 and 40g) of Raw Material (RM) were used.

The maximum yield was obtained in *CP* followed by *SS* and *IF* at 1:80 ratio. It is well proved by the experiments that the universal ratio of plant material and solvent for extraction cannot be generalized (Daniel, 1991). High water and low plant material has resulted into increase % extract yield. The reason for this may be the availability of

optimum quantity of water required for dissolving the water soluble fractions of plant material.

Table 2. Primary screening and standardization of concentration of the extract for mortality of *O. obesus*

Plant	Per cent Mortality at different doses*			
	10%	100µl	200µl	300µl
<i>C. procera</i>	100±0.0	33.33±0.0	66.67±0.0	100±0.0
<i>A. bracteata</i>	100±0.0	33.33±0.0	66.67±0.0	100±0.0
<i>S. surattense</i>	100±0.0	0.0±0.0	66.67±0.0	88.89±11
<i>E. tirucalli</i>	55.56±11	0.0±0.0	33.33±0.0	100±0.0
<i>R. communis</i> Oil	100±0.0	0.0±0.0	33.33±0.0	100±0.0
Control	0.0	0.0±0.0	0.0±0.0	0.0±0.0

*Data are the means of replicates with standard error (±).

Efficacy of extracts and formulations

Primary screening of the extracts, oil and milky latex from the respective plants (Table 2) reveals that *C. procera*, *A. bracteata*, *R. communis* and *E. tirucalli* were highly effective and causes 100% mortality in termite. In dose standardization experiments, a dose of 300µl of *C. procera*, *A. bracteata*, *R. communis* (oil) and *E. tirucalli* (latex) were found 100% lethal while as *Solanum surattense* showed 88.89% mortality (Table 2). At 100µl dose mixture 1 was found highly effective as compared to others while as at 150 µl dose mixture 2, 3 and 4 showed 100% mortality (Table 3). Plant contains large number of phytochemicals such as quinones, di-terpines, amides, flavonoids, etc. which are well known for their anti-feedant, repellent and toxic nature against termites (Boue and Raina, 2003; Meepagala *et al.*, 2006; Shi *et al.*, 2008). Nerio *et al.* (2010) in a review have thrown light on the importance of synergistic effects of natural compounds acting as repellent against termite. These natural chemicals can work synergistically,

improving their effectiveness. Seo *et al.* (2009) have shown a dose dependent response of essential oil ajowan (*Trachyspermum ammi*), allspice (*Pimenta dioica*), caraway (*Carum carvi*), dill (*Anethum graveolens*), geranium (*Pelargonium graveolens*), and litsea (*Litsea cubeba*) against termite. The above findings are very encouraging and provide an ecofriendly solution to develop a very effective and low cost product to control termites. A series of environmentally friendly products can be developed by varying the concentrations of plant extracts in formulations that can be used to control termites.

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Table 3. Screening of the combination of the plants.

Combinations of Extracts	% Mortality at different doses of formulation		
	100µl	150µl	200µl
Mixture 1 (<i>C. procera</i> , <i>A. bracteata</i> , <i>R. communis</i> , <i>S. surattense</i> , <i>E. tirucalli</i>)	88.89	88.89	100
Mixture 2 (<i>C. procera</i> , <i>A. bracteata</i> , <i>S. surattense</i>)	44.44	100	100
Mixture 3 (<i>A. bracteata</i> , <i>S. surattense</i> , <i>E. tirucalli</i>)	11.11	100	100
Mixture 4 (<i>A. bracteata</i> , <i>S. surattense</i> , <i>R. communis</i>)	66.67	100	100
Control	0.00	0.00	0.00

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