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RESEARCH ARTICLE

TERMICIDAL ACTIVITY OF SEAWEED EXTRACTS AGAINST *GLYPTOTERMES SP.* (ISOPTERA: TERMITIDAE)

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ABSTRACT

Treatment of soil with insecticides to control subterranean termites causes environmental degradation. Seaweed extracts from Kanyakumari coast (South West coast of India) were tested for termicidal activity against *Glyptotermes sps*. *Gracilaria edulis* showed maximum LD_{50} (0.53±0.36) and minimum LT_{50} (58.65, 45.69, 42.084 and 39.96min) at 0.25, 0.50, 0.75 and 1µ.ml^{-1} concentrations respectively than the other seaweeds extracts followed by *Chaetomorpha indica* (0.55±0.7), *Chaetomorpha compressa* (0.65±0.74) and *Amphirova anceps* (0.8±0.21) which showed minimum LD_{50} values. The presence of sugars, terpenoid, alkaloid, protein *G.edulis* might be the lead termicidal compounds if incorporated in to the paints or as a powder could control the termites.

INTRODUCTION

Termites cause significant damage to the wooden components of building structures in urban areas throughout the world. In USA alone, the estimated annual damage caused by termites has been reported to be US $ 1.7billion and corresponding loss is estimated to be more than US $ 100 million in Australia. Currently available organophosphate and pyrethroid soil termicides are effective (Su and Scheffrahn, 1990b; Kard, 1996a) but cause environmental degradation. Safe and alternative termicidal compounds are the need of the hour. It was estimated that about 90% of the species of marine plant are between algae and photosynthesis is contributed from alga (Dhargalkar and Neelam, 2005). Approximately 841 species of marine algae found in both inter-tidal and deepwater regions of the Indian coast (Oza and Zaidi, 2005). These vast varieties of seaweeds were found to possess useful untapped biochemical compounds, which might be a potential source of drug leads in the future (Huang *et al,* 2005). Until now, more than 2400 marine natural products have been isolated from seaweeds of subtropical and tropical populations (Munro *et al*., 1999 and Faulkner, 2001). These natural products are known as secondary metabolites which posses a broad range of ecological interactions in marine life (Hay, 1996). . Several seaweeds have shown a wide range of bioactive properties (Ravikumar *et al.,* 2002, 2005, 2009, 2010a; Suresh Kumar *et al.,* 2002; Jothibai Margret *et al.,* 2009; Barbosa *et al.,* 2007; Sultana *et al.,* 2005; Ponce *et al.,* 2003; Bazes *et al.,* 2009). The present study was undertaken to find out the termicidal activity of chosen seaweed extracts.

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MATERIALS AND METHODS

Collection of seaweeds

Eight species of seaweeds *viz*., *Amphiphora anceps* , *Chaetomorpha indica, Enteromorpha intestinalis, Gracillaria edulis, Ulva lactuca, Chaetomorpha compressa, Sargassum wightii* and *Helimeda gracilus* were collected from South West coast and North East coast of Tamil Nadu *viz.* Muttom, Arokiapuram (Lat 8° 06, 51.8''N and Long 69° 13' 22''E), Vattakottai (Lat 8° 07' 47.18N and Long.77° 33' 32.66E)and Mandapam (Lat 9° 45'N Long 79° 13E) Gulf of Mannar collected samples were washed thrice with tap water and twice with distilled water to remove the adhering salts and other associated animals and then shade dried for the extraction of bioactive compounds.

Extraction of Crude Bioactives

Dried seaweed samples were separately cut into small pieces and subjected for percolation (Cold extraction). Approximately 200 gm of seaweeds samples were soaked in 500 ml of ethanol for 7 days for the extraction of bioactive compounds. The coloured ethanol solvent along with the

flash evaporator (Suferfit, India) and further subjected for distillation (60°C). The solvent extracts were collected in separate petri dishes and excess ethanol allowed to evaporate for 24 hours. The dried seaweed extract was collected, weighted and stored at 4°C in pre- sterilized plastic tubes for subsequent use.

Table 1. LD_{50} values of seaweed extracts at different time against *Glyptotermes sp*

Seaweed extracts	Exposures Time (min)			
	24h (LFL-UFL)	48h (LFL- UFL)	72h (LFL- UFL)	96h (LFL- UFL)
Control	-	-	-	-
Amphirova anceps	1.42±0.19 (1.02-1.83)	1.60±0.25 (1.09-2.12)	0.833±0.24 (0.34-1.32)	0.8±0.21 (0.44-1.2)
Chaetomorpha indica	1.60±0.25 (1.09-2.12)	1.15±0.14 (0.89-1.44)	0.57±0.16 (0.24-0.9)	0.55.±0.7 (1.09-1.9)
Gracilaria edulis	1.53±0.56 (1.39-3.66)	0.933±0.24 (0.34-0.32)	0.81±0.72 (1.45-1.4)	0.53±0.36 (0.08-1.57)
Enteromorpha intestinalis	1.42±0.22 (0.96-1.89)	0.95±0.22 (0.5-1.4)	1.8±0.5 (0.7-2.8)	0.833±0.74 (0.68-2.34)
Chaetomorpha compressa	1.53±0.35 (0.98-0.45)	1.12±0.2 (0.22-1.9)	0.98±0.5 (0.44-1.2)	0.65±0.74 (0.54-1.7)
Sargassum weigtii	1.96±0.44 (1.07-2.88)	2.63±0.47 (1.66-3.60)	1.5±0.2 (1.09-1.9)	1.9±0.67 (0.63-3.36)
Ulva lactuca	1.08±0.17 (0.73-1.44)	1.09±0.19 (0.707-1.48)	1.6±0.25 (1.09-2.12)	0.9±0.22 (0.48-1.42)
Halimedia gracilus	1.56±0.2 (1.14-1.97)	1.5±0.2 (1.09-1.9)	1.02±0.13 (0.75-1.2)	0.4±0.74 (1.09-1.9)

LFL – Lower Fiducial Limits, UFL- Upper Fiducial Limits, ± Standard Error, (-) No activity

Table 2. LT_{50} values of seaweed extracts at different concentrations against *Glyptotermes sp*

Seaweed extracts	Concentration of Extracts (µg.ml^{-1})			
	(0.25 µg.ml^{-1}) (LFL-UFL)	(0.50 µg.ml^{-1}) (LFL-UFL)	(0.75 µg.ml^{-1}) (LFL-UFL)	(1.0 µg.ml^{-1}) (LFL-UFL)
Control	-	-	-	-
Amphirova anceps	52.2 (43.12 -61.2)	56.05 (48.09 – 93.2)	55.76 (44.7 – 93.2)	68.13 (56.33 – 87.7)
Chaetomorpha indica	55.57 (51.54 – 63.4)	56.92 (48.54 – 65.30)	59.81 (50.66 – 68.97)	60.38 (50.96 – 69.81)
Gracilaria edulis	58.65 (46.05 – 89.4)	45.69 (36.27 – 67.82)	42.084 (32.34 – 64.12)	39.96 (31.4 – 55.9)
Enteromorpha intestinalis	72.52 (84.56 – 92.6)	81.474 (74.89 – 92.65)	58.65 (46.05 –105.41)	84.93 (58.18 – 85.6)
Chaetomorpha compressa	58.23 (47 .92 – 95.6)	72.87 (53.47 – 88.9)	88.37 (57.5 – 82.1)	44.57 (35.23 – 65.5)
Sargassum weigtii	46.32 (38.1 – 54.44)	47.42 (41.6 – 57.1)	40.81 (32.3 – 56.76)	68.79 (49.8 – 65.7)
Ulva lactuca	76.87 (56.65 – 87.5)	85.88 (58.9 – 75.8)	76.55 (50.18 – 47.8)	76.83 (56.7 – 87.9)
Halimedia gracilus	59.81 (50.8 – 68.97)	63.16 (49.7 – 126.9)	58.65 (46.05 – 109.8)	56.91 (44.29 – 105.7)

LFL – Lower Fiducial Limits, UFL- Upper Fiducial Limits, ± Standard Error, (-) No activity

Table 3. Photochemical constituents in mangrove extracts

Name of Seaweeds	Phytochemical constituents													
	Alkaloids	Carboxylic acid	Coumarins	Flavanoids	Quinones	Phenols	Saponins	Xanthoproteins	Carbohydreate	Protein	Resins	Steroids	Terpenoids	Tannins
Amphirova anceps	+	-	-	+	+	+	-	-	+	+	-	+	-	-
Chaetomorpha indica	-	-	-	-	-	-	-	-	+	+	-	-	+	-
Gracilaria edulis	+	-	-	+	-	-	-	-	+	+	-	-	++	-
Enteromorpha intestinalis	-	-	-	-	-	-	-	-	-	+	+	-	-	-
Chaetomorpha compressa	+	-	-	-	-	-	-	-	+	+	-	+	-	-
Sargassum weigtii	-	-	-	-	-	-	-	-	-	+	+	-	-	-
Ulva lactuca	+	-	-	+	+	+	-	-	+	+	-	+	-	-
Halimedia gracilus	+	-	-	+	+	+	-	-	+	+	-	+	-	-

- Absent, + Medium, ++ High

No choice test (Toxic effect test)

Various concentrations of (0.25µg.ml^{-1}, 0.50µg.ml^{-1}, 0.75µg.ml^{-1} and 1µg.ml^{-1}) mangrove extracts were dissolved in ethanol solvent. Pre sterilized extract treated cellulose filter paper (4.5cm dia.) was placed at the bottom of covered plastic petridish (5cm dia. 3.5cm height). The solvent was allowed fully to evaporate from the filter paper until dry. 30 numbers of worker termites were placed in the petridish for each concentration. 1 ml of 70% ethanol without the extract served as control. Petri dishes were maintained in incubator under 26±2°C and RH 100%. The mortality rate was calculated for Lower fiducial level and Upper fiducial level values were calculated through Statplus 2009 professional programme.

RESULT

LD_{50} of leaf extracts of seaweeds are given in Table 1. The mortality time differed among the plant extracts. *G. edulis* showed minimum LD_{50} (0.53±0.36) value than the other seaweeds extracts and found significantly (P>0.05) followed by *C. indica* (0.55±0.7), *C. compressa* (0.65±0.74) and *A. anceps* (0.8±0.21). LT_{50} values of seaweeds extracts is represented in Table 2. It clearly reveals that, increasing concentration of extracts reduced the time to reach the LT_{50} of the seaweeds extracts, *G. edulis* showed minimum time (58.65, 45.69, 42.084 and 39.96min) at 0.25 µg.ml^{-1}, 0.50 µg.ml^{-1}, 0.75 µg.ml^{-1} and 1.0 µg.ml^{-1} concentrations respectively followed by *S. weigtii, H. gracilus, A. anceps C. indica* and *U. lactuca* . The phytochemical studies reveals that,

constituents namely, alkaloids, flavonoids, terpenoids, saponins, resins, carboxylic acids, quinones, xanthoproteins, steroids, coumarins, phenols, proteins and tannins (Table 3).

DISCUSSION

Termites cause significant damage to the wooden components throughout the world. An organochlorine insecticide has been widely used to control subterranean termites (e.g. *Glyptotermes sp, Coptotermes sp, Mastotermes sp*, *Heterotermes sp*). Owing to the undesirable environmental properties and potential human risks posed by the organophosphates (chlorpyrifos and isofenphos), pyrethroids (bifenthrin, cypermethrin, fenvalevate and permethrin) and chloronicotinyl (imidacloprid) insecticides have been used for many years in agriculture for insect pest control. Several studies have shown the importance of these chemicals to control termites (Cink *et al.,* 1993) and consequently they are being used to prevent and to control termites infestation in building structures.Seaweeds possess structurally diverse secondary metabolites and many researchers reported that, seaweeds are an excellent source of components such as polysaccharides, tannins, flavonoids, phenolic acids, bromophenols and carotenoid. Seaweeds showed various biological activities such as antibacterial (Ravikumar *et al.,* 2002, 2005, 2009; Suresh Kumar *et al.,* 2002; Shehnaz, 2003), antiplasmodial activity (Ravikumar *et al.,* 2010c) , antifungal (Ravikumar *et al.,* 2009; Rao and Shelat, 1982; Vidhyavathi and Sridhar, 1991), antiviral (Ponce *et al.,* 2003; Zhu *et al.,* 2003) , anti-inflammatory (Tan et al., 2000; Jothibai Margret *et al.,* 2009) , cytotoxic (Manilal *et al.,* 2009; Shehnaz, 2003) nematicidal (Manilal *et al.,* 2009; Baqar Naqvi *et al.,* 1992) , antifeedant (Manilal *et al.,* 2009) , larvicidal (Manilal *et al.,* 2009), phytotoxic (Shehnaz, 2003), anticoagulant (Anand Ganesh *et al.,* 2009) and spermicidal activities (Ravikumar *et al.,* 2011c). In the study, described herein, workers of *Glyptotermes sp* were killed at different time points with different seaweed extracts. This might be due to the presence of various phytochemical components such as alkaloids, flavonids, phenols, saponins, terpenoids, carbohydrate, protein, steroids, tannins, sugars present in the chosen seaweeds species (Table 3) It is already reported that, 45% mortality of *Heterotermes indicola* on filter paper with 1:1 (w/v) concentration of flower water of *Calotropis procera* was obtained in ten days (Abid *et al.,*1997). Several terpenoids and polyphenolic compounds have been already reported to have insecticidal action (Sahayaraj *et al*., 2002; Tripathi and Rathore, 2001). Terpenoid compounds are between seaweeds known to have nematicidal activity (Abid *et al.,* 1997). Domoic acid isolated from Digenea simplex and *Chondria armata* displayed anthelminthic activity (Higa *et al.,* 2000). Considering the emerging issues pertaining to the use of chemical pesticides, suitable alternative resources and ecofriendly perspective are an urgent need of sustainable agriculture. Many essential oils and their constituents are reported to possess juvenile hormone activity (Bowers, 1985).

Conclusion

It is inferred from the present study that, *G.edulis* showed maximum effect of termicidal activity (LD_{50} 0.53mg) and hence, the ethanolic extract of *G.edulis* could be used as a formulations and as powder dusting.

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