Anti-termite efficacy of hydro-alcoholic extracts from wild giant taro plant (Alocasia macrorrhizos)

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***Abstract*— A method of measuring the percentage of mortality and its cytotoxicity against white termites Odontotermes obesus (Isoptera: Odontotermitidae) using plant extracts from wild giant taro (Alocasia macrorrhizos). The utility of this technique is demonstrated using the different samples of plants extracts from leaves, rhizomes, and stalks using water and ethanol as solvents. The results of the study showed that the extraction of samples from stalks using ethanol were highly acidic, high mortality rate on brine shrimp nauplii and high toxicity level with an LC50 value of 39.75 g/ml as compared to the positive control. Almost no mortality was found in the control group. Hence, the extraction from the stalks proved to have high percentage yield and anti-termite efficacy using ethanol as solvent. More details about phytopharmacological studies must be investigated and it is recommended that people should be educated about these problems so as to prevent further poisonings and decrease use of this plant for decorative household purposes**

***Index Terms*— Anti-termite activity, Alocasia macrorrhizos, cytotoxicity, white termites.**

I. INTRODUCTION

Termites are invasive species of insects and often called white ants. They mostly feed on dead plant material and cellulose in the form of wood, leaf litter, soil, or animal dung. They are major detritivores, particularly in the subtropical and tropical regions.

Subterranean termites are insects that feed on wood, frequently becoming pests of homes. There are two types of termites commonly encountered by homeowners: the worker and the swarmer. Worker termites are creamy colored, 3-4 mm long, and typically only seen when a mud foraging tube is broken, or infested wood is broken open. Swarmers are the reproductive cast of the termite colony. They are approximately 4 mm long and dark brown or black in color. They may or may not have wings, as the swarmers lose their wings shortly after emergence.

Many termite species can do great damage to unprotected buildings and other wooden structures. Like damp wood termites only attack lumber material exposed to rainfall or soil and dry wood termites thrive in warm climates. Human activities can enable them to invade homes since they can be transported through contaminated goods, containers and ships.

Termite poisonings or termiticides were banned due to organochlorines that led to the introduction of other groups of chemicals known as organophosphates and synthetic pyrethroids. However, compared to the organochlorines,
these have a relatively short life in contact with the soil. There are also other non-chemical alternatives, the pyrethroids appear to have some repellent characteristics, but they are not as powerful as the banned organochlorines which have exceptional repellency.

It is of critical importance that you have a perimeter termite barrier around the outside of the building and that it is not disturbed. There have been many termite infestations in recently built houses, and the incidence appears to be increasing. Most attacks involve entry points around the outside of the building, where the termites have simply come up the concrete footing.

Other non-chemical alternatives that have some repellent characteristics are the extracts from wild giant taro plants (*Alocasia macrorrhizos*). This wild taro is a giant plant with distinctive leaves and is valued as as popular ornamental plant grown for its large foliage and striking aroid inflorescences. It has also shown promise in sewerage treatment, as it grows rapidly in wetland conditions and has a propensity to accumulate metal contaminants such as zinc. The rhizomes, the swollen underground stems contain an anti-fungal protein called alocasin. They are also used for food for people and animal feeds, but they require prolonged preparation and boiling or roasting to rid them of stinging calcium oxalate crystals.

However, *Alocasia macrorrhiza* becomes poisonous, if these plants are not properly handled, washed and cooked because it contains sapotoxin and calcium oxalate which can induce neurological and gastrointestinal disorder after ingestion of the plant. The latent period from exposure to onset of symptoms is 10 to 30 minutes and death might occur in patients with severe poisoning. Skin contact or eye contact with *Alocasia macrorrhiza* juice can cause pruritus, conjunctivitis and even blindness. Inhalation of *Alocasia macrorrhiza* powder can lead to severe mucosal irritation in the eye, nasal cavity and throat poisoning.

Hence the researcher wants to investigate a non-chemical insect repellent and less expensive termiticides utilizing the hydro-alcoholic extracts from wild giant taro plants (*Alocasia macrorrhizos*) against termite infestation.

II. OBJECTIVES

General Objective

To investigate the anti-termite efficacy of wild giant taro plants (*Alocasia macrorrhizos*) against white termites using hydro-alcoholic extract.

Specific Objective

1. To identify quantitatively the plant extracts using water and ethanol as solvents;
2. To investigate the percentage mortality and cytotoxicity level of the different plant's extracts;
3. To determine the anti-termite efficacy using different samples of plant extracts.

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Schematic Diagram

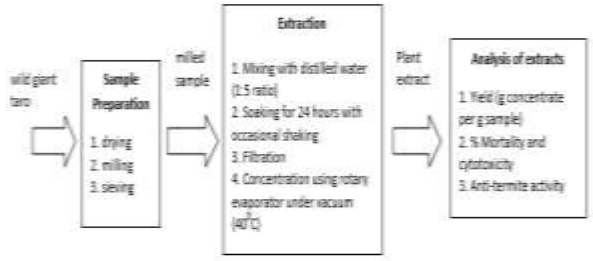

Fig. 1 A diagram showing the utilization of wild giant taro leaf extracts as termiticides

III. Methodology

Conceptual Process

The overall steps are employed to determine the product yield and the process from the utilization of the wild giant taro extract as an antitermitic activity as shown in Figure 2

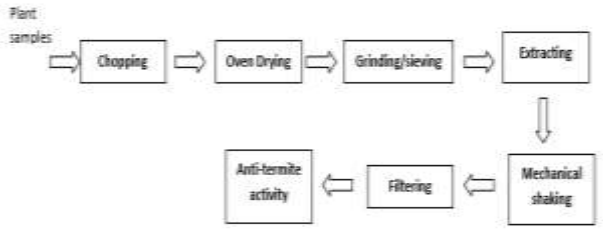

Fig. 2 A diagram showing the overall process steps of hydro-alcoholic extraction from wild giant taro

Plant material

A. macrorrhizos species or locally known as "*badjiang*" were collected in Sitio Kabayabsan, Brgy. San Miguel Palompon, Leyte Philippines, and were authenticated by local farmers and plant experts.

Preparation of extract

The rhizomes, stems, and leaves were oven-dried for 115-120 ^{0}C and ground into powder. The ground materials were soaked in a sufficient amount of ethanol for 1 week at room temperature, with occasional shaking and stirring, and were then filtered through a cotton plug followed by Whitman filter paper No. 1. The solvent was concentrated using rotary evaporator under vacuum at room temperature to yield a more concentrated liquid. The extract was then preserved in a refrigerator until further use.

Experimental animals

Termites, about 20 in number were collected from the Brgy. San Miguel Palompon, Leyte, and housed in glass cages under controlled conditions. These termites were exposed to an alternating cycle of 12 h of light and 12 h of the dark. These termites were allowed free access to get their food from the drift wood. The termites were acclimatized for 7 days.

Treatments

Thirty active termites were used in the study, divided randomly into two (2) sets having three (3) groups each. Each group in the sample contained five (5) termites. The first set of groups served as a control using water as a solvent was treated with different sample extracts. The other set of groups served as an experimental using ethanol as dissolving solvent. Each termite in a group received about 1ml dose of extracts from different samples.

Brine shrimp lethality

The cytotoxicity level was performed on brine shrimp (*Artemia salina*) nauplii. The matured shrimp were then applied to each of the experimental and the control containers. After 24 h, the containers were inspected using a magnifying glass and the number of surviving nauplii in each vial was counted. From these data, the percent (%) mortality of the brine shrimp nauplii was calculated for each concentration using the following formula:

$$\% \text{ Mortality} = (N_t / N_o) \times 100,$$

Where N_t = the number of killed nauplii after 24 h of incubation and N_o = the number total nauplii transferred, i.e. 5. The median lethal concentration (LC_{50}) was then determined.

IV. Results and Discussions

Percentage Yield

The different samples were dried in an oven for 8-10 hours. The initial and final masses were recorded using a digital weighing scale. The moisture content and percentage yield were determined from different masses as shown in Table 1.

Table 1. Percentage yield of samples after 8-10 hr oven drying

Mass	Samples		
	Leaves	Rhizomes	Stalks
Initial	300.00 g	300.00 g	300.00 g
Final	10.80 g	35.18 g	30.82 g
Moisture Content	289.20 g	264.82 g	269.18 g
% yield	3.60 %	11.73 %	10.27%

From Table 1, the moisture content from different samples was investigated. It has shown that leaves have high moisture content among different samples but very low percentage yield. The rhizomes and stalks have higher percentage yield of 11.73% and 10.27% respectively.

Mass of solutions from different solvents

The mass of solutions was determined before and after filtration method using different solvents as shown in Table 2 and 3.

Table 2. Mass of solutions before and after filtration method using H_2O as a solvent

Extracts	Before (g)	After (g)	Residue (g)	Filtrate (g)	Observation
Leaves + H_2O	97.15	14.52	82.63	14.94	Very slow filtration rate due to the presence of filamentous organisms that traps the filter
Rhizomes + H_2O	71.31	45.89	25.42	64.35	
Stalks + H_2O	106.58	45.42	61.16	42.61	

The extracts from rhizomes using water as a solvent as shown in Table 2 had better filtering process in which fewer residue was collected. The filtration rate from different extract was too slow because of the growth of filamentous organisms. As compared in Table 3, the ethanol extracts had better performance in separation process using filtration method and was observed that the filtration was done very easily.

Table 3. Mass of solutions before and after filtration using EtOH as a solvent

Extracts	Before (g)	After (g)	Residue (g)	Filtrate (%)	Observations
Leaves + EtOH	69.71	33.06	36.65	47.42	Very smooth filtration process. Fewer residues found in the filter.
Rhizomes + EtOH	58.49	47.70	10.79	81.55	
Stalks + EtOH	90.44	59.63	30.81	65.93	

pH solution from different extracts

The pH solutions from different extracts were observed as shown in Table 4 and 5. The extracts were soaked thoroughly for 5 days and the pH values were recorded before and after

soaking. The continuous mechanical shaker was introduced in order to dissolve easily all the solids.

Table 4. pH solution after 5-day soaking with EtOH as a solvent

pH values	Solvent extracts		
	Leaves + EtOH	Rhizomes + EtOH	Stalk + EtOH
Initial	4.95	4.99	4.76
Final	4.75	4.55	4.09
Average	4.85	4.77	4.43

As shown in Table 4, a solution of stalk and EtOH was recorded with a very low pH value of 4.43, which means very acidic as compared with the other extracts. However, Table 5 showed the pH value solution of 6.33, which was literally slight acidic using water as solvent. Hence, the extraction of samples using EtOH as solvent became more acidic in a solution than water.

Table 5. pH solution after 5-day soaking with H2O as a solvent

pH values	Solvent extracts		
	Leaves + H2O	Rhizomes + H2O	Stalks + H2O
Initial	6.88	6.72	6.43
Final	6.64	6.46	6.23
Average	6.76	6.59	6.33

Antitermitic activity

The activity of the extracts was investigated by addition of these extracts collected on termites. The volume of extracts was then measured and the mortality of the termites was observed as shown in Figures 3, 4 and 5. Generally, extraction from ethanol showed that number of termites species killed upon addition of samples and which has a lesser volume of EtOH needed as compared with H2O solvents. Among other samples of extracts, the extraction from the stalks proved to have better performance in terms of antitermitic activity using ethanol as solvent as shown in Figures 6 and 7.

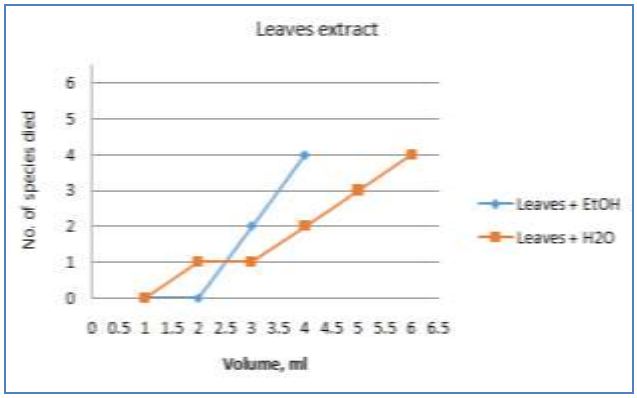

Fig. 3 Number of termite species killed after addition of extracts from leaves.

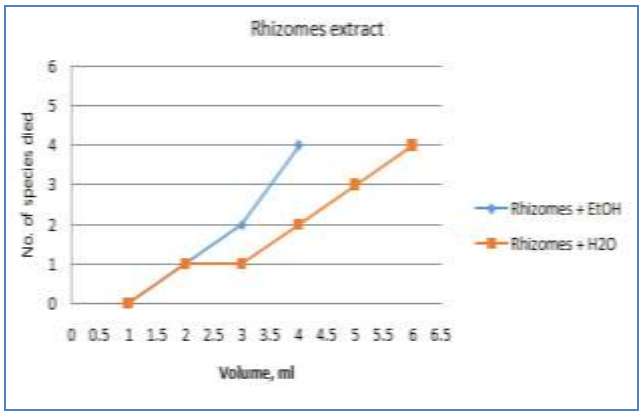

Fig. 4 Number of termite species killed after addition of extracts from rhizomes.

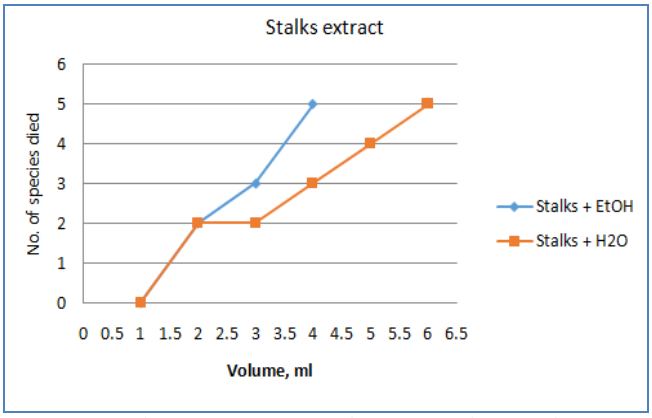

Fig. 5 Number of termite species killed after addition of extracts from stalks.

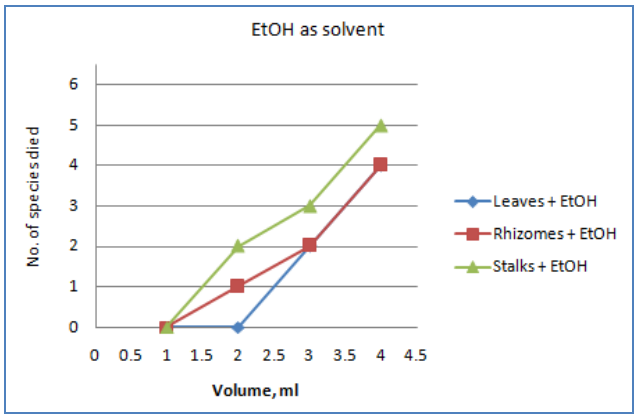

Fig. 6 Number of termite species killed after addition of extracts from different samples using EtOH as a solvent.

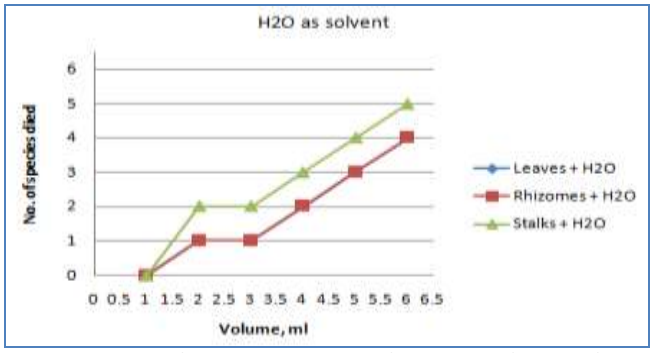

Fig. 7 A number of termite species killed after addition of extracts from different samples using H_2O as solvent.

Cytotoxicity of extracts

The mortality of brine shrimp nauplii from different samples using H_2O and EtOH as solvents was investigated with ten (10) samples of nauplii in a container. Each container was treated with the same amount of extracts until such time the nauplii killed after each treatment. It has been observed that the H_2O and EtOH solvent extracts used were 17.5 ml and 1.5 ml respectively as shown in Table 6 and 7.

Table 6. Percentage mortality of nauplii from different samples using H_2O as a solvent

Extracts	No. of nauplii killed per ml of extracts	% Mortality	LD_{50}
Leaves + H_2O	0.11	40	0.83
Rhizomes + H_2O	0.17	60	2.62
Stalks + H_2O	0.28	100	2.59

Table 7. Percentage mortality of nauplii from different samples using EtOH as solvent

Extracts	No. of nauplii killed per ml of extracts	% Mortality	LD_{50}
Leaves + EtOH	2.00	20	22.04
Rhizomes +EtOH	2.67	80	31.80
Stalks + EtOH	3.33	100	39.75

The brine shrimp lethality of the extract is shown in Figure 8. The stalks + EtOH extracts of *A. macrorrhizos* showed high toxicity level with an LC_{50} value of 39.75 g/ml as compared to stalk + H2O, which serve as the positive control with an LC_{50} value of 2.59 g/ml. Almost no mortality was found in the control group. An approximate linear correlation was observed when the concentration of the extract versus the percentage of mortality was plotted on the graph.

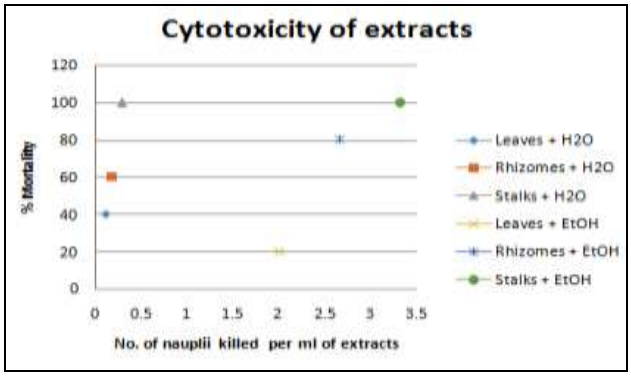

Fig. 8 Concentration of the extracts versus the percentage of mortality using different solvents.

V. Conclusions and Recommendations

A natural pest control from plant extracts of *A. macrorrhizos* against termite infestation is more effective and cheaper than utilizing the chemical pesticides that made up of synthetic products. *A. macrorrhizos* using the stalks and ethanol extracts showed to have high percentage yield, high anti-termite efficacy and high toxicity level with an LC_{50} value of 39.75 g/ml as compared to the positive control group.

More details about phytopharmacological studies must be investigated and it is recommended that people should be educated about these problems so as to prevent further poisonings and decrease use of this plant for decorative household purposes.

This study would give an idea and sufficient information among lumber users and furniture operators, specifically to the teachers having a problem with those termites attacking their classrooms. Furthermore, it would serve as a guide to people who lack knowledge on the botanical preparations to control termites as substitutes to synthetic pesticides.

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