Journal of Multidisciplinary Research and Innovations (JMRI) Vol. 2. No. 2. December, 2025. ISSN 3043-5021

BIOCIDAL EFFECTS OF AQUEOUS LEAF EXTRACT OF WATER HYACINTH (*Eichhornia crassipes)* FOR THE CONTROL OF TERMITES (*Odontotermes obesus*)

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ABSTRACT

Water hyacinth (*Eichhornia crassipes*) is a rapidly proliferating, invasive aquatic species that serves as a potential biomass resource for bioenergy generation and may be utilised as a biopesticide. The main objective of the study, was to evaluate the effectiveness of water hyacinth **(***Eichhornia crassipes)* extract against the termites **(***Odontotermes obesus***).** Fresh leaves of *E. crassipes* were gathered from the River Niger region in Niger State and evaluated for the phytochemical parameters, termite mortality, and the repellency of the plant extract against termites. The findings indicated the existence of saponins, tannins, flavonoids, glycosides, and anthraquinone. The leaf extract of water hyacinth induced mortality rates of 33.3%, 46.7%, and 60% in termites at concentrations of 1%, 2%, and 3% g/ml, respectively, after 6 hours of treatment. The leaf extract demonstrated 80%, 86.7%, and 100% mortality rates of termites at concentrations of 1%, 2%, and 3% g/ml, respectively, following an 18-hour treatment period. No significant difference ($p>0.005$) was seen between the 3% concentration of the extract and the standard control after 18 hours of treatment. The leaf extract of water hyacinth exhibited average percentage repellency against termites of 23.3%, 33.3%, and 36.7% at doses of 1%, 2%, and 3% g/ml, respectively. All concentrations of the extract exhibited class II repellency. The leaf extract of water hyacinth is advised for termite management in the environment as an alternative to synthetic insecticides.

Keywords: *Eichhornia crassipes, Odontotermes obesus,* phytochemical, mortality, repellency,

INTRODUCTION

Termites (Isoptera) are cellulose-consuming, sociable insects distributed globally. Termites inflict damage to standing crops, structural materials, and electrical lines, resulting in substantial financial losses annually (Krupal et al., 2017). A total of 2,800 termite species has been documented globally, with 185 species identified as pests (Krupal et al., 2017). In addition to infesting wild plant species, termites inflict significant harm on numerous crops, including wheat, sugar cane, paddy, cotton, groundnut, maize, and soybean (Kasseney et al., 2016). *Eichhornia crassipes*, generally referred to as water hyacinth, is a thermophilic aquatic plant that belongs to the family Pontederiaceae. It is recognised as one of the most productive plants on Earth and is regarded as the world's most detrimental aquatic weed (Gupta and Yadav, 2020). It can serve for compost, paper, fuel, animal feed, and for water filtration. It has been demonstrated to effectively manage microorganisms, including fungus and bacterial infections in both plants and humans, due to its phytochemical components (Gopal, 2016). The identification of plant defense mechanisms and phytochemicals has opened new avenues in medicine and pest management (War et al., 2012). It is widely acknowledged that substituting persistent synthetic pesticides with biodegradable substances derived from live organisms might mitigate the detrimental environmental impacts of synthetic pesticides (Krupal et al., 2017). Termites have been effectively controlled over the years by the use of synthetic insecticides. The potential threat and the long-term resistance established by insects have rendered the use of botanical pesticides essential (Uyi et al., 2019). This study aimed to assess the toxicity and repellant properties of leaf extracts from *Eichhornia crassipes* as protectants against termites (*Odontotermes obesus*).

MATERIALS AND METHODS

Collection and preparation of plant sample: Fresh leaves of *E. crassipes* were harvested from the River Niger region in Niger State and identified by a botanist in the Department of Biological Sciences, Federal Polytechnic Bida, Niger State. The leaves were meticulously rinsed twice under running water and once with sterile distilled water; subsequently, the leaf material was air-dried in the

laboratory. The air-dried plant material was pulverised into a fine powder using an electric blender and stored in a sealed container for future use.

Preparation of the plant extraction: One hundred and fifty grammes (150g) of plant powder was weighed using an electronic balance and immersed in 1000ml of purified water. The mixture was thoroughly combined with a glass rod at 12-hour intervals and allowed to rest for 24 hours. The combination was subsequently filtered through muslin fabric, and the filtrate was placed in the oven to allow the remaining solvent to evaporate. The resulting dry extract was then stored in a jar for future use (Nouron et al*.,* 2022)

Phytochemical Analysis: The dried crude extract was subjected to phytochemical analysis in order to find out the presence of phytochemical constituents. The phytochemical tests employed for alkaloids, tannins, cardiac glycosides saponins, flavonoids and terpenoids were in accordance with Jaradat et al. (2015) and Thilagavathi et al. (2015).

Test of Alkaloids (Mayer's test, Wagner's test, Dragendsoff's test): Three grammes (3g) of each extract was mixed with 5 ml of 1% aqueous hydrochloric acid in a hot water bath. The content was filtered and allocated into three 1ml portions in test tubes. A few drops of Dragendorff's reagent were added to the first portion, and the formation of an orange-red precipitate indicates the presence of alkaloids. To the second portion, a few drops of Wagner's reagent were added, and the emergence of a reddish-brown colour signifies the presence of alkaloids. In the third portion, a few drops of Mayer's reagent were added, and the appearance of a buff precipitate indicates the presence of alkaloids (Jaradat et al., 2015)

Test for Saponins (Frothings test): Zero point five gramme (0.5g) of the crude powder of the leaf extract was shaken vigorously with 10ml of distilled water in a test tube. The test tube was warmed in a water bath for observance of frothing. The persistence of the froth indicates the presence of saponins. The frothing was mixed with 3 drops of olive oil and observed for the formation of emulsion which confirms the presence of saponins (Thilagavathi et al., 2015).

Test for Tannins (Ferric chloride): Small quantity (0.5g) of the extract was mixed with distilled water and heated on a boiling water bath. The mixture was filtered and to the filtrate few drops of concentrated H_2S0_4 and 5% ferric chloride solution were added. Appearance of a blue-black, green or blue-green precipitate indicates the presence of tannins (Thilagavathi et al., 2015)

Test for flavonoids (Ferric chloride test): About 5ml of distilled water was added to the extract bath for 2minutes in a test tube. The content was filtered and to 2ml of the filtrate few drops of 10% alcoholic ferric chloride solution was added. Occurrence of effervescence with formation of dark brown solution which gradually changes to a deep red solution or appearance of pink coloration indicates the presence of flavonoids (Jaradat et al., 2015)

Test for Glycoside (Liberman test): Zero point two gramme (0.2g) of the crude extract was solved in 2mls of chloroform in a test tube. Few drops of acetic anhydride were added to the tube and was boiled and cooled. Concentrated $H_2S0_4$was added from the side of the test-tube using a pipette. Formation of a brown ring at the junction of the two layers and the turning of the upper layer to green shows the presence of steroids while formation of deep red colour indicates the presence of triterpenoids (Harbone, 2015).

Test for Anthraquinones (Borntrager's test): Two grammes of the powdered of crude extract were heated with four millilitres of 10% hydrochloric acid for three minutes. The mixture was filtered while hot, and the filtrate was permitted to cool. The cooled filtrate was subsequently agitated with an equivalent volume of chloroform to extract the anthraquinone. The chloroform layer was subsequently transferred to a clean test tube and treated with an equivalent volume of 10% NH_4OH. The mixture was subsequently agitated well, and the hue of the upper layer was recorded. The manifestation of a colour layer signifies the existence of anthraquinone, namely anthracene derivative (Jaradat et al., 2015)

Collection of termites (*Odontotermetes obesus*): Termite species *Odontotermes obesus* were collected from the termitarium in the Biological Garden, Federal Polytechnic Bida and brought to the Biology Laboratory, Federal Polytechnic Bida in a plastic container where they were identified by an entomologist using taxanomic characteristics and were maintained in a hygrostat chamber, specially designed. Humidity of 70% ± 5% in the chamber was maintained by placing a wet paper towel and the chamber was placed at ambient temperature of 25± 3ºC before being used for the experiment (Prasoona et al*.,* 2022)

Insect mortality bioassay: Three distinct concentrations (1%, 2%, and 3% g/ml) of the extracts were prepared, and five pairs of termites were positioned on filter paper within

a Petri dish. One millilitre of each concentration was administered to the termites via pipette, and after a treatment duration of three minutes, the termites were relocated to plastic containers. Each plastic container was wrapped with muslin cloth to facilitate oxygen supply while preventing the ingress and egress of insects. Each concentration was reproduced three times, and termite mortality was reported after 1 hour, 6 hours, 12 hours, and 18 hours. The studies were conducted at a temperature of 25±3°C and a relative humidity of 70±5%. The mortality percentage was determined using the formula established by Uyi et al. (2019).

$$\% \text{ mortality} = \frac{N_d}{N_t} \times 100 \quad (1)$$

Where, N_d = number of dead termites and N_t = total number of termites tested.

Repellency test of the plant extract against termites: The Whatman No. 1 filter paper (8 cm diameter) was bisected, with one half treated with 1 ml of each extract concentration (1%, 2%, and 3% g/ml), while the other half was treated with distilled water using a micropipette, serving as the control. The two sides of filter paper were air-dried to thoroughly evaporate the solvent (Jeyasankar et al., 2016) and placed in plastic containers with a diameter of 9 cm. The treated filter paper strips were affixed lengthwise, edge to edge, to untreated filter paper strips of comparable dimensions using cellophane tape (Hinazafer et al., 2020). Five pairs of termites were introduced at the centre, positioned between treated and untreated filter paper within plastic containers covered with muslin cloth to prevent their escape, and placed in darkness to mitigate the effects of light on the insects (Uyi et al., 2019). The experiment was replicated thrice, organized in a completely randomized pattern, and assessed after 15, 30, 45, and 60 minutes to document the quantity of termites present in treated and untreated filter paper. The proportion of repellency (% PR) was determined using the formula provided by Oni et al. (2018).

$$\% \text{ PR} = \frac{N_C - N_T}{N_C + N_T} \times 100 \quad (2)$$

Where N_C is the number of insects present in the untreated filter paper and N_T is the number of insects present in the treated filter paper. The average values were classified according to repellency classes (Jeyasankar et al., 2016)

Statistical analysis: Data obtained were subjected to analysis of variance (ANOVA) and where significant differences existed, mean treatment was compared using the statistical package at $P < 0.05$alpha levels of significance using Duncan multiple range test (DMRT)

RESULTS AND DISCUSSION

The phytochemical analysis of the ethanolic extract of *Eichhornia crassipes* revealed several active compounds such as alkaloids, flavonoids, glycosides, saponins, anthraquinones, and tannins. Alkaloids, glycosides, saponins, and anthraquinones were present in mild concentrations, whereas tannins and flavonoids were present in moderate concentrations (Table 1). The presence of tannin, glycosides, alkaloids, flavonoids, saponin and anthraquinones in the extract of water hyacinth align with those of Kharmal et al. (2021) who detects similar bioactive compounds. who found the presence of some bioactive chemicals in the leaf extract of water hyacinth.

Table 1: Phytochemical analysis of leaf extracts of *Eichhornia crassipes* (Water hyacinth)

Phytocompounds	Test	Observation	Inference
Test for Alkaloids	Wagner's test	Reddish-brown color	+
Test for Saponins	Frothing test	Reddish-brown	+
Test for Tannins	Ferric chloride	Presence of Emulsion	++
Test for Flavonoids	Ferric chloride	White Precipitate	++
Test for Glycoside	Liberman	Reddish-brown color	+
Test for Anthraquinone	Borntrager's Test	Reddish-brown color	+

Key: - = Absence; + = Mild; ++ = Moderate.

Effect of aqueous Extract of water hyacinth on mortality of adult termites: Table 2 illustrates the impact of aqueous leaf extract from water hyacinth on termite mortality. The results demonstrated that when concentration increases, both the mortality rate of termites and the duration of exposure ~~both~~ increased.. The recorded mortality rates of termites were 0.00%, 6.67%, and 13.3% at doses of 1%, 2%, and 3%, respectively, following a 1-hour treatment; however, no significant difference was observed between the 2% and 3% concentrations. All concentrations exhibited a statistically significant difference ($p<0.005$) compared to the control. Six hours post-treatment, the mortality rates of termites were 33.3%, 46.7%, and 60% at doses of 1%, 2%, and 3%, respectively. At 18 hours post-treatment, the mortality rates of termites were 80%, 86%, and 100% at doses of 1%, 2%, and 3% g/ml, respectively. The 3% concentration showed greater efficacy than other concentrations, achieving 100% mortality of termites, which exhibited no significant difference ($p>0.005$) compared to the positive control, whereas the negative control recorded 0.00% mortality of termites. The findings are consistent with those of Cece and Ibrahim (2022), who reported a 100% mortality rate in termites following treatment with stem bark extract of *Zanthoxylum zanthoxyloides*. In this study, the mortality rate of termites following a 6-hour treatment was 26.7%, which contrasts with the 60% mortality reported by Oni et al. (2018). The variation may be ascribed to disparities in termite species or the plant species utilised.

Table 2: Effect of aqueous leaves extract of water hyacinth on mortality of adult termites exposed to different concentrations at different time.

Conc. % (g/ml)	Mean % mortality of water hyacinth of termites at different time exposure			
	1hr	6hrs	12hrs	18hrs
1	$0.00+0.00^{d}$	$13.3+0.94^{c}$	$33.3+0.47^{d}$	$80.0+0.47^{c}$
2	$6.67+0.82^{c}$	$26.7+0.84^{b}$	$46.7+0.82^{c}$	$86.7+0.47^{b}$
3	$13.3+0.94^{b}$	$26.7+0.46^{b}$	$60.0+0.47^{b}$	$100.0+0.00^{a}$
Positive control	$63+0.00^{a}$	$84+0.00^{a}$	$100.0+0.00^{a}$	$100.0+0.00^{a}$
Negative control	$0.00+0.00^{d}$	$0.00+0.00^{d}$	$0.00+0.00^{e}$	$0.00+0.00^{d}$

Different letters within the same column are significantly different ($P<0.05$)

Effect of aqueous leaf extract of water hyacinth on repellency against termites: Table 3 illustrates the impact of aqueous leaf extract from water hyacinth on termite repellency. The results indicate that after 15 minutes of treatment, the recorded percentages of repellency were 6.67%, 20%, and 6.67% at concentrations of 1%, 2%, and 3% v/w, respectively, while the control exhibited no repellency. After 30 minutes of treatment, the reported percentage repellency was 33.3%, 20%, and 60% for concentrations of 1%, 2%, and 3% g/ml, respectively, with no repellency observed in the control group. After 45 minutes of treatment, the recorded-percentage repellency were 33.3%, 60%, and 60% at concentrations of 1%, 2%, and 3%, respectively. for 60 minutes of treatment, a repellency of 33.3% was observed for each concentration of 1%, 2%, and 3%. The average percentage repellency of the extract against termites was 23.3%, 33.3%, and 36.7% at concentrations of 1%, 2%, and 3% g/ml, respectively. All concentrations came under repellency class II, indicating moderate repellency at a concentration of 3%, while the negative control exhibited 0% repellency

Table 3: Effect of aqueous extract of water hyacinth on the repellency of termites

Conc. %(g/ml)	Repellency rate (%) at different time interval					
	15mins	30mins	45mins	60mins	Average (%)	Class
1	6.67	33.34	33.3	33.34	23.3	II
2	20.0	20.0	60.0	33.34	33.3	II
3	6.67	60.0	60.0	33.4	36.7	II
Control	0.00	0.00	0.00	0.00	0.00	0

against termites. This showed that, the extract exhibited repellency against the termites.

CONCLUSION

The aqueous leaf extract of water hyacinth showed some bioactives compound such as flavonoids, tannins, glycosides, anthraquinones, and alkaloids. A complete mortality rate of termites was seen at a concentration of 3% following an 18-hour treatment, and the repellency against termites was classified as level II.

RECOMMENDATIONS

The aqueous leaf extract of water hyacinth is a good anti-termite and therefore, recommended for termite control in the environment at a concentration of 3%. The government could organize an information campaign and seminars to inform the public about the advantages of water hyacinth in combating termites in the environment.

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