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Research Article

Biocidal Activity of Leaf Powder and Extract of *Dracaena Arborea* on the Adult Cockroach *Periplaneta Americana* (Dictyoptera: Blatellidae)

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Abstract: Biocidal activity of leaf powder and ethanol extract of *Dracaena arborea* were evaluated against the adult American cockroach (*Periplaneta americana*) aimed at its control. Leaf powder (10-50g) and extracts (10-50g/ml) of the test plant were introduced separately into breeding troughs containing the adult cockroaches to assess contact toxicity via filter paper and topical application. All experiments were replicated five times and with controls. There were significant difference ($p \leq 0.05$) between the treatments and the controls. All the treatments proved effective and were concentration dependent. Mortality of adults increased with increase in extract concentration and exposure time. Using ethanolic leaf extracts of *D. arborea* at highest concentration of 50g/ml, mean mortality was: control (03±0.36), 18±0.56, 20±1.10, 22±1.20, 26±1.30, 27±1.30 for 10-50g/ml respectively regarding contact toxicity by topical application; control (01±0.35), 10±0.45, 13±0.50, 15±0.52, 16±0.53, 18±0.56 for 10-50 g/ml concerning contact toxicity on filter paper and control (01±0.35), 07±0.35, 13±0.49, 14±0.49, 16±0.53, 18±0.56 for 10-50g respectively for leaf powder. Phytochemical screening revealed the presence of chemical groups like saponins, alkaloids, tannins, glycosides, flavonoids, terpenoids and phenols in varying quantities. This plant contained biocidal properties whether utilized in powder or extract forms and is significantly active in cockroach control. Botanicals as reported by literature, have no toxic effects on man, are eco-environmental friendly and locally available, hence *D. arborea* should be utilized in biological pest management practices and control systems.

Keywords: *Periplaneta americana*, Biocidal, Powder, Extract, *Dracaena arborea*, Botanicals.

INTRODUCTION

Cockroaches are the most abundant insect pest of public health importance; they infest hospitals, food manufacturing industries, kitchens and residential apartments (Appel, 1998). Cockroach (*Periplanata americana)* infestation has always raised safety concerns, especially as carriers of food-borne pathogens and food spoilage organisms (Bouamama *et al*., 2007). As they feed on materials, cockroaches leave filth and secrete offensive and sickening oily liquid having odour that ruin food (Ghosh & Gayen, 2006). Cockroaches feed on human excreta as well as human food, thus are potential transmitters of diseases such as dysentery, typhoid, cholera and other food-borne infections which have been experimentally confirmed (Tatfeng *et al*., 2005; Ghosh and Gayen, 2006; Bouamama *et al*., 2007). Dust containing cockroach excreta triggers allergic reaction such as wheezing in many individuals, making it particularly harmful to asthmatic patients (Silva *et al*., 2005). A robust association has been established between the presence of cockroaches and increase in the severity of asthma symptoms in individuals sensitive to cockroach allergen (Sarinho *et al*., 2004). Not only do cockroaches present variety of health hazard when found in our homes, but are also a threat in commercial places, spreading diseases through any food source hence cause food poisoning as they come in contact with food materials (Sarinho *et al.*, 2004). About twenty two species of bacteria, viruses, fungi, protozoa and five species of worms have been reportedly isolated from the body of *P. americana* (Kesetyaningsih, 2012). Cockroaches are confirmed as vectors of poliomyelitis virus, enteropathogenic bacteria, amoeba cyst, eggs of worms and the fungus Aspergillus species (Soedarto, 1995).

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The ancient man had deployed different methods of control, including prayers, magic spells, cultivation systems, mechanical practices as well as application of organic and inorganic substances (Jitendra *et al*., 2009) including pesticides, with developing countries and Nigeria in particular been faced with the most challenges in achieving the sound management of pesticides. However, the best pest control method is that which is non-toxic and environment friendly, hence the use of natural plant parts/products as bio-pesticides to overcome the problems of synthetic chemical hazards, is considered the best control measure which has become popular due to their degradability, least persistence and least toxicity to non- target organisms, economical and easy availability (Senthil and Kalaivani, 2005). *D. arborea* is a woody perennial tree of the lily family, Dracaenaceae characterized by fibrous and tough leathery, densely crowded leaves (with a sharp apex and 2cm broad at the base) that grow up to 6-15m high. Dragon tree is an elegant ornamental plant that grows in semi-arid areas. They are tree size with stout trunks. It occurs manly in the tropics and subtropics but is native to Africa and South Asia. The name dragon tree stems from the fact that juices from some species resemble dragon's blood and two new branches tend to grow at the point where a branch is cut (Udo, 2013). *D. arborea* is is commonly used as boundary plant due to its power of regeneration when a small stem is planted. Dragon blood among Ibibios is used to settle land dispute among people. Okunji *et al.*, (1996) reported the presence of anti-parasitic and antifungal compounds in Dracaena. The plant is also utilized as reptile repellents, agriculturally as fish poison, ornamental plants for boundaries, hedges, farming, hunting, forestry as well as fishing apparatus (Burkii, 1985). Aqueous methanolic extracts of *D. arborea* leaves mixed in palm wine is served as traditional alcohol solution for handling sexual impotency in males (Epidi and Njoku, 2009). *Dracaena* species have been shown to possess insecticidal properties. Udo, (2013) in their studies, reported the use of root, bark and leaf powders of *D. arborea* in controlling two storage pests of bean (*C. maculatus*) and maize (*S. zeamais*)**.** According to Udo, (2013), cut leaves of *D. steudneri* placed in a box with caterpillars of Charaxes (Nymphalidae) led to their death. Studies by Prosper *et al*., (2016) reported larvicidal activity of steroidal saponins from *D. arborea* on *Aedes albopictu*. Udo, (2013) stated in his work that ethyl acetate and aqueous fractions of leaf extract of *D. arborea* demonstrated insecticidal activity against *Sitophilus zeamais* (*Motsch*.) and *Callosobruchus maculatus* (*Fab*.) and offered protection to stored grains.

Plate 1: *Dracaena arborea* plant
Source: Author

MATERIALS AND METHODS

Study Area

The research was carried out in the Postgraduate Laboratory, Faculty of Science, Niger Delta University, Bayelsa State located between latitudes 4°45'N and 4°60'N and longitudes 6°50'E and 8°00'E.

STUDY PERIOD

The study period of this research work was from November, 2016 to September, 2018.

SAMPLE COLLECTION

Collection of *P. Americana* Adults

A total of one thousand eight hundred same age progeny of *P. americana* adults collected from the stock that were reared in the laboratory were used to establish the main test sample. Adopting the method of Udo *et al*., 2012 the adults were placed thirty in a trough in readiness for the various bioassays

COLLECTION OF PLANT MATERIAL

Fresh leaves of *D. arborea* were bought from florist shop in Yenagoa Local Government Area of Bayelsa state, Nigeria. The plants were identified by laboratory technologist and botanist Mr Dimie Otobo, of the department and taken to the Postgraduate laboratory of the Faculty of Science for processing and usage in the various bioassays.

PREPARATON OF POWDER

Using the methods employed by Briyai, (2012), Udo, (2008a), the fresh leaves of the test plant *D. arborea* were separated manually and washed briefly under running tap water to remove sand and debris, then sun- dried for a period of seven days until crispy. The leaves were ground using the hand mill and later blended to obtain finely divided powder which was further dried in a hot air oven at 60^0C for eight hours. 10-50g of the powdered materials were bagged and labeled separately for further usage.

PREPARATION OF ETHANOLIC EXTRACT

Adopting the procedures of Obeng-Ofori and Akuamoah, (1998); Udo *et al*., (2012), leaf the leaf powdered forms of *A. indica was* separately weighed as follows: 0.00g (control), 10.00g, 20.00g, 30.00g, 40.00g and 50.00g into different Bama bottles labelled A, B, C, D, E and F according to the measured weight in grams respectively. Equal volume of 10ml of 70% ethanol was added into each of the bottles by concentration in volume to volume (g/ml) ratio 0.00g:10ml, 10.00g:10ml, 20.00g:10ml, 30.00g:10ml, 40.00g:10ml and 50.00g:10ml respectively. The crude ethanolic extract was filtered using a Whatman No.1 filter paper through a plastic funnel to a 50ml beaker respectively. The filtrate was transferred to a round bottom flask and heated in a water bath at 40^oC for 72 hours to allow for ethanol evaporation. Using a rotary evaporator, the extracts were concentrated to dryness and used for the bioassay. Stock solution was prepared with 2.8 liters of ethanol in 1.5kg of the powder which was allowed to stand for 24 hours. The mixture was filtered and the filtrate evaporated in a desiccator. The resultant yield was 60g of the extract.

EXPERIMENTATION

To examine the effects of the leaf powder and extracts of the test plant on the adults, the treatments were applied both as contact poison for leaf powder and contact toxicity by topical application and contact toxicity on filter paper for ethanolic leaf extract. All treatments were arranged in completely randomized design (C.R.D.)

CONTACT TOXICITY OF LEAF POWDER

To evaluate contact toxicity of *D. arborea* leaf powder on adults, the methodology of Udo *et al*., (2004a) was adopted with slight modification, where 10g, 20g, 30g, 40g, and 50g respectively of leaf powder of the test plants were measured into different transparent plastic boxes with perforated lids and labeled. Thirty nymphs were randomly introduced into each box. Boxes were covered with vent nettings held by rubber stopper. No leaf powder was added to the control and the treatment replicated five times. Mortality rate was recorded at 24, 48, 72 and 96 hours respectively. After three blunt probes using a dissecting probe, the insects were considered dead.

CONTACT TOXICITY BY TOPICAL APPLICATION OF ETHANOLIC LEAF EXTRACT

Using the procedure spelt out by Udo, (2008a) to evaluate contact toxicity by topical application, thirty adult cockroaches were placed randomly in boxes lined with moist filter paper (Udo, 2008). Using a pipette, 10ml, 20ml, 30ml, 40ml and 50ml, respectively of the ethanolic leaf extracts was applied to the dorsal surface of the thorax of each nymph *P. americana*. Distil water was used as control and each treatment was replicated five times. Insects were examined daily for mortality within 24-96 hours and any insect that did not respond to three probing with a blunt probe at five minutes recovery period was considered dead.

CONTACT TOXICITY ON FILTER PAPER

Adopting the method employed by Udo, (2008b), Whatman No. 1 filter paper was placed in plastic boxes, where 10ml, 20ml, 30ml, 40ml and 50ml, respectively of the ethanolic leaf extracts were applied and allowed thirty minutes to dry off. Thirty nymphs were introduced randomly into each box. Distil water was used as control and each treatment was replicated five times. Insects were examined and recorded daily for mortality within 24, 48, 72 and 96 hours and any insect that was immobile and did not respond to three probing with a blunt dissecting probe at five minutes recovery period was considered dead.

QUALITATIVE TEST

The leaves of the test plant were screened qualitatively for phytochemicals according to standard procedures used by Okwu, (2001); Trease and Evans, (2002); Udo, (2013), where the leaf powder was extracted at room temperature with 75% ethanol by maceration and concentrated to dryness in a rotary evaporator.

DATA ANALYSIS

All results were tested and analyzed by excel for windows program version two Microsoft office 2010. Data obtained were expressed by calculation of the mean and standard error (Mean±SE) statistically. Student T-test and pair wise multiple comparisons were used for significant differences at alpha level, $p \leq 0.05$. All graphs were plotted using Microsoft excel.

RESULT

The mean mortality of adult cockroaches exposed to ethanolic leaf extract of *D. arborea* is presented on fig. 1. Death incidence of adult *P. americana* increased with increase in the concentration of extracts from 10-50g/ml and exposure time (96 hours), hence was concentration dependent. As the number of hours progressed, the mortality of cockroach also increased, however there was no significant difference ($p<0.05$) in cockroach mortality between increase in concentration and exposure time of extracts. As the number of hours progressed from 24 to 48, 72 and then 96, the toxicity potency of the extracts also increased bringing about the registered number of death of cockroaches.

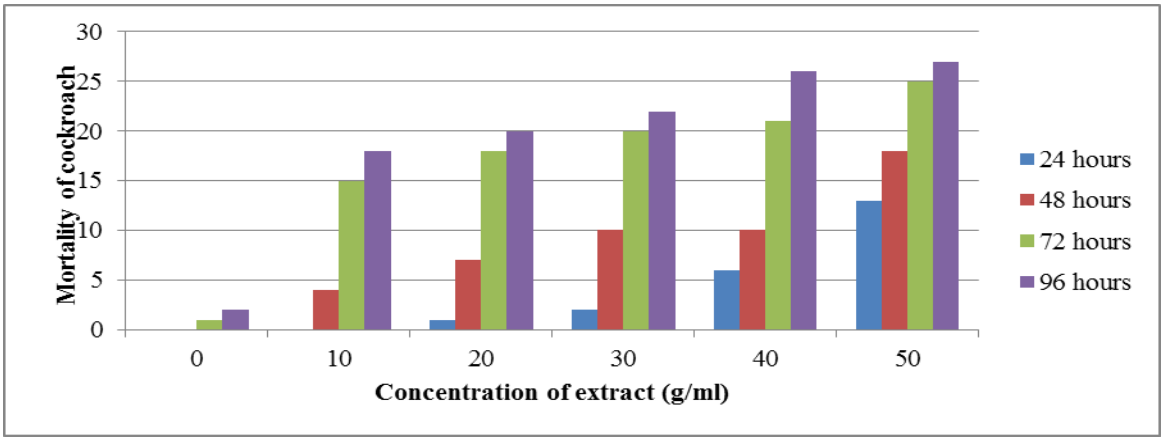

Fig. 1: Mean mortality of adult cockroach due contact toxicity by topical application of *D. arborea* ethanolic leaf extract.

Represented on fig. 2 is the mean mortality of adult cockroaches exposed to ethanolic leaf extract of *D. arborea* by contact toxicity on filter paper. The result showed that, mortality of adult cockroaches increased with direct increase in the concentration and exposure time of the extracts and was highest in 50g/ml (18) and lowest in the control (01). As the number of hours increased, the mortality of cockroach also increased, however there was no significant difference ($p<0.05$) in cockroach mortality between increase in concentration and exposure time of extracts. Toxicity of the extracts increased with increase in the number of hours of exposure, hence the number of recorded deaths with hours.

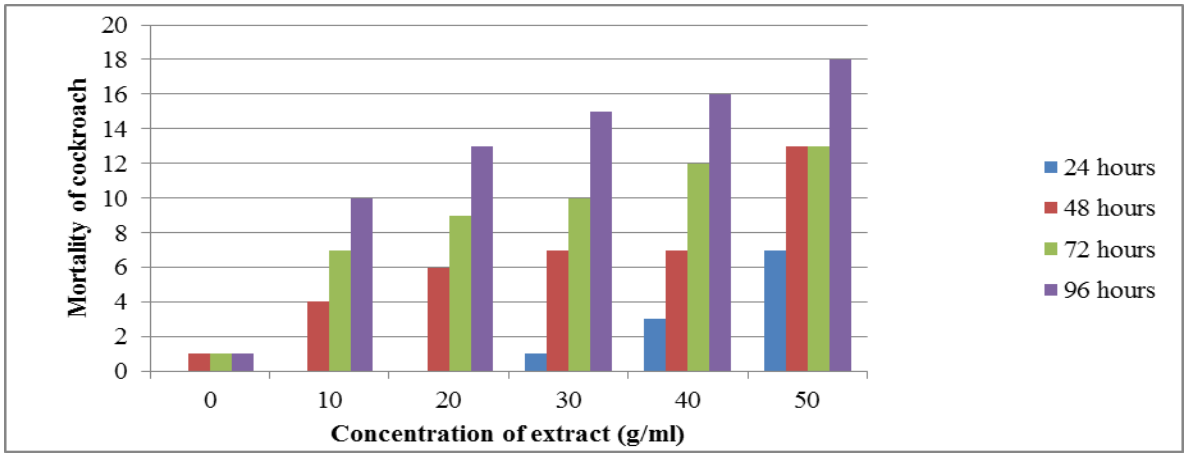

Fig. 2: Mean mortality of adult cockroach due contact toxicity of D. *arborea* ethanolic leaf extract.

Fig. 3 below gives the graphical illustration of the mean mortality of adult cockroaches exposed to leaf powder of *D. arborea* by contact toxicity. As the concentration of the powder increased, adult mortality also increased with time of exposure, however there was no significant difference ($p<0.05$) in cockroach mortality between increase in concentration and exposure time of extracts. Toxicity of the extracts increased with number of hours of exposure, hence the number of recorded deaths with hours. The highest concentration of 50g recorded the highest number of

cockroach mortality (18) after 96 hours interval while the least was the control which recorded no deaths (00).

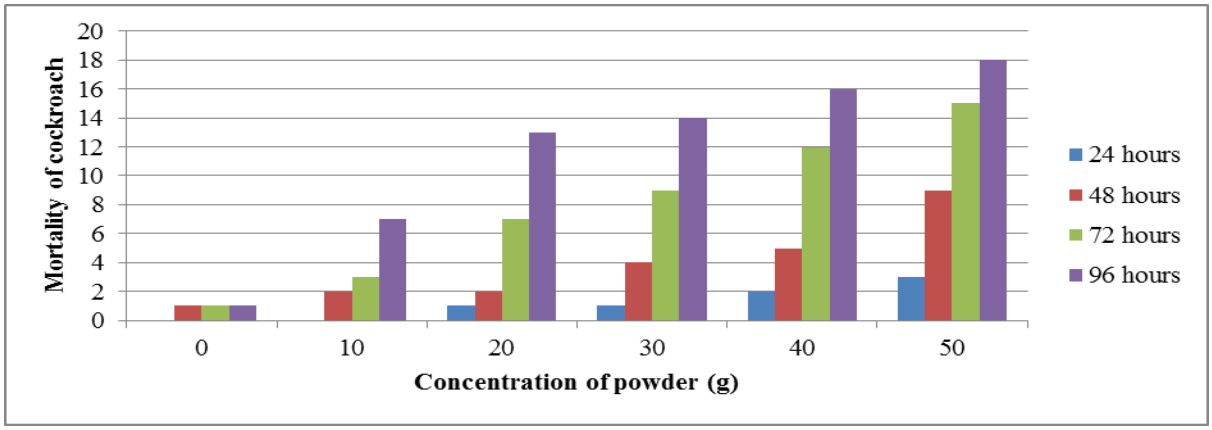

Fig. 3: Mean mortality of adult cockroach due contact toxicity of D. *arborea* leaf powder

DISCUSSION

Botanical pesticides represent an important component of integrated pest management systems in traditional pest control as they are broad spectrum in action, based on local material and potentially less expensive (Obeng-Ofori *et al*., 1997). They are also eco environment friendly and harmless to man and other mammals (Schmutterer, 1990; Bekele *et al*., 1994; Obeng-Ofori *et al*., 1998; Srivastava *et al*., 1998).

Death incidence of adult *P. americana* increased with increase in concentration of extracts from 10-50g/ml and exposure time (96 hours), hence was concentration dependent. Adult cockroaches were more susceptible to the contact toxicity by topical application of the ethanolic leaf extract than the contact and powder. Echendu (1991), Okonkwo and Okoye, (1996), Shaaya, *et al.*, (1991) disclosed the reason being that topical application of the extracts facilitated direct contact of the toxicants or active ingredients with the insects bodies. This is also in accordance with the report by Wardhana *et al*., (2005); Khalequzzaman and Sultana, (2006) who disclosed that ethanol is the most proven lowest toxic solvent compared to acetate and acetone with insecticidal properties against insect since it is soluble, has polar (hydrophilic) and nonpolar (hydrophobic) ends, shows the presence of Oxygen hence able to undergo hydrogen bonding in addition to its high electronegativity, extracting maximally the active substances or solubles found in the test plant samples.

Contact toxicity on filter paper showed the presence of insecticidal properties in the plant but higher potency was observed with topical application of the extracts especially ethanolic extracts of leaves. Direct contact of the toxicants or active ingredients in the test plants with the insect's bodies was facilitated the mortality of adults. These results are in agreement with those obtained by Adedire andAjayi, (1996); Echendu, (1991); Okonkwo and Okoye, (1996); Shaaya *et al*., (1991).

The reduced effectiveness of the powdered application of *D. arborea* tested on *P. americana* adults was due to the possession of wings covering the entire abdomen extended to the pygedium by the insect. Also the body size of the cockroach also enhanced its efficiency in detoxifying any toxic materials in the plant products applied. However application of ethanolic extracts of *D. arborea* recorded significant mortality compared to the powder and the control. This is in conformity with the findings of Prakash and Rao, (1997); Obeng-Ofori *et al.*, (1998) for biopesticide effectiveness. Furthermore, Momeni *et al*., (2005), Denloye and Makanjuola, (2001) stated that the significant mortality obtained for cockroach tested respectively using *D. arborea* treatments was possibly due to the presence of a secondary metabolite aleuritolic acid, a lipid with short chained fatty acids thus confirming the presence of insecticidal properties in *D. arborea.*

Qualitative phytochemical screening *of D. arborea* leaves revealed the presence of saponins, tannin, flavonoids, terpenoid, alkaloid glycoside and phenols in trace to high levels. The aforementioned compounds being secondary metabolites and their detection arose from the reaction of the functional groups(s), they contain with chemical reagents to produce different colours and changes in physical nature which is in conformity with results indicated by Udo, (2008b); Udo, (2013). Isman, (1997) reported that the presence of the above mentioned active ingredients, instil natural defence on the plants against herbivory. He disclosed that these secondary metabolites consisted of mixtures of closely related compounds rather than a single toxicant.

CONCLUSION

This study revealed that *D. arborea* contained insecticidal properties whether utilized in powdered form or as extracts. Its application against *P. americana* adults has added to the vast source of botanicals used in insect pest control. Also, the use of the leaf and extracts had almost the same activity against the insect pest. The

phytochemical screening showed the presence of chemical groups like saponins, terpenoids, flavonoids, tannin, alkaloids and glycosides in the the plant. These chemical groups are associated with bioactivity against the insect pest. Therefore we recommend the full utilization of this plant in traditional pest control system since it is locally availability, ecofriendly and cost effective.

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