ISSN 1996-3351

Asian Journal of Biological Sciences

http://knowledgiascientific.com

Knowledgia SCIENTIFIC
A Place to Publish Outstanding Research

OPEN ACCESS Asian Journal of Biological Sciences

ISSN 1996-3351
DOI: 10.3923/ajbs.2019.905.910

Research Article

Efficacy of *Chromolaena odorata* (L.) (Asteraceae) Root Powder Against the Tropical Bedbug, *Cimex hemipterus* (F.) (Hemiptera: Cimicidae)

[1]Adeyemi Daniel Adetimehin, [1]Afure Joan Ejomah and [1,2]Osariyekemwen Uyi

[1]Department of Animal and Environmental Biology, University of Benin, Benin City, Nigeria
[2]Department of Zoology and Entomology, University of Fort Hare, Private Bag X1314, 5700 Alice, South Africa

Abstract

Background and Objective: Several studies have empirically demonstrated the insecticidal activities of the root powder and/or extract of *Chromolaena odorata* (L.) King and Robinson (Asteraceae) against several insect pests, however studies on the insecticidal activity of the root powder of the plant against bedbug species are scarce. This study examined the insecticidal activity of the root powder of *C. odorata* against the tropical bedbug, *Cimex hemipterus* (F.) (Hemiptera: Cimicidae). **Materials and Methods:** Five unsexed adult *C. hemipterus* were exposed to different concentrations (0.0, 1.0, 1.5 and 2.0 g) of *C. odorata* root powder in the laboratory after which percentage mortality was monitored every 24 h for a period of 168 h (= 7 days). **Results:** Percentage bedbug mortality was observed to be independent of the duration of exposure to, but dependent on the concentrations of *C. odorata* root powder used. Following a 168 h exposure period, the highest concentration (2.0 g) of *C. odorata* root powder, accounted for the highest percentage mortality (80%) against *C. hemipterus*. **Conclusion:** This study is the first to examine the insecticidal activity of the root powder of *C. odorata* against *C. hemipterus* and it further suggests its usage in the management and control of the pest in the tropics

Key words: *Chromolaena odorata*, invasive alien plant, bedbugs, root powder, king and robinson, bedbug mortality, insecticidal activity

Citation: Adeyemi Daniel Adetimehin, Afure Joan Ejomah and Osariyekemwen Uyi, 2019. Efficacy of *Chromolaena odorata* (L.) (Asteraceae) root powder against tropical the bedbug, *Cimex hemipterus* (F.) (Hemiptera: Cimicidae). Asian J. Biol. Sci., 12: 905-910.

Corresponding Author: Osariyekemwen Uyi, Department of Zoology and Entomology, University of Fort Hare, Private Bag X1314, 5700 Alice, South Africa Tel: +27 78 4674626

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Bedbugs are mainly active at night, but are not exclusively nocturnal and they have the ability to feed on their host without being noticed or detected, with their bites typically painless due to the presence of anesthetic substances in their saliva[1,2]. In spite of this, speculations exist on the ability of bedbugs to emit an easily detectable offensive odor caused by an oily secretion in their abdomen[1,3]. Several side effects such as skin rashes, exceptional anemia, post-inflammatory hyper-pigmentation, urticaria, sleeplessness, anxiety, shame, discomfort and ostracism have been reported from bedbug bites and infestation[4]. Furthermore, psychological distress coupled with nightmares, personal dysfunction and invariably posttraumatic stress disorder have been reported in some individuals who have experienced bedbug infestations and attacks[5]. It is noteworthy to state that bedbugs have been suspected to be vectors of a number of infectious agents with over 40 micro-organisms being considered as strong candidates[4,6]. Nevertheless, no study has clearly found the insect culpable in the transmission of disease causing agents to humans[7,8].

A number of published articles exist on the incidence and occurrence of bedbug species in several communities and settlements of some states in Nigeria[8-10]. For example, Oduola *et al.*[11] reported the incidence of *C. lectularius* in 2 selected settlements in Ilorin, Kwara state, north-central Nigeria with infestation rates ranging between 10-40%. Goddard and Deshazo[5] further reported high levels of infestations in household items such as mattresses (70%) and wooden furniture (17.2%). Similarly, Okwa and Omoniyi[12] who studied the prevalence of *C. hemipterus* in Lagos, southwestern Nigeria reported an infestation rate of about 50% and above in two of the five communities studied. Following the well-established resistance of insect pests including bedbugs to synthetic insecticides such as DDT, carbamates, organophosphates and pyrethroids[4,7], alongside the acute toxicity of these insecticides to humans and other non-targeted organisms[7], recent studies have empirically demonstrated the insecticidal efficacies of natural products (oils, extracts and powders) from plant origin against insect pests (including bedbugs) and have categorically called for their application in the control and management of insect pests[2,7,13-16].

Chromolaena odorata (L.) King and Robinson (Asteraceae) is an invasive weedy shrub native to the Americas that has been proven to be of significant ecological and economic burden to many tropical countries including Nigeria where it impacts negatively on agriculture, biodiversity and human livelihoods[17]. Despite its obvious negative impacts, Uyi and Igbinoba[13], Uyi and Adetimehin[14], Lawal *et al.*[18], Udebuani *et al.*[19], Uyi and Obi[20] and Uyi *et al.*[21] have empirically demonstrated the insecticidal activities of several parts viz. leaf, stem and root against a number of insect pests such as *Callosobruchus maculatus*, *Sitophilus zeamais*, *Macrotermes* species amongst others. For instance, Uyi and Adetimehin[14] reported that the stem powder of *C. odorata* at the highest concentration (5.0 g) accounted for 100% mortality in *C. maculatus* following a 72 h exposure period. Although, Uyi *et al.*[16] had earlier studied the insecticidal activity of the leaf powder of *C. odorata* against *C. lectularius*, the studies on the insecticidal activity of the root powder of *C. odorata* against any bedbug species are scarce. Therefore, this study investigated the insecticidal activity of the root powder of *C. odorata* against the tropical bedbug, *C. hemipterus*.

MATERIALS AND METHODS

Location of study: The trial was conducted at the Laboratory of the Department of Animal and Environmental Biology, University of Benin, Benin city, Nigeria, between September and October 2016.

Collection and preparation of plant powder: Fresh plants of *C. odorata* were collected from an open farmland at the Dentistry quarters, within the vicinity of the University of Benin Teaching Hospital (UBTH), Benin city (6°39'N', 5°56'E). Following collection, the roots were chopped off from the plants with the aid of a knife washed with running water and shade dried for approximately 7 days and thereafter oven dried at 60°C for 72 h. The dried roots were further blended into a fine powder using an electric blender (Braun Multiquick Immersion Hand Blender, B White Mixer MR 5550CA, Germany) and then preserved in an air-tight and water-proof container for further use.

Insect collection: Adult bedbugs (*C. hemipterus*) used for this experiment were collected from several infested areas such as cracks and crevices in walls, beds, iron and wooden chairs and also iron bunks from several rooms in one of the Halls of residence (Aminu Kano Hall), University of Benin, Benin city, Nigeria. Following collection, the insects where morphologically identified by a medical entomologist in the Department of Animal and Environmental Biology after which they were maintained in a 200 mL transparent plastic container stuffed with detached foam (to enable the insects

(= bedbugs) aggregate) at an ambient temperature of 25±2°C and RH of 78% in the laboratory of the Department of Animal and Environmental Biology, University of Benin, Benin city. Experiments were conducted 24 h after collections.

Mortality bioassay: To perform the mortality bioassay, different concentrations (= grams) of the root powder of *C. odorata* (0, 1.0, 1.5 and 2.0 g) were weighed and added into a 100 mL transparent plastic container after which the top part of the container was covered with a sheet of paper and tightly sealed with a rubber band. Five unsexed adult *C. hemipterus* were introduced into each plastic container through a small hole made on the paper and thereafter, sealed with a paper tape to prevent the insects from escaping. Each concentration including the control was replicated 5 times and arranged in a Completely Randomized Design (CRD). In this way, it was possible to evaluate the efficacy of different concentrations of *C. odorara* root powder against *C. hemipterus*. Bedbug mortality for all the treatments (= concentrations) including the control was monitored for a total of 168 h (= 7 days). Mortality was recorded every 24 h and insects were confirmed dead when there was no response to probing with a sharp pin at the abdomen.

Statistical analysis: Control treatments, where *C. hemipterus* individuals were not exposed to the root powders of *C. odorata* plant caused less than 1.0% mortality, hence the controls were not included in the statistical analyses. The effects of exposure durations on mortality levels of *C. hemipterus* when treated with three different concentrations (g) of *C. odorata* root powder was analyzed with General Linear Model one-way Analysis of Variance (GLM ANOVA). When the overall results were significant in the GLM analysis, the difference among the treatments was compared using Tukey's Honest Significant Difference (HSD) test. All data were analyzed using SPSS Statistical software, version 16.0 (SPSS, Chicago, USA).

RESULTS

Percentage mortality differed as a function of concentration tested and duration of exposure. When bedbugs were exposed to *C. odorata* root powder, percentage mortality varied ($F_{2,14}$ = 4.85; p = 0.029) after 24 and 48 h with the highest mortality level (64%) caused by 2.0 g of the powder and the least mortality (20%) caused by 1.0 g of the powder while 1.5 g of the powder caused 52% mortality in both exposure periods (Fig. 1, 2).

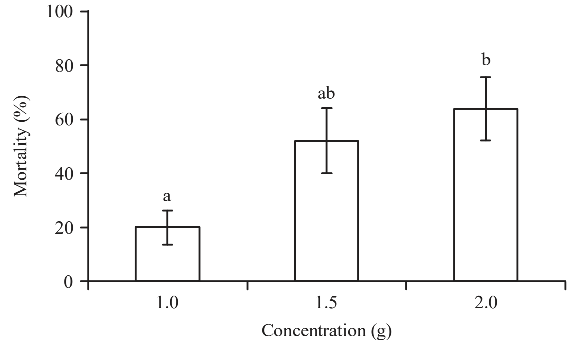

Fig. 1: Percentage mortality (Mean±SE) of *Cimex hemipterus* following a 24 h exposure to different concentrations of *Chromolaena odorata* root powder

Means capped with different letters are significantly different (after Tukey's Honest Significant Difference Test (HSD) (p<0.05)

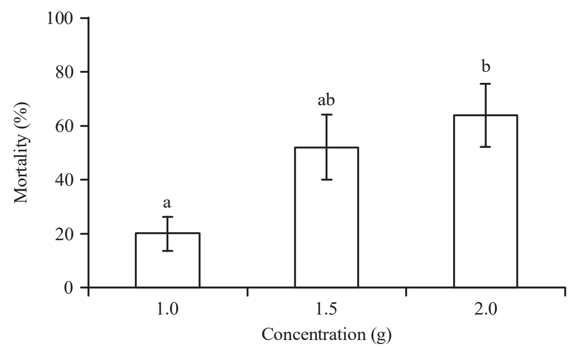

Fig. 2: Percentage mortality (Mean±SE) of *Cimex hemipterus* following a 48 h exposure to different concentrations of *Chromolaena odorata* root powder

Means capped with different letters are significantly different (after Tukey's Honest Significant Difference Test (HSD) (p<0.05)

Following a 72 h exposure period percentage mortality approached statistical significance ($F_{2,14}$ = 3.82; p = 0.052) with the highest concentration (2.0 g) resulting in the highest mortality recorded (68%) (Fig. 3). In the 96 h exposure trial percentage mortality varied significantly ($F_{2,14}$ = 4.80; p = 0.029) with the 2.0 g of the root powder causing the highest mortality (72%) followed by 1.5 g (56%) while the 1.0 g treatment caused the least mortality (40%) (Fig. 4). In the 120 h exposure trial percentage mortality also varied significantly ($F_{2,14}$ = 4.21; p = 0.041) with 2.0 g of the powder causing the highest percentage mortality (76%), followed by the 1.5 g treatment (56%) while the 1.0 g of the powder recorded the least mortality (40%) (Fig. 5). Similarly, following a 144 h exposure, bedbug mortality levels also differed ($F_{2,14}$ = 5.63; p = 0.019) among the three treatments with 2.0 g of the powder causing the highest percentage mortality (80%) (Fig. 6). Similarly, in the

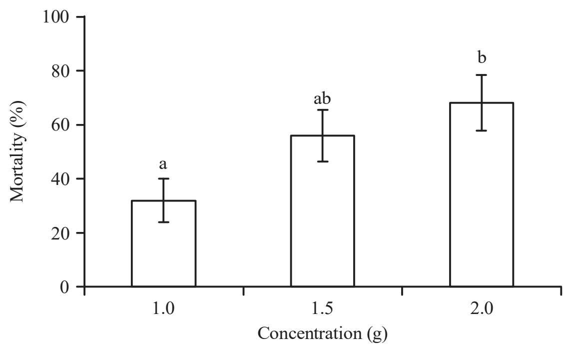

Fig. 3: Percentage mortality (Mean±SE) of *Cimex hemipterus* following a 72 h exposure to different concentrations of *Chromolaena odorata* root powder
Means capped with different letters are significantly different (after Tukey's Honest Significant Difference Test (HSD) ($p>0.05$)

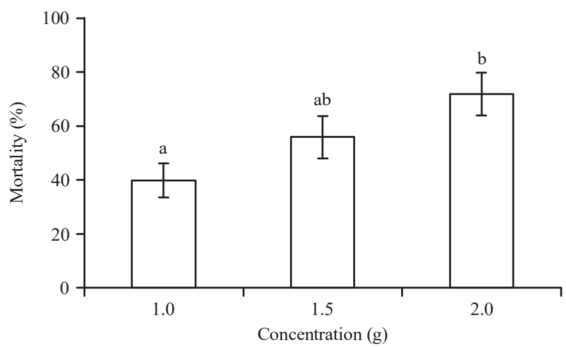

Fig. 4: Percentage mortality (Mean±SE) of *Cimex hemipterus* following a 96 h exposure to different concentrations of *Chromolaena odorata* root powder
Means capped with different letters are significantly different (after Tukey's Honest Significant Difference Test (HSD) ($p<0.05$)

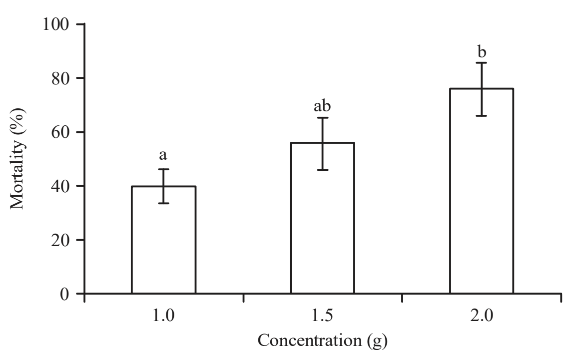

Fig. 5: Percentage mortality (Mean±SE) of *Cimex hemipterus* following a 120 h exposure to different concentrations of *Chromolaena odorata* root powder
Means capped with different letters are significantly different (after Tukey's Honest Significant Difference Test (HSD) ($p<0.05$)

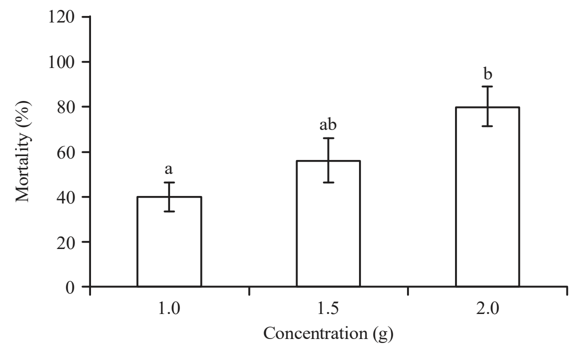

Fig. 6: Percentage mortality (Mean±SE) of *Cimex hemipterus* following a 144 h exposure to different concentrations of *Chromolaena odorata* root powder
Means capped with different letters are significantly different (after Tukey's Honest Significant Difference Test (HSD) ($p<0.05$)

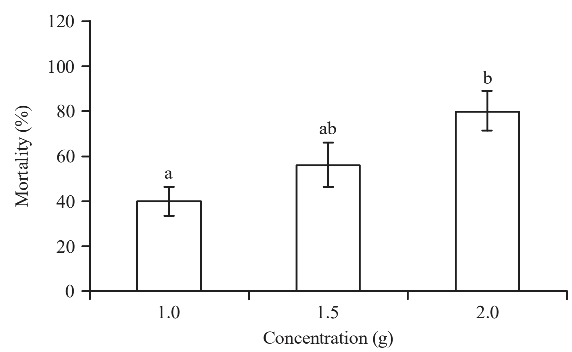

Fig. 7: Percentage mortality (Mean±SE) of *Cimex hemipterus* following a 168 h exposure to different concentrations of *Chromolaena odorata* root powder
Means capped with different letters are significantly different (after Tukey's Honest Significant Difference Test (HSD) ($p<0.05$)

168 h exposure treatment, bedbug mortality levels differed significantly ($F_{2,14} = 5.63$; $p = 0.019$) with the 2.0 g treatment causing the highest percentage mortality (80%) while the 1.0 g treatment recorded the least percentage mortality (40%) (Fig. 7). Finally, percentage mortality of *C. hemipterus* increased with an increase in the concentration of *C. odorata* root powder but was independent of the duration of exposure (Fig. 8).

DISCUSSION

This study documented the insecticidal activity of the root powder of *C. odorata* against *C. hemipterus*. The insecticidal activity demonstrated by the root powder of *C. odorata* against *C. hemipterus* was clearly a function of the concentrations used. This result concurs with the findings of Uyi *et al.*[16], who reported 72% mortality in *C. lectularius* following a 168 h exposure to 2.0 g leaf powder of *C. odorata*. In contrast to the findings of other researchers

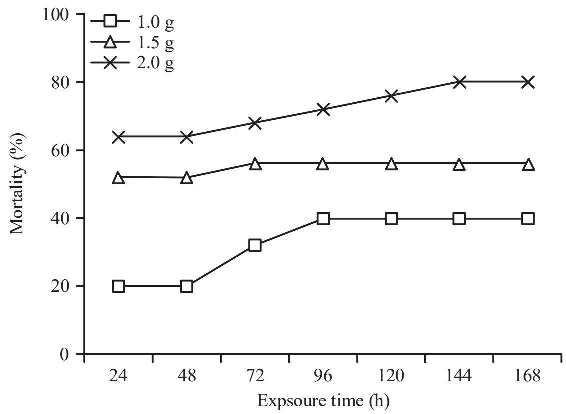

Fig. 8: Relationship between percentage mortality *Cimex hemipterus* exposed to different concentrations of *Chromolaena odorata* root powder and different exposure periods

Uyi and Igbinoba[13], Uyi and Adetimehin[14], Lawal *et al.*[18] and Uyi and Obi[20], bedbug mortality observed in this study had little or no correlation with increasing period of exposure to the plant material. After exposing *C. hemipterus* to different concentrations of *C. odorata* root powder for 144 h and 168 h, respectively, no significant increment in the mortality of the test insect was observed.

Results from this study evidently revealed that the root powder of *C. odorata* possesses potentially lethal effects against *C. hemipterus*. Although, several studies Uyi and Igbinoba[13], Uyi and Adetimehin[14], Uyi *et al.*[16,17], Uyi and Obi[20] and Uyi *et al.*[21] have consistently reported the insecticidal activities of the leaf, stem, root powders and/or extracts of *C. odorata* against several insect pests such as *C. maculatus*, *S. zeamais*, *Macrotermes* species, *Periplaneta americana* however, studies focusing on the insecticidal activities of the leaf, stem and/or root powders of *C. odorata* against any bedbug species received attention only recently[16]. As has been documented in other studies[13,14,16], the considerably high insecticidal activity exhibited by the root powder of *C. odorata* against *C. hemipterus* might be attributed to the presence of complex mixtures of bioactive compounds such as flavonoids, saponins, alkaloids, cardenolides, phenols, tannins and anthraquinones in the roots of *C. odorata*[22,23] and these compounds have been reported to demonstrate toxicological activities against a number of insect pests[20].

CONCLUSION

This study concluded that the insecticidal activity by the root powder of *C. odorata* against *C. hemipterus* was clearly a function of the concentrations used. For instance, at the highest concentration (2.0 g), the root powder of *C. odorata* accounted for 80% mortality in *C. hemipterus* following a 168 h exposure period. This study is the first study to elucidate the insecticidal activity of the root powder of *C. odorata* against *C. hemipterus* and it suggested its usage in the control of the pest particularly in the tropics where it exists. Further studies should examine the insecticidal activities of the root extracts of *C. odorata* using different extracting solvents against *C. hemipterus* for a better comparison with the results presented here.

SIGNIFICANCE STATEMENT

This study discovered the insecticidal activity of the root powder of an invasive alien plant, *C. odorata* against a serious nuisance insect pest, *C. hemipterus* that has not been previously reported. Furthermore, it adds to and also validates previously existing reports on the insecticidal activities of the root powder of *C. odorata* against insect pests.

REFERENCES

1. Reinhardt, K. and M.T. Siva-Jothy, 2007. Biology of the bed bugs (Cimicidae). Annu. Rev. Entomol., 52: 351-374.
2. Parte, S.G., A.S. Kharat, A.D. Mohekar, J.A. Chavan, A.A. Jagtap, A.K. Mohite and R.N. Patil, 2015. Efficacy of plant extracts for management of *Cimex lectularius* (Bed Bug). Int. J. Pure Applied Biosci., 3: 506-508.
3. Delaunay, P., V. Blanc, P. Del Giudice, A. Levy-Bencheton, O. Chosidow, P. Marty and P. Brouqui, 2011. Bedbugs and infectious diseases. Clin. Infect. Dis., 52: 200-210.
4. Doggett, S.L., D.E. Dwyer, P.F. Penas and R.C. Russell, 2012. Bed bugs: Clinical relevance and control options. Clin. Microbiol. Rev., 25: 164-192.
5. Goddard, J. and R. de Shazo, 2012. Psychological effects of bed bug attacks (*Cimex lectularius* L.). Am. J. Med., 125: 101-103.
6. Goddard, J. and R. de Shazo, 2009. Bed bugs (*Cimex lectularius*) and clinical consequences of their bites. J. Am. Med. Assoc., 301: 1358-1366.
7. Kebede, D., S. Mekonnen, A. Ambelu and K. Karunamoorthi, 2016. Laboratory evaluation of insecticidal activity of *Phytolacca dodecandra* L. 'Herit leaves extracts against bedbug, (Heteroptera: Cimicidae). ARC J. Public Health Commun. Med., Vol. 1.
8. Emmanuel, O.I., A. Cyprian and O.E. Agbo, 2014. A survey of bedbug (*Cimex lectularius*) infestation in some homes and hostels in Gboko, Benue state, Nigeria. Psyche: J. Entomol., Vol. 2014. 10.1155/2014/762704.

9. Omudu, E.A., 2008. A survey of bedbug (Hemiptera: Cimicidae) infestation in some homes and hostels in Makurdi and Otukpo, Benue state, Nigeria with notes on public health implications. Niger. J. Pure Applied Sci., 1: 84-91.
10. Omudu, E.A. and C.N. Kuse, 2010. Bedbug infestation and its control practices in Gbajimba: A rural settlement in Benue state, Nigeria. J. Vector Borne Dis., 47: 222-227.
11. Oduola, A.O., A.I. Omotayo, O.J. Adelaja and A. Obembe, 2017. Bedbug (*Cimex lectularis*) infestation and its control practices in two selected settlements in Ilorin, Kwara State, Nigeria. Anim. Res. Int., 14: 2818-2825.
12. Okwa, O.O. and O.A.O. Omoniyi, 2010. The prevalence of head lice (*Pediculus humanus capitus*) and bed bugs (*Cimex hemipterus*) in selected human settlement areas in Southwest, Lagos state, Nigeria. J. Parasitol. Vector Biol., 2: 8-13.
13. Uyi, O.O. and O.G. Igbinoba, 2016. Repellence and toxicological activity of the root powder of an invasive alien plant, *Chromolaena odorata* (L.) (Asteraceae) against *Callosobruchus maculatus* (Fab.) (Coleoptera: Chrysomelidae). Anim. Res. Int., 13: 2510-2517.
14. Uyi, O.O. and A.D. Adetimehin, 2018. Efficacy of the stem powder of an invasive alien plant, *Chromolaena odorata* (L) (Asteraceae) against *Callosobruchus maculatus* (Fab.) (Coleoptera: Chrysomelidae). J. Applied Sci. Environ. Manage., 22: 379-385.
15. Adetimehin, A.D. and O.O. Uyi, 2018. Larvicidal activity of the cold and hot water leaf extracts of *Azadirachta indica* A. Juss (meliaceae) against the larvae of *Culex quinquefasciatus* say (Diptera: Culicidae). Anim. Res. Int., 15: 3048-3054.
16. Uyi, O., A.D. Adetimehin, E.E. Uyamasi and A.J. Ejomah, 2018. Insecticidal activities of the leaf powders of *Chromolaena odorata* and *Mimosa diplotricha* against the common bed bug, *Cimex lectularius* (L.). Int. J. Zool. Res., 14: 37-42.
17. Uyi, O.O., F. Ekhator, C.E. Ikuenobe, T.I. Borokini and E.I. Aigbokhan *at el.*, 2014. *Chromolaena odorata* invasion in Nigeria: A case for coordinated biological control. Manage. Biol. Invasions, 5: 377-393.
18. Lawal, O.A., A.R. Opoku and I.A. Ogunwande, 2015. Phytoconstituents and insecticidal activity of different solvent leaf extracts of *Chromolaena odorata* L., against *Sitophilus zeamais* (Coleoptera: Curculionidae). Eur. J. Med. Plants, 5: 237-247.
19. Udebuani, A.C., P.C. Abara, K.O. Obasi and S.U. Okuh, 2015. Studies on the insecticidal properties of *Chromolaena odorata* (Asteraceae) against adult stage of *Periplaneta americana*. J. Entomol. Zool. Stud., 3: 318-321.
20. Uyi, O.O. and B.N. Obi, 2017. Evaluation of the repellent and insecticidal activities of the leaf, stem and root powders of siam weed (*Chromolaena odorata*) against the Cowpea Beetle, *Callosobruchus maculatus*. J. Applied Sci. Environ. Manage., 21: 511-518.
21. Uyi, O.O., A.D. Adetimehin and O.P. Ogu, 2018. Repellent and insecticidal activities of the root extracts of *Chromolaena odorata* and *Mimosa diplotricha* against *Macrotermes* species. J. Entomol., 15: 135-142.
22. Agaba, T.A. and B. Fawole, 2014. Phytochemical constituents of Siam weed (*Chromolaena odorata*) and African custard apple (*Annona senegalensis*). Int. J. Food Agric. Vet. Sci., 6: 35-42.
23. Agaba, T.A., B. Fawole and B. Claudius-Cole, 2015. Screening of siam weed (*Chromolaena odorata*) and african custard apple (*Annona senegalensis*) for nematicidal activity. J. Biol. Agric. Healthcare, 5: 50-56.