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Common Household Insecticides Used in Nigeria Induced Oxidative Stress in Wistar Rats

Augustine I. Airaodion[1*], Kenneth O. Ngwogu[2], Ada C. Ngwogu[3], Anthony U. Megwas[4], John A. Ekenjoku[5] and Olaide O. Awosanya[6]

[1]Department of Biochemistry, Federal University of Technology, Owerri, Imo State, Nigeria.
[2]Department of Pathology, Abia State University, Uturu, Nigeria.
[3]Department of Microbiology, Abia State University, Uturu, Nigeria.
[4]Department of Optometry, Federal University of Technology, Owerri, Imo State, Nigeria.
[5]Department of Pharmacology and Therapeutics, Abia State University, Uturu, Nigeria.
[6]Department of Biochemistry, University of Ibadan, Oyo State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author AIA conceptualized, designed the study and also wrote the manuscript. Authors ACN and OOA managed the analyses of the study. Author KON managed the literature searches. Author JAE wrote the protocol while Author AUM performed the statistical analysis. All authors read and approved the final manuscript

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ABSTRACT

Background: The use of household insecticides for the eradication of insects especially mosquitoes in Nigeria is increasing. These insecticides are used without consideration of their adverse effect on human health.
Aim: This study is therefore sought to investigate the effect of common household insecticides used in Nigeria on oxidative stress biomarkers.
Methodology: Thirty (30) male Wistar rats were divided into five groups of six (6) each. Rats in group 1 were exposed to Rambo, those in group 2 were exposed to Mortein, those in group 3 were exposed to Raid, those in group 4 were exposed to Baygon while those in group 5 were not exposed to any insecticide and served as the control group. The exposure was done twice daily via inhalation route. Throughout the experiment, animals were fed *ad libitum* with standard feed and

**Corresponding author: E-mail: augustineairaodion@yahoo.com;*

drinking water. After twenty-one (21) days of exposure, they were sacrificed after an overnight fast under diethyl ether as anesthesia. Blood samples were collected via cardiac puncture. Oxidative stress biomarkers (lipid peroxidation, glutathione, catalase, superoxide dismutase and glutathione peroxidase) were determined using standard methods.

Results: The results obtained showed that exposure of the animals to all types of insecticides (Rambo, Mortein, Raid and Baygon) significantly ($p < 0.05$) increased lipid peroxidation an index of oxidative biomarkers in rats when compared to the control group. Conversely, the concentration of glutathione was significantly ($p < 0.05$) reduced compared to the corresponding control group.While the activities of antioxidant enzymes (catalase, superoxide dismutase and glutathione peroxidase) were observed to significantly ($p < 0.05$) increase as a result of insecticides exposure to animals when compared with the control group animals.

Conclusion: From the findings of the present study, it can be concluded that common household insecticides used in Nigeria induced oxidative stress in Wistar rats and might compromise the immune system. Suggesting that such oxidative stress inducing effects of these insecticides as observed in animals used in this study may be extrapolated in humans who use these insecticides to protect against various insects. Therefore, staying in a room fumigated with these insecticides when the effect has not completely subsided may be hazardous to humans and hence, this should be discouraged.

Keywords: Antioxidants; free radicals; household insecticides; oxidative stress.

1. INTRODUCTION

Oxidative stress (OS) is the results of production of reactive oxygen species (ROS). Sometimes they are also referred to as reactive oxygen intermediates (ROI). They occur as a result of metabolism of tissues [1]. ROS act as signaling mediators as most of the time may be beneficial. Most of the exogenous substances may activate the production of these ROS. Cigarette smoke, UV radiation in the atmosphere, alcohol, drugs and cancer chemotherapeutic agents and radiotherapy treatments induce oxidative stress. Petroleum combustion products, heavy metals as well as pesticide particles and their metabolic end products also initiate the oxidative stress. Infections, tissue injury, and ischaemia also contribute in the elevated levels of ROS [2]. Cigarette smoke is one of the exogenous agents that induce oxidative damage in cell line. Cigarette smoke induces oxidation of structural and functional components and also able to decrease the endothelial growth. In a recent study, Airaodion et al. [3] reported that hydrocarbon induced OS when animals were fed with crude oil treated-diet. Several studies have also reported that alcohol has the propensity to induce oxidative stress [4,5,6].

Insecticides are substances used to kill, repel or mitigate one or more species of insects. They also include ovicides and larvicides used against insect eggs and larvae, respectively [7]. Insecticides are used in agriculture, healthcare, industry and by individuals. Insecticides have been reported to be a major factor behind the increase in the 20th century's agricultural productivity [8]. Nearly all insecticides have the potential to significantly alter ecosystems; many are toxic to humans and/or animals; some are accumulate in the body and bio-magnify as they pass along the food chain [8].

Insecticides can be classified into two major groups: systemic insecticides, which have residual or long term activity; and contact insecticides, which have no residual activity. The mode of action describes how the pesticide kills or inactivates a pest. It provides another way of classifying insecticides [7]. Mode of action can be important in understanding whether an insecticide will be toxic to unrelated species, such as fish, birds and mammals. Insecticides may be repellent or non-repellent. Social insects such as ants cannot detect non-repellents and readily crawl through them. As they return to the nest they take insecticide with them and transfer it to their nestmates. Over time, this eliminates all of the ants including the queen. This is slower than some other methods, but usually completely eradicates the ant colony [9]. Insecticides are distinct from non-insecticidal repellents, which repel but do not kill. The common household insecticides used in Nigeria are systemic insecticides. They include Rambo produced by Gongoin and Co, Mortein produced by Reckitt Benckiser, Raid and Baygon both produced by S.C. Johnson and Co. People use these insecticides without consideration of their adverse effect on health. Airaodion et al. [10] has reported that these insecticides had adverse effect on male reproductive hormones. This

present study therefore sought to evaluate the effect of these insecticides on oxidative stress biomarkers in Wistar rats.

2. MATERIALS AND METHODS

2.1 Collection of Insecticides

Baygon, Raid and Mortein insecticides were purchased from 'Pinnacle' supermarketwhile Rambo was purchased from 'Medhelp' Pharmacy both in Ibadan, Nigeria. They were kept at room temperature before and during the experiment.

2.2 Experimental Design and Animal Treatment

Thirty (30) male Wistar rats weighing between 220 and 245 g were used for this study. They were acclimatized for seven (7) days to laboratory conditions before the commencement of the experiment. During this period, they were fed *ad libitum* with standard feed and drinking water and were housed in clean cages placed in well-ventilated housing conditions (under humid tropical conditions) throughout the experiment. All the animals received humane care according to the criteria outlined in the 'Guide for the Care and Use of Laboratory Animals' prepared by the National Academy of Science and published by the National Institute of Health. They were randomly divided into five groups of six rats each and kept in different rooms. Rats in group 1 were exposed to Rambo insecticide, those in group 2 were exposed to Mortein insecticide, those in group 3 were exposed to Raid insecticide, those in group 4 were exposed to Baygon insecticide while those in group 5 were not exposed to any insecticide and served as the control group. The exposure was done twice daily via inhalation route. Throughout the experiment, they were fed *ad libitum* with standard feed and drinking water.After twenty-one days of exposure, the rats were sacrificed after an overnight fast under diethyl ether as anesthesia. Blood samples were collected via cardiac puncture.

2.3 Determination of Oxidative Stress Biomarkers

Determinationof Lipid Peroxidation (LPO), Reduced Glutathione (GSH), Catalase (CAT), Superoxide Dismutase (SOD) and Glutathione peroxidase (GPx) were carried out on the serum of animals according to the methods previously described by Airaodion et al. [11].

2.4 Statistical Analysis

Data were subjected to analysis using Analysis of Variance (ANOVA) with the aid of graph pad prism. Data from each parameter was expressed as mean value ± standard error of the mean (SEM). Data were considered to be significantly different at 95% confidence level ($P \leq 0.05$).

3. RESULTS

The results of the effect of common household insecticides used in Nigeria LPO, GSH, CAT, SOD and GPx are presented in Figs. 1-5 respectively.

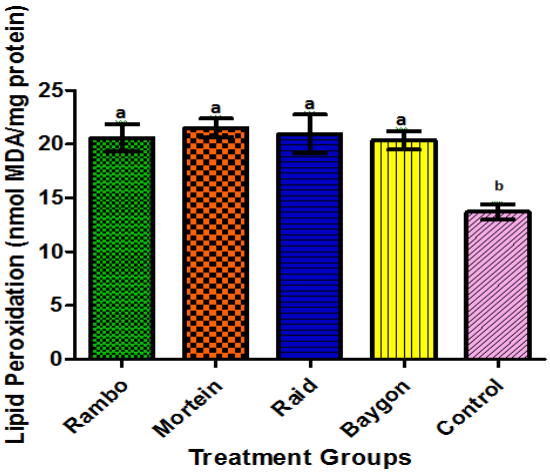

Fig. 1. Effect of household Insecticides on the lipid peroxidation in Animals after 21 Days of exposure

Results are presented as mean ± SEM with n = 6. bars with different letters are significantly different at P < 0.05

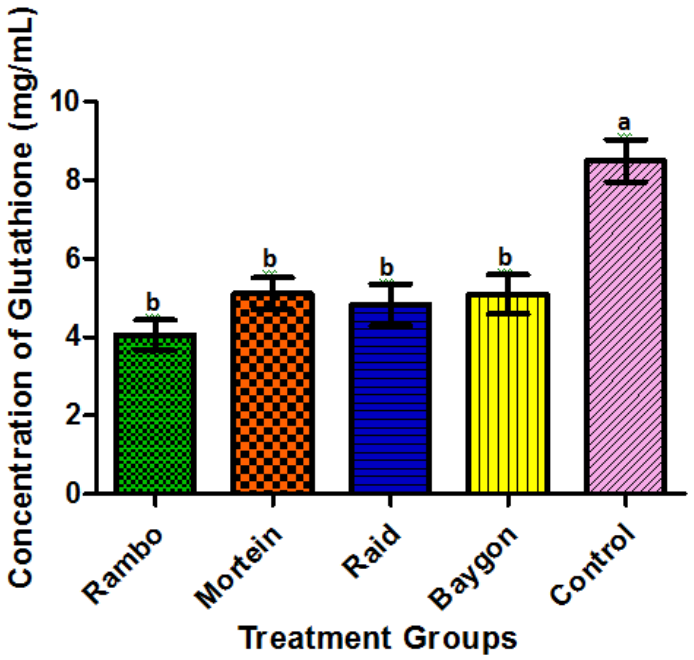

Fig. 2. Effect of household insecticides on the concentration of reduced glutathione (GSH) in animals after 21 days ofexposure

Results are presented as mean ± SEM with n = 6. bars with different letters are significantly different at P<0.05

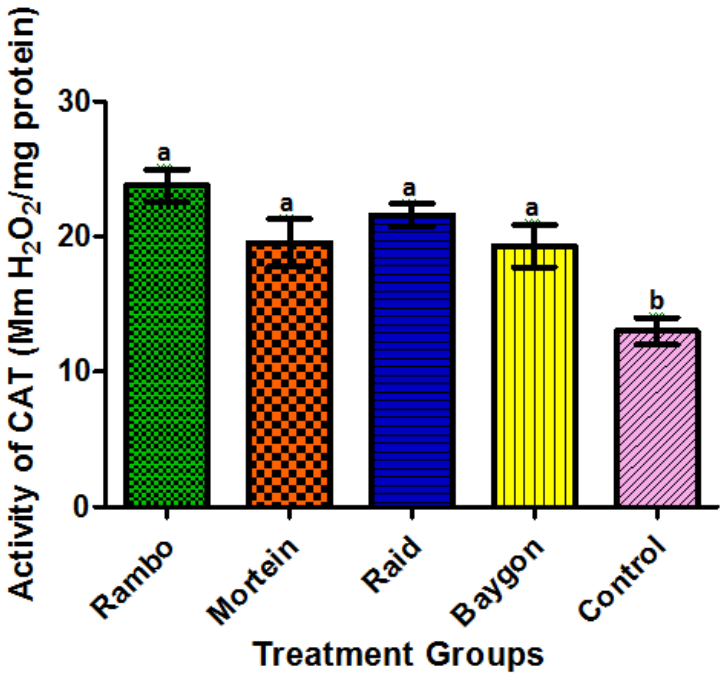

Fig. 3. Effect of household insecticides on the activity of catalase (CAT) in animals after 21 days of exposure

Results are presented as mean ± SEM with n = 6. bars with different letters are significantly different at P<0.05

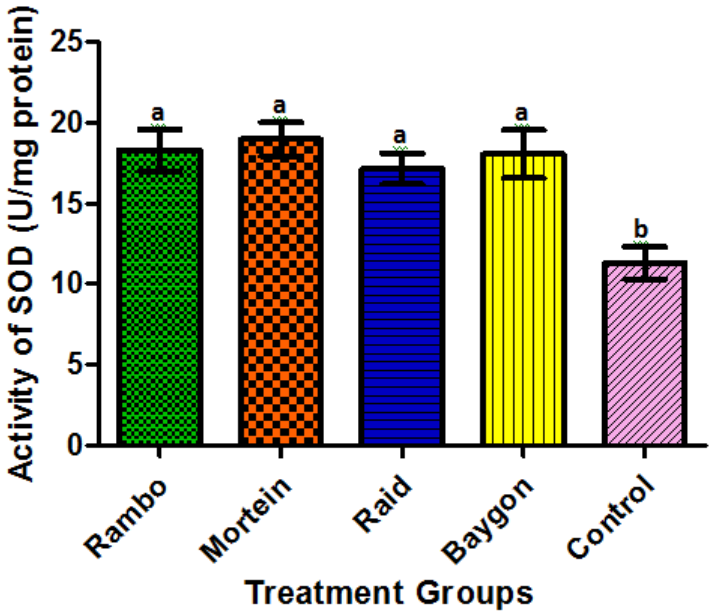

Fig. 4. Effect of household insecticides on the activity of superoxide dismutase (SOD) in animals after 21 days of exposure

Results are presented as mean ± SEM with n = 6. bars with different letters are significantly different at P<0.05

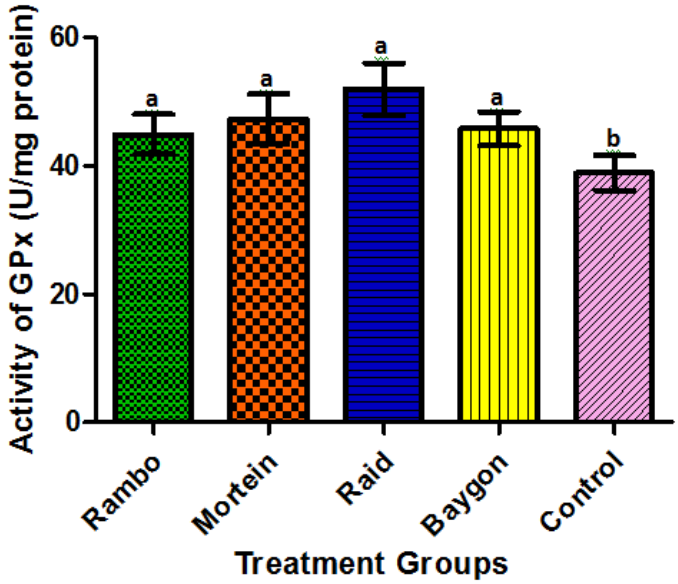

Fig. 5. Effect of household insecticides on the activity of glutathione peroxidase (GPX) in animals after 21 days of exposure

Results are presented as mean ± SEM with n = 6. bars with different letters are significantly different at P<0.05

4. DISCUSSION

In this study, it was observed that all the insecticides used in this study significantly elevated the malondialdehyde (MDA) levels in animals indicating enhanced peroxidation and breakdown of the antioxidant defense mechanisms. Decomposition products of lipid hydroperoxide such as MDA and 4-hydroxynonenal can cause chaotic cross-linkage

with proteins and nucleic acids, which plays an important role in the process of carcinogenesis. In this investigation, serum lipid peroxidation (LPO) activities showed significant increase due to insecticide exposure [12]. Furthermore, extensive damage to tissues in a free radical mediated LPO results in membrane damage and subsequently decreases the membrane fluid content [13].

Glutathione (GSH) is a tripeptide (L-α-glutamylcysteinol glycine) which is highly abundant in all cell compartments and it is the major soluble antioxidant. Glutathione directly quenches ROS such as lipid peroxides, and also plays a major role in xenobiotic metabolism [11,14]. Glutathione detoxifies hydrogen peroxide and lipid peroxide by donating electron to hydrogen peroxide to reduce it to water and oxygen protecting macromolecules such as lipids from oxidation. In this study, the decrease in the reduced serum glutathione level in animals exposed to insecticides for 21 days might be connected to insecticide-induced oxidative stress and direct conjugation of GSH with reactive intermediates of insecticide oxidation.

In this present study, all the insecticides were observed to significantly ($p < 0.05$) increase the activities of antioxidant enzymes (SOD, CAT GPx) investigated when compared to those in their respective control group (Figs. 3-5). SOD plays an important role in reducing the effect of free radicals' attack. It is the only enzymatic system quenching O_2- to oxygen and H_2O_2 and plays a significant role against oxidative stress [14]. These radicals have been reported to be deleterious to polyunsaturated fatty acids and proteins [3,11]. CAT and GPx are other enzymatic antioxidants that act as a defense mechanism against oxidative stress [14]. The significant increase in the activities of antioxidant enzymes in animals exposed to insecticides might be an indication that these insecticides increased the generation of free radicals which these enzymes tend to combat, thereby increasing their activities. These insecticides have been reported to induce nephron- and hepato-toxicity in Wistar rats due to the generation of free radicals [15]. The mechanism in which insecticides increased the activities of these enzymes is unclear but Airaodion et al. [3] reported that hydrocarbon exposure significantly increased these enzymes. Thus, the mechanism of action of insecticides in this present study might be similar to that of hydrocarbon.

5. CONCLUSION

From the result of this present study, common household insecticides used in Nigeria induced oxidative stress and might compromise the immune system. Thus, staying in a room fumigated with these insecticides when the effect has not completely subsided may be hazardous, and thus should be discouraged.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Repine JE, Bast AL. Oxidative stress in chronic obstructive pulmonary disease. Oxidative stress study group. American Journal of RespirCrit Care Med. 1997;156: 341–357.
2. Kasahara Y, Tuder RM, Cool CD, Lynch DA, Flores SC, Voelkel NF. Endothelial cell death and decreased expression of vascular endothelial growth factor and vascular endothelial growth factor receptor 2 in emphysema. Am J RespirCrit Care Med. 2001;163:737–744.
3. Airaodion AI, Ogbuagu U, Ekenjoku JA, Ogbuagu EO, Airaodion EO, Okoroukwu VN. Hepato-protective efficiency of

ethanol leaf extract of *Moringa oleifera* against hydrocarbon exposure. International Journal of advances in Herbal and Alternative Medicine. 2019; 03(01):32-41.

4. Airaodion AI, Ogbuagu EO, Ewa O, Ogbuagu U, Awosanya OO, Adekale OA. Ameliorative efficacy of methanolic extract of Corchorusolitorius leaves against acute ethanol-induced oxidative stress in Wistar rats. Asian Journal of Biochemistry, Genetics and Molecular Biology. 2019; 7(6):1-9.
5. Ogbuagu EO, Airaodion AI, Ogbuagu U, Airaodion EO. Prophylactic propensity of methanolic extract of Vernonia amygdalina leaves against acute ethanol-induced oxidative stress in Wistar rats. International Journal of Bio-Science and Bio-Technology. 2019;11(7):37-46.
6. Airaodion AI, Akinmolayan JD, Ogbuagu EO, Esonu CE, Ogbuagu U. Preventive and therapeutic activities of methanolic extract of Talinum triangulare leaves against ethanol-induced oxidative stress in Wistar rats.International Journal of Bio-Science and Bio-Technology. 2019;11(7): 85-96
7. IUPAC. Glossary of Terms Relating to Pesticides. International Union of Pure and Applied Chemistry. 2006;2123. [Retrieved January 28, 2014]
8. van Emden HF, Peakall DB. Beyond Silent Spring. Springer. 1996. [ISBN 978-0-412-72800-6]
9. Murray B. Isman botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annual Review of Entomology. 2013;51:45-66.
10. Airaodion AI, Ngwogu AC, Megwas AU, Ekenjoku JA, Ngwogu KO. Effect of common household insecticides used in Nigeria on rat male reproductive hormones. International Journal of Research and Reports in Gynaecology. 2020;2(1):1-8.
11. Airaodion AI, Ogbuagu EO, Ogbuagu U, Adeniji AR, Agunbiade AP, Airaodion EO. Hepatoprotective effect of Parkia biglobosaon acute ethanol-induced oxidative stress in Wistar rats. International Research Journal of Gastroenterology and Hepatology. 2019;2(1):1-11.
12. Airaodion AI, Ngwogu AC, Ekenjoku JA, Ngwogu KO. Hepatoprotective potency of ethanolic extract of Garciniakola (Heckel) seed against acute ethanol-induced oxidative stress in Wistar rats. International Research Journal of Gastroenterology and Hepatology. 2020;3(2):1-10.
13. Oyenihi OR, Afolabi BA, Oyenihi AB, Ogunmokun OJ, Oguntibeju OO. Hepato- and neuro-protective effects of watermelon juice on acute ethanol-induced oxidative stress in rats. Toxicology Reports. 2016;3: 288–294.
14. Airaodion AI, Ogbuagu EO, Ekenjoku JA, Ogbuagu U, Airaodion EO. Therapeutic effect of methanolic extract of telfairia occidentalis leaves against acute ethanol-induced oxidative stress in Wistar rats. International Journal of Bio-Science and Bio-Technology. 2019;11(7):179-189.
15. Airaodion AI, Ekenjoku JA, Megwas AU,Ngwogu KO, Ngwogu AC. Nephro- and hepato-toxicity of common household insecticides used in Nigeria. International Research Journal of Gastroenterology and Hepatology. 2020;3(3):1-8.

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