SUSCEPTIBILITY OF MOSQUITO LARVAE TO CONVENTIONAL INSECTICIDES IN A TROPICAL ARID ECOSYSTEM

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ABSTRACT

The susceptibility of 4th instar larvae of Aedes aegypti and Culex quinquefasciatus to dieldrin, dichlovos and cypermethrin were evaluated in laboratory. Larval mortality was assessed 24 hour after exposure. The result showed that the LD_{50} values for Aedes aegypti exposed to dieldrin, dichlovos and cypermethrin were 0.48, 37.09 and 0.29 µg per liter respectively. The LD_{50} values for Culex quinquefasciatus of exposed to dieldrin, dichlovos and cypermethrin were 0.11, 10.05 and 0.05 µg per liter respectively.

Keywords: *Aedes aegypti, Culex quinquefasciatus,* LC_{50}, Dieldrin, Dichlovos, Cypermethrin.

INTRODUCTION

The development of resistance in mosquitoes to a wide variety of conventional insecticides has posed a serious problem for vector control program (Brown, 1986; Boike *et al.,* 1989; WHO, 1992; Deedat, 1994; Chandre *et al.,* 1999). These invariably led to the development of new insecticides for mosquito control besides the use of other control measures and multiple| overdosed treatments, thus fostering serious human health concerns (Rozendaal, 1997; Brown, 1983). Pesticide resistant is a major constraint to mosquito control (Busvine, 1978).

To keep tract of these problems, the screening for susceptibility status of mosquitoes in the local environment is imperative. Little work is done to establish the susceptibility status of mosquitoes to commonly used insecticides in arid tropical ecosystem of Maiduguri, Nigeria.

The present study compares the susceptibility status of larvae of two vector mosquito species viz: *Culex quinquefasciatus* and *Aedes aegypti* to three conventional insecticides (Dieldrin, Dichlovos and Cypermethrin) using field strains of mosquitoes.

MATERIALS AND METHODS

Study Areas: The study was conducted in Maiduguri located in the Sahel Savanna region of Northeastern Nigeria at latitude 11°05' North and longitude 13°05' East (BSBLS, 2004). Maiduguri has mean annual rainfall of about 625 mm .The mean annual temperature and is about 32°C. The mean annual relative humidity for dry and rainy seasons was 40% and 60% respectively while the mean annual evaporation rate is about 1600 mm (Marte, 1986).

Dieldrin: Old stock of dieldrex 20 EC was obtained from a pesticide store. Dieldrex is a brand of dichlovos with a chemical formula: $C_{12}H_8Cl_6O$. It is a contact and stomach poison with highly mammalian toxicity. They are Persistent insecticide (Kumar, 1984). The stock solution was serially diluted to obtain 20, 40, 60, 80 and 10 µg per liter.

Dichlovos: Nuvan 100EC was purchased from a pesticide store in Maiduguri. Nuvan is a brand of dichlovos with a chemical formula: $C_4H_7Cl_2O_4P$. It is a fumigant, contact and stomach poison with low mammalian toxicity (Kumar, 1984). The stock solution was serially diluted to obtain 20, 40, 60, 80 and 10 µg per liter.

Cypermethrin: Cypercot 25 EC was purchased from a pesticide store in Maiduguri. Cypercot 25EC is a brand of cypermethrin with a chemical formula: $C_{22}H_{19}Cl_2NO_3$. It is a contact poison with low mammalian toxicity (Kumar, 1984). The stock solution was serially diluted to obtain 20, 40, 60, 80 and 10 µg per liter.

Rearing of Mosquitoes: The larvae of *A. aegypti* and *C. quinquefasciatus* were collected from their natural breeding habitats in Maiduguri, Borno State. The adults of both sexes were fed with 10 % glucose solution (Sneller and Dadd, 1977). In addition, females were fed on blood meal twice a week from restrain chicken with shaved abdominal feathers (Azmi *et al.*, 1998). A 250 ml glass beaker containing 150 ml of distilled water with a filter paper smoothly adhered to the inner wall serves as oviposition sites for A. aegypti and a plastic container with little quantity of water serve as oviposition sites for C. quinquefasciatus. The larvae of each species were separately held in plastic containers and were daily fed on a pinch of finely powdered liver and brewer's yeast mixed at the ratio of 3: 2 (wt: wt) (Roberts, 1998).

Laboratory Bioassay: A batch of 20; 4th instars larvae of *A. aegypti* or *C. quinquefasciatus* were separately exposed to 20, 40, 60, 80 and 10 µg of dieldrin, dichlovos and cypermethrin per liter o distilled water respectively. Larval mortality was assessed after 24 hours after exposure. The experiment was conducted at 37 ± 5 ^{0}C and 80 – 90 % relative humidity. The data obtained was subjected to probit

analysis using Statsdirect Statistical Software Version 4.2. (Statsdirect, 2005).

RESULTS

The result of the study is presented in table 1. The result showed that the LD_{50} values for A. aegypti exposed to dieldrin, dichlovos and cypermethrin were 0.48 37.09 and 0.29 µg per liter respectively. The LD_{50} values *C. quinquefasciatus* exposed to dieldrin, dichlovos and cypermethrin were 0.11, 10.05 and 0.05 µg per liter respectively.

Table 1: Comparative toxicity of synthetic insecticides to *A. aegypti* and *C. quinquefasciatus*

Insecticide	Mosquito species	
	A. aegypti	***C. quinquefasciatus***
Dieldrin	0.481 (0.60-0.05)2	0.111 (0.16-0.08) 2
Dichlovos	37.09 (42.13-32.63)	10.05 (13.62-6.89)
Cypermethrin	0.29 (0.40-0.23)	0.05 (0.59-0.03)

L LD_{50} values in µg per liter, 295 % Confidence interval

DISCUSSIONS

Pesticide resistant is a major constraint of insect vector control (Busvine, 1978). Resistance in pest or vector population is expected to develop quickly whenever all individuals in the population are intensively selected with insecticides for several generations (Malcom, 1988). Results obtained in this study reveal that both *A. aegypti* and *C. quinquefasciatus* are less susceptible to dichlovos but more susceptible to cypermethrin and dieldrin. This confirms the findings of Molta and Ali (1998) who indicates that permethrin is potent against Anopheles species in northeastern Nigeria. The high mortality recorded with cypermethrin could be due to intoxication effects at different levels of pharmacokinetic interaction, thus; penetration of barrier tissue, distribution, storage, metabolism in internal tissue, and molecular interaction with the target site (Narahashi, 1976; WHO, 1980; Shamaan *et al.,* 1993; Curtis *et al.,* 1996).

Several other studies have revealed organophosphorus resistance in various species of mosquitoes (Don-Pedro and Adegbite, 1985; Amin and Peiris, 1990). The present study has shown that A. aegypti and *C. quinquefasciatus* were less susceptible to dichlovos. Thus their use in mosquito control may not be effective in the local environment. However, studies by Georghiou, (1980) and WHO (1992) showed that dichlovos could be use in mosquito control with effective resistance management techniques. These authors used higher concentrations then the ones used in this study. Although the present study did not indicate selection to dieldrin and cypermethrin in the local environment, other studies have revealed the resistance of mosquitoes to dieldrin (WHO, 1986; Amin and Hemingway, 1989) and cypermethrin (Chandre *et al.,* 1999). The studies of Kristan *et al.* (2003) revealed that resistance to pyrethroid insecticides was caused by the kdr gene in the malaria vector *Anopheles gambiae* Giles s.s. (Diptera: Culicidae).

Although the present study indicates that both mosquito species were susceptible to dieldrin and cypermethrin, the later is recommended for mosquito control because dieldrin has undesirable effects (Metcalf, 1980) and has been banned in many countries including Nigeria. As suggested by Dorta *et al.* (1993) synthetic pyrethroids could be effectively employed in integrated vector control operations. However, several reports have shown resistance to pyrethroids in several species of mosquitoes (WHO, 1992; Vulule et al., 1994). Their results further revealed that A. aegypti is less susceptible to all the three insecticides then *C. quinquefasciatus*. This could be due to interplay of several factors Viz: biochemical (Hill, 1985), genital (Hemingway, 1983), behavioral (Miller and Gibson 1994) and physiological (Lockwood *et al.,* 1984).

It is concluded from the present study that, of the insecticides tested cypermethrin can be effectively used for controlling mosquito vectors and shall play a vital role in reducing the morbidity and mortality of mosquito borne-diseases in northeastern Nigeria and other mosquito endemic countries. However, pyrethroids insecticides could be used rationally, otherwise resistance problem to these insecticides will appear in the local environment in the future.

REFERENCE

AMIN, A. M. and HEMINGWAY, H. (1989). Preliminary investigation of the mechanisms of DDT and Pyrethroid resistant in Culex quinquefasciatus Say (Diptera: Culicidae) from Saudi Arabia. *Bulletin of Entomological Research, 79:* 361 – 366.

AMIN, A. M. and PEIRIS, H. T. R. (1990). Detection and selection of organophosphorus and Carbamate resistance *Culex quinquefasciatus* Say (Diptera: Culicidae) from Saudi Arabia. *Medical and Veterinary Entomology, 4:* 265 – 269.

AZMI, M. A., NAQVI., S. N. H., AHMAD, I., TABASSUM, M. R. and ANBREEN B. (1998). Toxicity of Neem Leaves Extract (NLX) Compared With Malathion (57 EC.) Against Late 3rd Instar Larvae of *Culex fatigans* (Wild Strain) by WHO Method. *Tropical Journal of Zoology, 22:* 213 – 218.

BOIKE, A. H. JR., RATHBURN, C. B. JR., FLOORE, T. G., RODRIGUEZ, H. M and COUGHLIN, J. S. (1989). Insecticide tolerance of *Culex nigripalpus* in Florida. *Journal of American Mosquito Control Association 5:* 522 – 528.

BSBLS (2004). *Map of Borno State, Nigeria*. Borno State Bureau of Land and Survey, Maiduguri, Borno State, Nigeria. 1 pp.

BROWN, A .W .A. (1983). Insecticide resistance as a factor in the integrated control of Culicidae. Pages 161 – 235. *In:* Laird, M. and Miles, J. W. (Eds). *Integrated mosquito control methodologies.* Academic Press, New York.

BROWN, A. W. A. (1986). Insecticide resistance in mosquitoes: A pragmatic review. *Journal of the American Mosquito Control Association, 2:* 123 – 140.

BUSVINE, J. R. (1978). Current problems in the control of mosquitoes. *Nature, 273*: 604 – 607.

CHANDRE, F., DARRIET, F., MANGA, L., AKOBELLO, M., FAYE, O., MOUCHET, J. and GUILLET, P. (1999). Status of pyrethroid resistance in *Anopheles gambiae* sensu lato. *Bulletin of World Health Organization, 77:* 230 – 234.

CURTIS, C. F., MYAMBA, J. and WILKES, T. J. (1996). The comparison of different insecticides and fabrics for anti-mosquito bed nets and curtains. *Medical and veterinary Entomology, 10(1):* 1 – 11.

DEEDAT, Y. D. (1994). Problems associated with the use of pesticides: An overview. *Insect Science and Application, 15:* 247 – 251.

DON-PEDRO K. N. and ADEGBITE, T. O. (1985). Nuvan resistance in a strain of Aedes aegypti in Lagos, Nigeria. *Environmental Pollution, (Series A) 38:* 19 – 24.

DORTA, D., MVASUKI, V. and RAJAVEL, A. (1993). Evaluation of organophosphorus and synthetic pyrethroid insecticides against six vector mosquito species. *Reviews of Saúde Públications*, *27:* 391 – 397.

GEORGHIOU, G. P. (1980). Insecticide resistance and prospects for its management. *Residue Reviews*, *76:* 131 – 145.

HEMINGWAY, J. (1983). The genetics of Malathion resistance in *Anopheles stephensi* from Pakistan. *Transaction of Royal Society of Tropical Medicine and Hygiene, 7:* 106 – 108.

HILL, N. (1985). The biochemistry of insecticide resistance in *Anopheles sacharovi.* Comparative studies with a range of insecticide susceptible and resistance *Anopheles* and *Culex* species. *Pesticide Biochemistry and Physiology, 24:* 68 – 76.

KUMAR, R. (1984). *Insect pest control with special reference to African agriculture.* Edward Arnold Publishers. 180 pp.

KRISTAN, M., FLEISCHMANN, H., DELLA TORRE, A., STICH, A. and CURTIS, C. F. (2003) Pyrethroid resistance/susceptibility and differential urban/rural distribution of *Anopheles arabiensis* and *An. gambiae* s.s. malaria vectors in Nigeria and Ghana. *Medical and Veterinary Entomology, 17(3):* 326 – 332.

LOCKWOOD, J. A., SPARKS, T. C. and STORY, R. N. (1984). Evolution of insect resistance to insecticides: a reevaluation of the roles of physiology and behavior. *Bulletin of Entomological Society of America, 30:* 41 – 50.

MALCOM, C. A. (1988). Current status of pyrethroids resistance in Anopheline. *Parasitology Today, 4:* 513 – 515.

MARTE, M. A. (1986). Groundwater Exploitation and Drilling Technology in Arid Areas of Nigeria, Borno as a Case Study. Pages 141 – 173. *In: Proceedings of the First Annual Symposium and Training Workshop on Groundwater Resources in Nigeria*, University of Lagos, Nigeria.

METCALF, R. L. (1980). Changing role of insecticide resistances in crop protection. *Annual Review of Entomology, 25:* 219 – 256.

MILLER, J. E. and GIBSON, G. (1994). Behavioural response of host-seeking mosquitoes (Diptera: Culicidae) to insecticide-impregnated bed netting: a new approach to insecticide bioassays. *Journal of Medical Entomology, 31:* 114 – 122.

MOLTA, N. B. and ALI A. (1998). Susceptibility of *Anopheles* species of northeastern Nigeria to Permethrin. *Entomological Society of Nigeria Occasional Publication, 31:* 101 – 107.

NARAHASHI, T. (1976). Nerve membrane as a target of pyrethroids. *Pesticide Science, 7*: 267 – 272.

ROBERTS, D. (1998). Overcrowding of *Culex sitiens* (Diptera: Culicidae) larvae: Population regulation by chemical factors or mechanical interference. *Journal of Medical Entomology, 35(5):* 665 – 669.

ROZENDAAL, J. A. (1997). *Vector control.* World Health Organization, Geneva, Switzerland

SHAMAAN, N. A., HAMIDAH, R., JEFFRIES, J., HASHIM, A. J. and WAN NGAH, W. Z (1993). Insecticide toxicity, glutathione transferases and carboxylesterase activities in the larva of the Aedes mosquito. *Comparative Biochemistry and Physiology Part C: Comparative Pharmacology, 102 (1):* 107 – 110.

SNELLER, V. P. and DADD, R. H. (1977). Requirement for sugar in a chemically defined diet for *Aedes aegypti* larvae. *Journal of Experimental and Applied Entomology, 14:* 387 – 392.

STATSDIRECT (2005). StatsDirect Ltd.Uk Version 4.2, 11 Gresham Way Cheshire, M33 3UY UK.

VULULE, J. M., BEACH, R. F., ATIELI, F. K., ROBERTS. J. M., MOUNT, D. L. and MWANGI, R. W. (1994). Reduced susceptibility of Anopheles gambiae to permethrin associated with the use of permethrin-impregnated bed nets and curtains in Kenya. *Medical and Veterinary Entomology, 8:* 71 – 75.

WHO (1980). Resistance of vectors of disease to pesticides: 5th report of expert committee on Vector biology and control. *World Health Organization Technical Report Series, 655:* 1 – 63.

WHO (1986). Resistance in vectors and reservoirs of diseases to pesticides. *Bulletin of World Health Organization Technical Report Series, 737:* 1 – 88.

WHO (1992). Vector resistance to pesticides. 15th report of the WHO Expert Committee on Vector Biology and Control. *World Health Organization Technical Report Series, 818:* 1 – 71.

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