

Susceptibility status of dengue vectors against various insecticides in Koderma (Jharkhand), India

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The role of *Aedes* mosquitoes in the spread of many arboviral infections including dengue and chikungunya¹ is now well-documented. *Aedes aegypti* (Linn) which play a key role in transmission in various states as a principal vector of dengue fever is widely present in India and recently, dengue and chikungunya virus have also been detected in *Ae. albopictus* (Skuse)^{2–4}. Now this vector has spread to rural areas and spreading in areas which were so far free from this disease^{5–6}. More than 50 million dengue cases including 0.5 million cases of dengue haemorrhagic fever require hospitalization every year in the world. District Koderma in Jharkhand state of India is endemic for malaria and other vector borne diseases. Since 1958, this area has been receiving intensive indoor residual spraying with two rounds of DDT and other insecticides. Literature survey revealed absence of data on susceptibility of dengue vectors and other disease vectors to insecticides used under National Vector Borne Disease Control Programme in the area. The present study was carried out with a view to find out the insecticide susceptibility status of dengue vectors in different localities of four PHCs of Koderma district, namely Koderma, Jhumritelaiya, Markacho and Satgawan.

Insecticides/larvicides susceptibility against *Aedes* spp (adults and larvae) were carried out from August and September 2008 during the high prevalence period of respective vectors by using WHO standard diagnostic dosages and test kits of various insecticides, namely organochlorine (DDT), organophosphorous (malathion), and synthetic pyrethroids (permethrin, deltamethrin, lambda-cyhalothrin and cyfluthrin) for adult mosquitoes and for larvicides (fenthion, malathion and temephos). Ambient room temperature of $27 \pm 2^\circ\text{C}$ and relative humidity of 75–85% were maintained. The WHO standard procedures were adopted for adult and larval bioassays^{7–8}.

Wild *Ae. aegypti* and *Ae. albopictus* mosquitoes were collected from human dwellings in morning hours (0600 to 1000 hrs) with the help of suction tube and flash-light, and identified up to species level with the help of standard identification keys⁹. The collected adult female mosquitoes were allowed to feed on 10% glucose solution soaked

in cotton pads and transported in caged cloth to the field laboratory maintained at room temperature of $27 \pm 2^\circ\text{C}$ and relative humidity of 75–85%. Insecticide impregnated papers received from University Sans Malaysia, Malaysia with different diagnostic dosages were used for detection of resistance to DDT (4%), malathion (5%), deltamethrin (0.05%), permethrin (0.75%), lambda-cyhalothrin (0.05%) and cyfluthrin (0.15%).

Mosquitoes were exposed against the diagnostic dosages of insecticides for one hour. Four replicates of each vector species usually containing 20–25 female mosquitoes were taken simultaneously for each insecticide. Control replicates were also held parallel to each test. After exposure to the requisite period, the holding tubes were kept for recovery in dark and cool recovery chambers immediately maintained at room temperature of $27 \pm 2^\circ\text{C}$ and relative humidity of 80%. Cotton pads soaked in 10% glucose solution were given as supplementary food during recovery period for 24 h. The corrected percent mortalities were calculated by scoring the dead and alive mosquitoes after 24 h of recovery period and corrected by Abbott's formula.

For larval susceptibility tests, III and IV stages larvae collected from the field were separated and were washed in tap water to remove debris and kept under observation for a period of 24 h to detect and remove unhealthy or dead larvae. The larvae were tested against the WHO recommended diagnostic dosages for *Aedes* spp. of temephos (0.02 mg/L), fenthion (0.05 mg/L) and malathion (1.0 mg/L). Four replicates and a control, each containing 20 to 25 larvae were taken for each insecticide. The mortalities were calculated by scoring the dead, moribund and alive larvae after 24 h of recovery period. Both dead and moribund larvae were treated as dead.

The results of susceptibility of *Ae. aegypti* mosquitoes to different insecticide diagnostic dosages are given in Table 1. The corrected percent mortality of adult *Ae. aegypti* to DDT ranged from 54.67 to 63.88%, malathion from 95.83 to 100, lambda-cyhalothrin from 97.33 to 100, deltamethrin from 98.26 to 100; whereas percent mortality of *Ae. albopictus* mosquitoes to DDT ranged from 35.76

Table 1. Susceptibility of *Aedes* mosquitoes to various insecticides in Koderma district (Jharkhand), India

Name of PHC	Insecticide papers used in % conc.	<i>Ae. aegypti</i> mosquito exposed		<i>Ae. albopictus</i> mosquito exposed		Corrected % mortality in adults	
		Test	Control	Test	Control	<i>Ae. aegypti</i>	<i>Ae. albopictus</i>
Koderma	DDT 4.0	75	25	120	45	60	37.21
	Malathion 5.0	75	25	75	25	95.83	95.83
	Lambda-cyhalothrin 0.05	75	25	75	25	97.33	97.33
	Deltamethrin 0.05	75	25	75	25	100	100
	Cyfluthrin 0.15	75	25	75	25	100	100
	Permethrin 0.75	75	25	75	25	100	100
Jhumritelaiya	DDT 4.0	75	20	150	50	54.67	52.08
	Malathion 5.0	75	25	75	25	97.8	97.67
	Lambda-cyhalothrin 0.05	75	25	75	25	97.8	98.67
	Deltamethrin 0.05	75	25	75	25	100	100
	Cyfluthrin 0.15	75	25	75	25	100	100
	Permethrin 0.75	75	25	75	25	100	100
Satgawan	DDT 4.0	75	25	100	40	63.88	49.74
	Malathion 5.0	75	25	75	25	97.8	97.21
	Lambda-cyhalothrin 0.05	75	25	75	25	97.8	98.67
	Deltamethrin 0.05	75	25	75	25	100	100
	Cyfluthrin 0.15	60	20	60	20	100	100
	Permethrin 0.75	75	25	75	25	100	100
Markacho	DDT 4.0	60	20	60	20	60.07	35.76
	Malathion 5.0	60	20	60	20	100	98.33
	Lambda-cyhalothrin 0.05	60	20	60	20	100	96.67
	Deltamethrin 0.05	60	20	60	20	98.26	98.26
	Cyfluthrin 0.15	60	20	60	20	100	100
	Permethrin 0.75	60	20	60	20	100	100

Table 2. Susceptibility of larvae of *Aedes* mosquitoes to various larvicides in Koderma district (Jharkhand), India

Name of PHC	Diagnostic dosages used	No. of larvae exposed		Corrected % mortality in <i>Aedes</i> larvae
		Test	Control	
Koderma	Malathion (1.0 mg/L)	80	25	97.33
	Temephos (0.02 mg/L)	80	25	100
	Fenthion (0.05 mg/L)	80	25	100
Jhumritelaiya	Malathion (1.0 mg/L)	80	25	98.67
	Temephos (0.02 mg/L)	80	25	100
	Fenthion (0.05 mg/L)	80	25	100
Satgawan	Malathion (1.0 mg/L)	60	20	100
	Temephos (0.02 mg/L)	60	20	100
	Fenthion (0.05 mg/L)	60	20	100
Markacho	Malathion (1.0 mg/L)	60	20	96.53
	Temephos (0.02 mg/L)	60	20	98.67
	Fenthion (0.05 mg/L)	60	20	100

to 52.08, malathion from 95.83 to 98.33, lambda-cyhalothrin from 96.67 to 98.67% and to deltamethrin from 98.26 to 100%. Both mosquito species were susceptible to lambda-cyhalothrin, deltamethrin, permethrin and cyfluthrin tested in this area as per WHO criterion (98–

100% : Susceptible; 81–97%: Verification required; < 80%: Resistant).

The results of the larval susceptibility tests revealed that the larvae of *Aedes* species were susceptible to all the three larvicides, viz. temephos (0.02 mg/L), fenthion (0.05

mg/L) and malathion (1.0 mg/L) as 96.53 to 100% mortality was found within 24 h of treatment (Table 2).

The results emphasize that the dengue vectors in Koderma district are resistant to DDT and are susceptible to other insecticides tested. Resistance to DDT may be due to prolonged use of inadequate dosages of DDT in IRS for mosquito control since 1958. There is however no report available on the development of resistance in *Aedes* mosquitoes to insecticides from Koderma. Raghavan *et al* for the first time recorded resistance in arthropods of public health importance to DDT from several places in India in the year 1967¹⁰. Madhukar and Pillai also reported resistance in Indian strains of *Aedes* mosquitoes to insecticides from India¹¹. Azeez for the first time reported resistance in *Ae. aegypti* mosquitoes to DDT from Jharia, Dhanbad district (Jharkhand)¹² in erstwhile Bihar, but no indication of resistance in dengue vectors to other insecticides in the Jharkhand state. This study confirmed the finding in Koderma as *Ae. aegypti* continues to be resistant to DDT only. In addition *Ae. albopictus* mosquito was also found resistant to DDT from Koderma district of Jharkhand state.

The present study revealed that *Ae. aegypti* and *Ae. albopictus* were resistant to DDT in Koderma, but still susceptible to malathion, permethrin, deltamethrin, lambda-cyhalothrin and cyfluthrin. In view of the presence of DDT resistance in both the species, further study is warranted on district-wise mapping of susceptibility status of dengue vectors to the insecticides being used by the NVBDCP in the vector control programme.

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