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THE NATURALLY AVAILABLE PHYTO-PRODUCTS OF INDIAN MEDICINAL PLANTS AGAINST ADULTICIDAL ACTIVITY OF HUMAN VECTOR MOSQUITOES

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Globally, most of the research community's consideration for the control of vectors has moved from synthetic chemical pesticides to naturally available phyto-products. In the present investigation, we attempted to evaluate the bio efficacy of various floral extracts and its derived major phyto-compounds against adulticidal activity with different concentrations against the adults of medically important vector mosquitoes *Aedes aegypti* and *Culex quinquefasciatus*. The major phyto-chemical compounds of *N. brachiata*, *L. crustacea* and *O. corniculata* leaf extracts were analyzed with GC and Mass Spectroscopy. *N. brachiata* leaf methanol extract had a total of 10 bio-active compounds acquiring 100% and the major bio-active compounds were 1,4-benzenedicarboxylic acid, bis(2-ethylhexyl) ester (31.03%) and phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester (1.86%). Therefore, *L. crustacea* leaf methanol extract had a total of 10 bio-active compounds acquiring 100% and the major bio-active compounds were 2-acetylamino-2-cyano-acetamide (22.3%) and Phosphorin, 2,4,6-tris(1,1-dimethylethyl)- (28.96%). Similarly, *O. corniculata* leaf methanol extract had a total of 15 bio-active compounds acquiring 100% and the major bio-active compounds were Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester (18.95%) and 1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester (19.91%). The efficacies of the phyto-products were assessed under laboratory conditions. The LC_{50}/ LC_{90} values of leaf

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methanol extracts of *N. brachiata*, *L. crustacea* and *O. corniculata* and its derived major phyto-compounds 1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester, Phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester, 2-Acetylamino-2-cyano-acetamide, Phosphorin, 2,4,6-tris(1,1-dimethylethyl)-, Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester and 1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester were tested against adults of vector mosquitoes *Aedes aegypti* and *Culex quinquefasciatus* of results were 84.82/168.78, 88.46/182.55, 92.30/174.63, 94.51/175.44, 96.42/174.84, 98.58/186.62 and 12.71/23.86, 11.23/22.82, 12.46/23.06, 12.34/23.37, 12.96/24.34, 12.89/23.85, 11.84/23.27, 12.36/23.79, 11.42/21.90, 11.34/21.93, 10.67/20.93 and 10.85/21.47 µg/ml, respectively. The outcomes of this present investigation well clearly indicated that the leaf methanol extracts of *N. brachiata*, *L. crustacea* and *O. corniculata* and its derived major phyto-compounds 1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester, Phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester, 2-Acetylamino-2-cyano-acetamide, Phosphorin, 2,4,6-tris(1,1-dimethylethyl)-, Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester and 1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester had the potential effects on selected medical pests *Ae. aegypti* and *Cx. quinquefasciatus*. The findings of outputs as possible role battle with *Ae. aegypti* and *C. quinquefasciatus*. Further studies regarding the application selected phyto-products in the field application which will give the way for development of newer phyto-mosquitocide.

Keywords: Phyto-products; phyto-compounds; adulticidal activity; vector mosquitoes; phyto-mosquitocide.

1. INTRODUCTION

The mosquitoes are very small flying blood sucking vectors which belong to the Family Culicidae and Oder Diptera. The mosquitoes are sexually dimorphic insects among them female adult's only feed on bloods meals from higher vertebrates but males are feed on nectar and other sources of sugar solutions [1]. They are nuisance insect pests and disease vectors of dangerous human and animal diseases in Asia and other tropical and subtropical countries of the world [2]. WHO has declared the mosquitoes as "public enemy number one". Mosquito borne diseases are prevalent in more than 100 countries across the world, infecting over 700,000,000 people per annum which more dangerous to Indian population [3,4]. They act as a vector for malaria, yellow fever, dengue fever, chikungunya fever, filariasis, encephalitis, West Nile virus infection, *etc*., in the areas where mosquitoes are in prevalence [5,6]. Mosquito control is considered as essential to prevent the spreading of mosquito borne diseases and to improve quality of sustainable environment and the health status of publics [7, 8].

Earlier, synthetic mosquitocides were used as the major tool in mosquito control operation but, this has not been completely successful due to human, technical, operational, economical and ecological factors [9]. In past few decades, the indiscriminate application of several synthetic insecticides in mosquito control programme has been banned or limited. It is due to lack of novelty, high cost, concern for environmental sustainability, harmful effect on human health, and other non-target creatures, prolonged persistence in nature, higher rate of biological magnification through ecosystem, and increasing insecticide resistance on a global scale [10,11]. These factors have resulted in an urge to look for environment friendly, cost-effective, biodegradable and target specific insecticides against mosquito species. Considering these, the application of eco-friendly alternatives such as biological control of vectors has become the central focus of the control programme in lieu of the chemical insecticides Mathivanan et al. [12], Krishnappa and Elumalai [13], Krishnappa and Elumalai [14]. Exploration of plants and plant based secondary metabolites are one of the positive approaches under the biological control programme in mosquito control. Furthermore, unlike conventional insecticides which are based on a single active ingredient, insecticides from plant's origin comprised of spectrum of chemical compounds which act concertedly in many processes by disturbing the insect's physiology or morphology [15,16]. Hence, there is very meagre chance of developing resistance to such substances by the mosquitoes. Identifying bio-insecticides that are efficient, as well as being suitable and adaptive to ecological conditions, is imperative for continued effective vector control management [17]. Botanicals have broad spectrum of insecticidal properties and will obviously work as a new armament in the future may act as suitable alternative product in combating the mosquitoes [18,19]. Hence, in the present investigation, the identified the major phyto-compounds and adulticidal activity of selected phyto-products investigated on the adults of *Ae. aegypti* and *C. quinquefasciatus*.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of Plant Extracts

The fresh leaves of *Nothosaerva brachiata, Lindernia crustacean* and *Oxalis corniculata* were collected from Chidambaram, *Cuddalore District*, Tamil Nadu,

India. The leaves were properly cleaned under running water, dried in the shade, pulverised, and sieved through a kitchen strainer. The fine powder was used for extraction by adapting the Soxhlet method. The extraction of plant samples was done with various solvents. Then, the filtration was carried out using Whatman No.1 filter paper. The filtrates were then placed in a rotary vacuum evaporator [20]. The crude obtained from the evaporator is again allowed to air dry to remove traces of the solvent. Then, the crude is stored in a brown vial for further study.

2.2 GC-MS Analysis of Various Medicinal Plants

The GC-MS analysis of *N. brachiata, L. crustacean* and *O. corniculata* leaf methanol extract was subjected to Agilent technologies (6890 N), JEOL GCMATE II which comprised of an auto sampler instrument and it functioning at following condition for GC-2010: Column Oven Temperature: 50^0C; Injection Temperature: 250^0C; Injection Mode: Split; Flow Control Mode: Linear Velocity; Pressure: 68.1kPa; Total Flow: 16.2mL/min; Column Flow: 1.20 mL/min; Linier Velocity: 39.7 cm/sec; Purge Flow: 3.0 mL/min; Split Ratio: 10.0; Oven Temperature Program: 50-280^0C and Holding Time: 2 min. GCMS-QP2020 operating following condition: Ion Source Temperature: 200^0C; Interface Temperature: 250^0C; Solvent Cut Time: 3.50 min; Detector Gain Mode: Relative to the Tuning Result; Detector Gain: +0.00KV; Threshold: 1000. Operation of MS table at following condition: Start Time: 4.0 min; End Time: 40.33 min; ACQ Mode: Scan; Event Time: 0.30 sec; Scan Speed: 1666; Start m/z: 50; end m/z: 500; Sample Inlet Unit: GC. By GC-MS analysis of *N. brachiata, L. crustacean* and *O. corniculata* leaf methanol extract was finding the various phyto-compounds were availed/ identified through based on the comparison of retention indices (RI), retention time (RT), mass spectra of NIST and WILEY library [6].

2.3 Collection and Rearing of Medical Pests

Immature mosquito populations (larvae and pupae) were gathered from various locations, including drains, marshes, cesspits, cesspools, water-filled tires and wastebaskets, and a house-building site. A shallow water plane has also been sunk in certain areas. These were discovered to be a possible source of mosquito eggs, larvae and pupae. In the laboratory, the larvae were identified, cleaned with water, and separated. Water-filled plastic trays (23×15× 6.5 cm) with a partially submerged filter paper liner were used to collect *Ae. aegypti* and *Cx. quinquefasciatus* eggs and larvae within the University campus. For larval hatching, the eggs were put in plastic trays (23x15x 6.5 cm) holding two liters of tap water and incubated at room temperature (27±2°C) with a photoperiod of 12:12 h (L:D). The field collected larvae and pupae were kept in separate containers and fed yeast powder under the same laboratory conditions. The trays with pupae were kept in separate mosquito cages at 27 ± 2°C and 75±5% percent relative humidity for adult emergence. Each mosquito cage also has cotton soaked in a 10% aqueous sucrose solution in a Petri dish to feed adult mosquitoes. An immobile baby chick was placed inside the cage for three hours to provide a blood meal for female mosquitoes. A plastic tray (11x10x4) filled with tap water with a coating of partially absorbed filter paper was placed inside each cage to allow the female mosquitoes to deposit their eggs. The eggs from the laboratory-reared mosquitoes were either utilized right away in toxicity tests or allowed to hatch out under the same controlled lab conditions described above. In all bioassays, only newly hatched particular instars of larvae or pupae of distinct mosquito species were utilized.

2.4 Adulticidal Activity of Medical Pests

The adulticidal activity was determined using the WHO [21], adult mosquitoes (0–24 hours old; sugar with multivitamin-fed, blood-starved) were collected from the insect rearing cage and carefully put into a glass holding tube. The phyto-products were produced at varying concentrations and applied to filter sheets (size 120×120 mm). Under the same conditions, control paper was only treated without phyto-products. The diluted phyto-products were soaked on filter sheets, which were then allowed to dry at room temperature overnight to evaporate the respective solvent. Prior to testing, freshly produced impregnated papers were created. The test was carried out in an experimental setup that included two 100ml cylindrical glass tubes. The mosquitoes were exposed to the phyto-products in one tube and held in another tube before and after the exposure durations. In the exposure tube, the impregnated sheets were rolled and put. A cotton cloth with a mesh size of 12 was used to seal one end of each tube. The selected experimental mosquitoes were introduced into the tube, and the phyto-products mortality effects were examined every 3 hrs. for a total of 24 hours. The mosquitoes were put in the holding tube after 3 hrs. of exposure period. For each test concentration, the experiment was repeated three times. The adulticidal activity of the imported mosquito was determined by counting the dead mosquitoes [22]. If a mosquito did not move when pushed repeatedly with a soft brush, it was considered dead.

2.5 Statistical Analysis

The larval mortality: LC_{50}, LC_{90}, 95% confidence of Upper Confidence Limit, Lower Confidence Limit, Chi-Square, Slope, Regression and adulticidal activity [23], mean and standard deviation were calculated by using software, Statistical Package of Social Science (SPSS), results with $p \leq 0.05$ were considered to be statistically significant.

3. RESULTS AND DISCUSSION

3.1 GC-MS Analyses of Various Medicinal Plants

The major phyto-chemical compounds in the *N. brachiata*, *L. crustacea* and *O. corniculata* leaf extracts were analyzed with GC and mass spectromettry. Retention time and peak area with their respective chemical formulae were identified with the vast array of compounds available in the NIST library. *N. brachiata* leaf methanol extract had a total of 10 bio-active compounds acquiring 100% and the major bio-active compounds of *N. brachiata* was 1,4-Benzenedicarboxylic acid, bis (2-ethylhexyl) ester (Peak- 3, Retention time- 37.555, Area- 123999, Area%- 31.03, Height- 50484, Height%- 35.29) and Phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester (Peak- 7, Retention time- 38.695, Area- 47397, Area%- 11.86, Height- 22023, Height%- 5.77). Therefore, *L. crustacea* leaf methanol extract was assessed through GC-MS analysis, a total of 10 bio-active compounds acquiring 100% and the major bio-active compounds were 2-Acetylamino-2-cyano-acetamide (Peak- 6, Retention time- 39.165, Area- 48845, Area%- 22.3, Height- 23240, Height%- 6.14) and major bio-active compound Phosphorin, 2,4,6-tris(1,1-dimethylethyl)- (Peak- 10, Retention time- 40.07, Area- 63445, Area%- 28.96, Height- 27576, Height%- 6.18). Similarly, *O. corniculata* leaf methanol extract was assessed through GC-MS analysis, a total of 15 bio-active compounds acquiring 100% and the major bio-active compound was Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester (Peak- 3, Retention time- 37.275, Area- 49650, Area%- 18.95, Height- 21929, Height%- 18.75) and 1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester (Peak- 14, Retention time- 40.058, Area- 52163, Area%- 19.91, Height- 22296, Height%- 19.06) as well as the identified major bio-active compound was strongly confirmed through MS studies they shown in Tables 1-3. Earlier, comparably resemblance of many research outputs were observed by many different medicinal plants *C. limetta*, *J. repens* [5,6]. The GC-MS spectral analysis is a preliminary as well as basic assessment for identifying the naturally abundance of functional groups from different medicinal plants. They had potential pesticide activities in various life stages of various pests species as well as zero hazards to non-target fauna and flora [24,25,4,26].

3.2 Adulticidal Activity of Medicinal Plants Extracts and Phyto-compounds

The bio efficacy of various floral extracts and its derived major phyto- compounds against adulticidal activity with different concentrations against the adults of medically important vector mosquitoes *Aedes aegypti* and *Culex quinquefasciatus*. The efficacies of the phyto-products were assessed under laboratory conditions. The LC_{50}/ LC_{90} values of leaf methanol extracts of *N. brachiata*, *L. crustacea* and *O. corniculata* and its derived major phyto-compounds 1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester, Phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester, 2-Acetylamino-2-cyano-acetamide, Phosphorin, 2,4,6-tris(1,1-dimethylethyl)-, Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester and 1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester were tested against adults of vector mosquitoes *Aedes aegypti* and *Culex quinquefasciatus* of results were 84.82/168.78, 88.46/182.55, 92.30/174.63, 94.51/175.44, 96.42/174.84, 98.58/186.62 and 12.71/23.86, 11.23/22.82, 12.46/23.06, 12.34/23.37, 12.96/24.34, 12.89/23.85, 11.84/23.27, 12.36/23.79, 11.42/21.90, 11.34/21.93, 10.67/20.93 and 10.85/21.47 µg/ml, respectively (Table 4). In the present investigation leaf methanol extracts of *N. brachiata*, *L. crustacea* and *O. corniculata* and its derived major phyto-compounds 1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester, Phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester, 2-Acetylamino-2-cyano-acetamide, Phosphorin, 2,4,6-tris(1,1-dimethylethyl)-, Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester and 1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester were showed statistically significant activity against adult mosquitoes of *Ae. aegypti* and *Cx. quinquefasciatus*. Among the different phyto-products tested the selected major phyto-compounds has predominant activity then the leaf methanol extracts of *N. brachiata*, *L. crustacea* and *O. corniculata* against selected medical pests. The evaluation of adulticidal activity of leaves of *Lippia alba* against two medically important mosquito species, *Ae. aegypti* and *Cx quinquefasciatus* vector mosquitoes which showed potential as well as vulnerability on selected mosquitoes [27]. The efficacies of floral formulations from *A. galanga*, *C. zedoaria* and *Z. cassumunar* were produced highest toxicity against females mosquitoes of *Ae. albopictus* and *An. minimus* [28]. The in vitro activity of *M. cajuputi* floral leaf extract tested on *Ae. aegypti* and *Ae.*

albopictus which exhibited moderate toxicity effects against the adults of selected medical pests and may be used as an alternative to chemical insecticide [29]. The effectiveness and applicability of locally-produced phyto-products on adults of vector mosquitoes showed predominant toxicity at lowest concentration in laboratory condition [4,30]. The two different phyto-products of *P. guineense* and *E. aromatic* which noticed effective toxicity on adults of *An. gambiae.* The naturally available herbal derivatives had a prospective alternative eco- friendly vector control tool as well zero hazards to other non-target fauna and flora [31].

Table 1. GC-MS analysis of *N. brachiata* leaf methanol extract

PE	RT	CA%	CN
1	21.174	16.11	Hydroperoxide, 1,4-dioxan-2-yl
2	34.932	7.21	1,2-Benzenedicarboxylic acid, dioctyl ester
3	37.555	31.03	1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
4	38.078	9.97	4-[4-(N,N-Dimethylamino)-2,3,5,6-tetrafluorophenyl)-2-methyl-3-butyn-2-OL
5	38.381	9.07	Phytol acetate
6	38.53	2.39	1,15-Di(1-phenylpropyl)-2,2,4,4,6,6,8,8,10,10,12,12,14,14-tetradecamethyl-1,3,5,7,9,11,13,15-octaoxa-2,4,6,8,10,12,14-heptasila
7	38.695	11.86	Phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester
8	38.953	4.8	Silikonfett
9	39.855	4.8	Heptasiloxane, hexadecamethyl-
10	40.025	2.77	Adipic acid, 3-pentyl tetradecyl ester

PE: Peak; RT: Retention Time; CA: CA%: Composition Area%; CN: Compounds Name

Table 2. GC-MS analysis of *L. crustacea* leaf methanol extract

PE	RT	CA%	CN
1	34.933	5.95	1,2-Benzenedicarboxylic acid, dioctyl ester
2	37.553	5.12	1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
3	38.944	4.44	Propanamide, 3-chloro-n-(1,1-dimethylethyl)-
4	39.004	4.3	1,15-Di(1-phenylpropyl)-2,2,4,4,6,6,8,8,10,10,12,12,14,14-tetradecamethyl-1,3,5,7,9,11,13,15-octaoxa-2,4,6,8,10,12,14-heptasila
5	39.105	3.96	Pentafluoropropionic acid, hexyl ester
6	39.165	22.3	2-Acetylamino-2-cyano-acetamide
7	39.271	7.5	3H-1,2,4-Triazole-3-thione, 2,4-dihydro-4,5-dimethyl-
8	39.342	9	2-(Benzyl-d7)-1-(methoxycarbonyl)-2-azaspiro[4.5]decan-9-one isomer
9	39.41	8.47	2-Methyl-3-(p-chlorocinnamoyl)quinoxaline-1,4-dioxide
10	40.07	28.96	Phosphorin, 2,4,6-tris(1,1-dimethylethyl)-

PE: Peak; RT: Retention Time; CA: CA%: Composition Area%; CN: Compounds Name

Table 3. GC-MS analysis of *O. corniculata* leaf methanol extract

PE	RT	CA%	CN
1	16.152	4	PENTADECANE
2	34.922	6.65	1,2-BENZENEDICARBOXYLIC ACID, DIOCTYL ESTER
3	37.275	18.95	Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester
4	37.427	7.35	1,1,1,5,7,7,7-Heptamethyl-3,3-bis(trimethylsiloxy)tetrasiloxane
5	37.541	1.19	1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
6	37.74	1.11	2,6,7-TRIOXABICYCLO[2.2.2]OCTANE, 1-(6-BROMOHEXYL)-4-METHYL-
7	38.343	2.66	2-ANTHRACENECARBOXYLIC ACID, 9,10-DIHYDRO-6,8-DIHYDROXY-3-METHOXY-1-METHYL-9,10-DIOXO-, METHYL ESTER
8	38.786	9.05	2-Pentanol, pentafluoropropionate
9	38.941	11.59	1,15-Di(1-phenylpropyl)-2,2,4,4,6,6,8,8,10,10,12,12,14,14-tetradecamethyl-1,3,5,7,9,11,13,15-octaoxa-2,4,6,8,10,12,14-heptasila
10	38.976	2.53	1-(1-PIPERIDINYLMETHYL)-1H-INDOLE-2,3-DIONE 3-[(2,4-

PE	RT	CA%	CN
			DINITROPHENYL)HYDRAZONE]
11	39.06	7.93	1,11-Di(1-phenylpropyl)-2,2,4,4,6,6,8,8,10,10-decamethyl-1,3,5,7,9,11-hexaoxa-2,4,6,8,10-pentasilaundecane
12	39.346	1.48	N-BUTYL-N-[(3E)-1'-BUTYLPYRROL-3'-YL)-4,8-DIMETHYLNONA-3,7-DIEN-5-YN-1-YL]ACETAMIDE
13	39.624	2.63	2-Acetylamino-2-cyano-acetamide
14	40.031	19.91	1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester
15	40.058	2.96	2-Heptenoic acid, isobutyl ester

PE: Peak; RT: Retention Time; CA: CA%: Composition Area%; CN: Compounds Name

Table 4. LC values of major bio-active compounds against adults of medical pests

Species tested	LC_{50} (µg/ml)	95% FL (µg/ml)		LC_{90} (µg/ml)	95% FL (µg/ml)		Regression	χ^2 value
		LCL	UCL		LCL	UCL		
***N. brachiata* leaf methanol extract**								
Ae. aegypti	84.82	67.82	94.46	168.78	148.39	179.73	y=1.3+0.01x	3.671
Cx. quinquefasciatus	88.46	72.26	95.23	182.55	152.42	194.28	y=1.2+0.01x	5.713
1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester								
Ae. aegypti	12.71	11.55	13.79	23.86	22.12	26.17	y=1.48+0.12x	3.899
Cx. quinquefasciatus	11.23	10.73	16.24	22.82	17.43	28.65	y=1.28+0.11x	3.370
Phthalic acid, hexadecyl 2,3,4,5-tetrafluorobenzyl ester								
Ae. aegypti	12.46	11.34	13.50	23.06	21.44	25.20	y=1.53+0.12x	2.447
Cx. quinquefasciatus	12.34	11.18	13.42	23.37	21.67	25.62	y=1.46+0.12x	4.526
***L. crustacea* leaf methanol extract**								
Ae. aegypti	92.30	73.80	102.49	174.63	153.35	188.74	y=1.4+0.12x	4.632
Cx. quinquefasciatus	94.51	75.72	105.62	175.44	156.92	197.26	y=1.8+0.12x	4.766
2-Acetylamino-2-cyano-acetamide								
Ae. aegypti	12.96	9.43	15.96	24.34	20.32	33.56	y=1.52+0.12x	7.830
Cx. quinquefasciatus	12.89	11.77	13.95	23.85	22.11	26.15	y=1.6+0.13x	6.213
Phosphorin, 2,4,6-tris(1,1-dimethylethyl)-								
Ae. aegypti	11.84	10.61	12.95	23.27	21.50	25.64	y=1.47+0.13x	6.902
Cx. quinquefasciatus	12.36	11.17	13.47	23.79	22.00	26.12	y=1.51+0.13x	7.197
***O. corniculata* leaf methanol extract**								
Ae. aegypti	96.42	71.73	108.47	174.84	157.30	195.81	y=1.4+0.02x	6.532
Cx. quinquefasciatus	98.58	73.29	112.94	186.62	162.47	199.44	y=1.3+0.02x	5.213
Succinic acid, 2-methylpent-3-yl pentafluorophenyl ester								
Ae. aegypti	11.42	7.47	14.35	21.90	18.19	30.49	y=1.18+0.1x	8.756
Cx. quinquefasciatus	11.34	6.95	14.47	21.93	18.03	31.60	y=1.15+0.1x	9.787
1,2-Cyclohexanedicarboxylic acid, di(2-fluorophenyl) ester								
Ae. aegypti	10.67	9.49	11.72	20.93	19.40	22.94	y=1.16+0.11x	6.285
Cx. quinquefasciatus	10.85	6.85	13.70	21.47	17.86	29.64	y=1.11+0.1x	8.149

LC_{50}=Lethal Concentration brings out 50% mortality and LC_{90} = Lethal Concentration brings out 90% mortality. LCL = Lower Confidence Limit; UCL = Upper Confidence Limit

4. CONCLUSION

The unadvisable synthetic chemical pesticides usages of broad application on mosquitocidal perspective drastically cause the unimaginable environmental hazards as well as unpredictable defects on non-target fauna and flora including human health. Consequently, many researcher and scientific communities globally started to search newer biodegradable, zero-hazards, eco-friendly naturally available phyto-products which may strongly alternative to commonly used synthetic chemicals pesticides. In this context, application of selected phyto-products evidently proven to control on adults of selected vector mosquitoes. Further, the present investigation gives the new passage for development of eco-friendlier mosquitocidal properties in future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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