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Larvicidal and ovicidal activities of *Datura metel* L. (Family: Solanaceae) solvent extracts against *Aedes aegypti*

P Saranraj[1*], S Dinesh Kumar[2], Kirandas Manickan[3], K Gayathri[1], B Lokeshwari[1]
[1] Department of Microbiology, Sacred Heart College (Autonomous), Tirupattur, Tamil Nadu, India
[2] Department of Biotechnology, Nehru Arts and Science College, Thirumalaiyampalayam, Coimbatore, Tamil Nadu, India
[3] Department of Health Science, Biomedical Materials Lab, Center for Autoimmune and Allergic Diseases (CAAD), University of Piemonte Orientale (UPO), Novara, Italy

Abstract
Mosquitoes are recognized to be carriers of a wide range of illnesses. Mosquito borne diseases such as dengue, malaria, chikungunya, filariasis, dengue and, hemorrhagic fever continue to be a major concern to public health in India and other Asian countries because of the region's tropical or sub-tropical environment. The present research was conducted against the Mosquito vector, *Aedes aegypti* for its larvicidal and ovicidal activities using *Datura metel* leaf extracted with acetone, ethanol, and chloroform. After being exposed to various doses (which ranged from 50 to 250 ppm), 25 *Aedes aegypti* larvae in their early third instar underwent analysis. The *Datura metel* leaf extracts 24 hours LC_{50} was calculated using probit analysis. Under laboratory circumstances, the ovicidal activity against *Aedes aegypti* was assessed at different doses ranging from 60 to 300 ppm. After 48 hours treatment, the rates of egg hatching were evaluated. The LC_{50} values of *Datura metel* extracts against *Aedes aegypti* larvae in their early third instar were 189.70, 139.70, and 145.29 ppm, respectively. The *Datura metel* ethanol extract had the highest larvicidal efficacy, followed by those containing chloroform and acetone. In the control group, there was no mortality. The ethanol extracts of *Datura metel* exhibited 100 % mortality at 240 and 300 ppm among the three solvents studied. The findings suggest that *Datura metel* crude extracts have the ability to suppress the *Aedes aegypti* mosquito.

Keywords: Mosquito, vector borne diseases, *Aedes aegypti*, *Datura metel*, larvicidal activity and ovicidal activity

Introduction

Plants contain bioactive compounds that work on a limited number of species, including specific target insects, and are harmless for the environment, making them an excellent source of alternative Mosquito control chemicals. Human civilizations have been using plant-based pesticides for many millennia (Siva Sakthi *et al*., 2011) [1]. The first step in selecting an eco-friendly, cost-efficient, and highly effective insecticide to control mosquitoes is to screen plants to evaluate their insecticidal qualities. *Datura metel* L. is a native of Nigeria and is commonly used in phytomedicine to treat ailments like insanity, convulsions, cough, and thorn-apple. It is also known by other names, such as Devil trumpet and belongs to the family Solanaceae. The leaves and seeds are commonly used as an aesthetics, antispasmodics, antitussives, bronchodilators, and hallucinogens in herbal medicine. From the past research reports, it was discovered that the *Datura metel* L. exhibited the highest larvicidal activity against various Mospquito larvae. The Medicinal plant extract was found to have a dosage-dependent effect on Mosquito larvae, as evidenced by the plant's dose dependency and an increase in percentage fatality with increasing concentrations. The evaluation of a plant's toxicity to Mosquito larvae may aid in developing efficient methods for reducing its population (Pancharoen *et al.*, 2002) [2].

The virus that causes Vector borne diseases are endemic to Africa, America, South east part of Asia and the Pacific island region is commonly known to be transmitted by the Mosquito *Aedes aegypti*. Additionally, this mosquito spreads Yellow fever throughout West Africa, Central America, and South America (Murugan *et al.*, 2011) [3]. The Cosmo tropical species *Aedes aegypti* thrives in water containers inside and outside of homes. Numerous household containers, including jars for storing water, drums, tanks, and plant or flower containers, are used by *Aedes aegypti* to breed. Given their significance to medicine, mosquito management is a Global concern. Notable factors include a frightening rise in physiological resistance in mosquito vectors, high costs, and greater toxicity to non-target organisms, all of which are related to the trend of using more potent synthetic insecticides to control mosquitoes more quickly (WHO, 1975) [4]. The majority of synthetic chemicals are costly, hazardous to people, animals, and other non-target creatures, and bad for the environment. Furthermore, they destroy other beneficial organisms and are not selective. Certain insecticides have the potential to cause cancer and can even enter the food chain, affecting organisms that are not the intended target. Alternative vector control techniques are therefore crucial, especially those that are economical and highly successful (Kalyanasundaram and Das, 1985) [5]. The present study was aimed to determine the Larvicidal activity and Ovicidal activity of the Medicinal herb *Datura metel* L. Solvent extracts against the Mosquito vector, *Aedes aegypti*.

Material and Methods

Collection of *Datura metel* Leaf

The fresh and healthy leaves of *Daura metel* L. was collected from the Farmer's field in Periya Olaipadi Village, Tiruvannamalai District, Tamil Nadu, India. The collected fresh leaves of *Daura metel* were gathered and allowed to air dry in the shade area. Then, dried and powdered into a fine powder and kept at Room temperature (approximately 28 ºC) for the further study.

Extraction of *Datura metel* L. Leaf Extract

A commercial Stainless steel blender was used to grind 100 g of dried *Daura metel* L. leaves into a fine powder. Then, in a Soxhlet device, the leaves were extracted with 500 ml of Chloroform, Acetone, and Ethanol until all of the liquid was gone. Rotavapor concentrated the extract at 45 °C with a lowered pressure of 22 – 26 mm Mercury. The residue that was left over was stored in an amber vial at 4 °C. The vials were then given names, sealed in silver foil, and brought to the laboratory. Until they were utilized, the vials were kept cold and dark at 4 °C (Siva Sakthi *et al*., 2011) [1].

Larvicidal activity

The Larvicidal activity was studied by following the standard WHO procedure with some minor adjustments. Various concentrations of *Datura metal* leaf extract *viz*., 50, 100, 150, 200, and 250 ppm were produced from the Stock solution. A volume of 200 ml of water were added to each of the 250 ml Plastic cups containing the Mosquito larvae in the early stages of the Third instar. Water was mixed with Acetone to create a Control. After 24 hours, larvae death was reported. Four replicates were kept at a time for every experiment. Finally, the Percentage mortality was calculated with the help of Abbott's Formula (Abbott, 1925) [6].

Ovicidal activity

The *Daura metel* leaf extract was evaluated for its Ovicidal activity by following the method proposed by Su and Mulla (1998) [7]. A variety of concentrations ranging from 70 ppm to 350 ppm were applied to the *Aedes aegypti* eggs. By mixing 1.0 ml of a suitable stock solution with 99 ml of tap water, the test solution's desired concentrations were obtained. Each *Aedes aegypti* egg raft has 100 eggs, each dose of extract was exposed to the eggs for 48 hours and, eggs were counted under a Microscope. The Dimethyl sulfoxide (DMSO) was used as the Control. For every concentration, four duplicates were maintained. The egg rafts or eggs exposed to each concentration were moved to distilled water cups after a 24 hours incubation period. The following formula was used to compute the hatch rates.

Percentage Mortality (%) = Mortality at Treatment - Mortality at Control / 100 Mortality at Control × 100

Statistical analysis

The LC_{50}, LC_{90}, and other statistics were determined using the analysis programme Probit (Finney, 1971) [8]. Regression, chi-square, slope, mean, and standard deviation values were computed using SPSS 12.0 software.

Results and Discussion

Medicinal plants are the major treasurer of this universe (Saranraj *et al*., 2010) [8]. The present research evaluated the toxicity of various solvent crude extracts of *Datura metel* L. against the *Aedes aegypti* larvae (Table - 1). The plant's larvicidal and ovicidal activities were indicated by the extract, suggesting its potential application in controlling Mosquito populations (Table - 2). Following the recording of the data, statistical information about LC_{50}, LC_{90}, LCL, UCL, and chi-square values was also computed. Acetone, ethanol, and chloroform extract of *Datura metel* L. had LC_{50} and LC_{90} values of 184.70 ppm, 134.70 ppm, and 140.29 ppm against early third instar *Aedes aegypti* larvae, and 279.09 ppm, 218.57 ppm, and 222.86 ppm, respectively. The extract containing Ethanol had the highest Larvicidal efficacy, followed by those containing Chloroform and Acetone. In the control group, there was no mortality. The Table - 3 shows the percentage of *Aedes aegypti* eggs that hatch when using *Datura metel* L. leaf extract. At 240 ppm and 300 ppm, the ethanol extracts resulted in 100 % mortality (Zero hatchability). The findings of the present research were in line with the research of Saranraj *et al.* (2022) [18].

Table 1: Larvicidal activity of different Solvent leaf extracts of *Datura metel* L. against the Instar larvae of *Aedes aegypti*

Species	Solvent	Percentage Mortality ± SD (%)				
		50 ppm	100 ppm	150 ppm	200 ppm	250 ppm
Aedes aegypti	Acetone	2.4±0.44	8.6±1.14	24.8±2.16	54.2±2.48	78.4±2.50
	Ethanol	10.4±1.48	24.6±1.81	48.2±2.04	76.8±1.78	97.8±0.44
	Chloroform	8.6±1.67	20.6±2.30	46.6±2.60	74.8±2.28	95.8±1.78

Significant at $P<0.05$ level; SD - Standard Deviation; ppm - Parts Per Million.

Table 2: Probit analysis of Larvicidal activity of *Datura metel* extract against *Aedes aegypti*

Species	Solvent	LC_{50} (LCL-UCL) ppm	LC_{90} (LCL-UCL) ppm	Slope	x^2
Aedes aegypti	Acetone	184.70 (179.90 - 200.50)	279.09 (266.01 - 308.16)	3.598886	1.099*
	Ethanol	135.70 (113.57 - 165.20)	218.57 (192.30 - 286.42)	4.991848	8.430*
	Chloroform	140.29 (136.62 - 153.97)	222.86 (214.58 - 244.73)	4.542066	6.721*

LC_{50}= Lethal concentration that kills 50 % of the exposed parasite; LC_{90} = Lethal concentration that kills 90 % of the exposed parasite; LCL - Lower Confident Limit; UCL - Upper Confident Limit.

Table 3: Ovicidal activity of the *Datura metel* L. Solvent extracts against *Aedes aegypti*

Solvents	Percentage of Egg hatch ability					
	Concentration (ppm)					
	Control	60 ppm	120 ppm	180 ppm	240 ppm	300 ppm
Acetone	100.0±0.0	96.8±1.30	82.4±2.60	62.2±2.86	44.6±2.30	27.4±2.50
Ethanol	100.0±0.0	64.6±2.50	36.2±1.78	9.8±1.48	NH	NH
Chloroform	100.0±0.0	81.4±3.28	60.6±2.60	39.2±3.19	17.4±2.19	NH

*NH - No hatch ability

Plant-derived chemicals are safer to employ, do not have phototoxic qualities, and do not leave behind any residue in the environment, biopesticides with plant origins are recommended for use against a variety of insect species, particularly disease-transmitting Mosquito vectors (Schmutterer, 1990) [9]. Ruskin (1992) [10] has revealed that chemicals isolated from *Azadirachta indica* caused death for *Anopheles stephensi* larvae in their fourth instar in mosquitoes, with LC_{50} values of 60 ppm and 43 ppm. For *Culex quinquefasciatus*, the LC_{50} and LC_{90} values for *Datura metel* Chloroform extract were 94.76 mg/L and 103.10 mg/L, respectively. According to the findings of Rajkumar and Jebanesan (2005) [11], when compared to ethanol treatment controls at 0.01 %, 0.025 %, 0.05 %, 0.075 %, and 0.1%, the leaf extract of *Solanum trilobatum* decreased egg laying by gravid females of *Anopheles stephensi* from 18 % to 99 %. In *Culex tarsalis* and *Culex quinquefasciatus* eggs exposed to a 10 ppm concentration, the bioactive component Azadirachtin (*Acalypha indica*) demonstrated full ovicidal activity (Dinesh Kumar Subbaraj *et al*., 2017) [12]. According to studies by Broadbent and Pree (1984) [13], when Mosquito eggs were directly exposed to high concentrations of the compounds, more chemicals entered the egg shell and affected the Embryogenesis process. Additionally, lengthier exposure times increased the chemicals potency by facilitating deeper penetration of the shells. The larvicidal and ovicidal effects of different solvent-extracted *Acalypha indica* leaf extracts on *Anopheles stephensi* (Vedha *et al*., 2023) [16]. The evaluation of the hatch rates took place 48 hours after treatment. The LC_{50} and LC_{90} values of acetone, benzene, chloroform, acetone, and ethanol extracts from *Acalypha indica* against *Anopheles stephensi* larvae in a 24 hours period were 76.29 ppm, 58.82 ppm, 53.59 ppm, 65.84 ppm, 51.78 ppm, and 205.85 ppm, 193.23 ppm, 185.16 ppm, 196.72 ppm, and 181.00 ppm, respectively. This information was reported by Gokulakrishnan *et al*. (2012) [14]. The LC_{50} and LC_{90} values of *Datura metel*'s Chloroform, Acetone, and Chloroform against *Culex quinquefasciatus* larvae. First instar in 24 hours were 136.75, 145.69, 139.49, and 143.64 mg/L; 149.07, 158.24, 151.95, and 156.14 mg/L, respectively (Baranitharan and Dhanasekaran, 2014) [15]. Elumalai *et al*. (2012) [14] reported that 100 % mortality was seen from the *Datura metel* acetone and ethanol extracts at 100 ppm. The LC_{50} values of these extracts were 139.86 ppm and 121.65 ppm (Salomi *et al*., 2023; Saranraj *et al*., 2022) [17, 18].

Conclusion

The outcome of the present research unequivocally shows that the *Datura metel* leaf extract has the ability to operate as both an ovicidal and a larvicidal agent against the mosquito vector *Aedes aegypti*, as well as acting in concert with it. As a result, the dengue vector control program ought to support the current approach. It is important to examine and ascertain the *Datura metel* extract's larvicidal and ovicidal qualities in the field. Furthermore, it is crucial that additional research be done soon on the impact on non-target organisms.

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