LARVICIDAL ACTIVITY AND EFFICACY OF VITEX SPECIES: A REVIEW

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***ABSTRACT*:** *Malaria dengue, Chikungunya fever and Zika virus infections are human disease which spreading by mosquitoes as pathogenic microorganism. Natural resources being able as alternative compound to prevent this disease. Vitex species have been reported to show activity against various species of mosquitoes. The review of this article aims to compare between several general of Vitex which have antilarva activity. There are Vitex Schiliebenii, Vitex rotundifolia Linn, Vitex agnus-castus, Vitex trifolia Linn, Vitex negundo Linn. This research was conducted by searching articles from 2010 to July 2020 on data base PubMed and Google Scholar. Extensive analysis of published literature revealed that the larvicidal potency of herbal resources varied from sub-microgram/ml to practically insignificant. Overall, this unprecedented summarized and arranged information can be utilized for design, development and optimization of herbal based formulation having potential larvicidal activity.*

Keywords: Vitex species, Larvicidal activity, Vector-borne diseases

INTRODUCTION

Malaria dengue, Chikungunya fever and Zika virus infections are human disease which spreading by mosquitoes as pathogenic microorganism. human life and produce a lot of high morbidity and mortality were threatened by these pathogen[1]. These problems triggeres reseacrher to make use of natural resources as alternative compound to prevent Malaria dengue, Chikungunya fever and Zika virus infections. [2].

One of natural resources is plants which have secondary metabolites. It have potential activity to control disease vectors and / or transmitted diseases. In view of malaria`s incidence in Africa and other tropical countries searched alternative tools and techniques for mosquito control have considered it of special importance. There are several types of plant products have been sought and most of the constituents of plants that are not volatile that is poisonous [3]. There are nine families of plants had been studied for larvicidal effects. Such as Annonaceae, Asteraceae, Cladophoraceae, Labiatae, Meliaceae, Oocystaceae,Piperaceae, Rutaceae, and Verbenaceae. Reciprocally, Vitex species have been reported to show activity against various mosquito species, such as Culex trataeniorhnchus, Anopheles gambiae, Culex quinquefasciatus, Plutella xylostella, and Callosobruchus maculate [4].

The purpose of the present article is to review the available published information on the larvacidal activities and efficacy of vitex species as a basis for future drug development.

METHOD

Literature Search Strategy

This article review is a comprehensive summary of several research studies that are determined based on a particular theme. Literature search was conducted in June-July 2020. The data used in this study are secondary data obtained not from direct observation, but obtained from the results of research conducted by previous researchers. Secondary data sources obtained in the form of articles of national and international reputation with a predetermined theme. Literature search in this systematic review uses 2 databases, namely Pubmed, and Google Scholar from January 2010 to July 2020.

Search for articles or journals using keywords (AND, OR) that are used to expand or specify a search, making it easier to determine the article or journal used. The main search strategy is done in PubMed with the key word as follows: "(Vitex) AND (Larvidical)". This keyword is used as a guide for finding articles in other databases. The search is carried out by identifying articles in sequence (title, abstract, and then full text).

Inclusion and Exclusion Criteria

Inclusion criteria are in the form of national and international reputation journals that make information about several genera vitex and larvicidal activities. All data sources used have a maximum publication time of the last 10 years. Then for the exclusion criteria, namely journals, the last 10 years that are not specific to some of the Vitex genus and larvicidal activities that do not contain information as desired and not open access Journal.

RESULT AND DISCUSSION

Results compiled in Table 1 are elaborated below.

Study characterizes the main components of essential oils (EO) derived from the vegetative part of the Vitex rotundifolia plant and its larvicidal activity against important mosquito vectors. EO was extracted by water distillation and gas chromatography-mass spectrometry (GC-MS) analysis and larvicidal activity test were conducted on Aedes aegypti, Ae. albopictus and Culex quinquefasciatus. Vitex rotundifolia plants showed significant larvicidal activity against three mosquito species, with LC50 values <100 µg / mL for 12 and 24-hour treatment regimens. Specifically, EO P. amboinicus showed the highest larvasid activity, with LC50 between 42.9 and 64.15 µg / mL against both Aedes mosquito species and values of 22.88 and 23.34 µg / mL for 12 and 24 hour treatment regimens.

This result shows that Cx. quinquefasciatus is more sensitive than Aedes mosquitoes against P. amboinicus Eos. Death Cx. quinquefasciatus larvae reach 80% within 5 minutes after treatment with 100 ppm EOP. amboinicus; However, no dead larvae were found until 30 minutes for Ae. aegypti in the same condition. LT50 values of P. amboinicus EOs at a concentration of 100 ppm were 2.51 and 61.16 minutes for Cx. quinquefasciatus and Ae. aegypti, respectively. Especially the exposure of Ae. aegypti larvae up to 20 ppm

Table 1. Plants employed in this study and the larvicidal activities of of Vitex species

No.	Title	Species	The Plant part used	Formulation/ Solvent used	Target organisms	Results and reported activity	Reference(s)
1.	Phytochemical composition and larvicidal activity of essential oils from herbal plants	Vitex rotundifolia	Fresh leaves from Vitex rotundifolia	Sodium sulfate anhydrous	Aedes aegypti, Ae. albopictus dan Culex quinquefasciatus.	Current results indicate that the EO leaves of V. rotundifolia show larvasidal activity and eleven components were identified, with α-pinene and 1,8-cineole forming the main EO constituents (23.64 and 23.86%, respectively).	[1]
2.	Larvicidal activity and GC-MS analysis of flavonoids of Vitexnegundo and Andrographispaniculata against two vector mosquitoes Anopheles stephensi and Aedesaegypti	Vitex negundo	V. negundo (leaves, stems, roots and flower buds)	Methanol	Mosquitoes Anopheles stephensi and Aedesaegypti	The flavonoid extract from the Vitex flower bud in particular was found to have a higher level of larvasidal activity against An. stephensi and Ae. aegypti, whereas in the case of other extracts (obtained from different parts), the concentration must be increased for better larvicidal effects.	[2]
3.	Time-course effects of Vitex schiliebenii (Varbenaceae) solvent extracts on Anopheles gambiae giles s.s. larvae under simulated semi-field conditions	Vitex schiliebenii (Verbenaceae)	Vitex schiliebenii leaves	Methanol	Anopheles gambiae giles s.s. larvae	At higher concentrations (≥25 ppm), exceptionally observed larval mortality shows that V. schilibenii can be used as an insecticide agent.	[3]
4.	Comparison of the effects of extracts from three Vitex plant species on Anopheles gambiaes.s. (Diptera: Culicidae) larvae	Vitextrifolia, Vitex schiliebenii, Vitexpayos	Vitexrifolia, leaves, bark and root bark of Vitex schiliebenii and bark and root bark of Vitex payos	Acetone and methanol	Anopheles gambiaes.s. (Diptera: Culicidae) larvae	In this study, acetone extracts from different parts of two plants showed a strong larvicidal effect at higher doses (≥100 ppm).	[4]
5.	Larvicidal activity of essential oil from Vitexnegundo and Vitextrifolia on dengue vector mosquito Aedesaegypti	Vitex trifolia (V. trifolia) dan Vitex negundo (V. negundo), keluarga Lamiaceae	Leaves (Made in the form of essential oils)	Methanol	Larva Aedes aegypti dan Culex quinquefasciatus	This study found the highest toxicity effect on V. trifolia extracts against C. quinquefasciatus larvae (LC50 = 9.26 and LC90 = 21.28 ppm). The study also assessed the efficacy of V. trifolia and V. negundo essential oils against C. quinquefasciatus and Ae larvae. Aegypti	[5]
6.	Mosquito larvicidal activity of methyl-p-hydroxybenzoate isolated from the leaves of Vitextrifolia Linn.	Vitex trifolia Linn	Vitex trifolia Linn leaves	Methanol	C.quinquefasciatus dan A. aegypti	Shows 100% of larval deaths from both mosquitoes at 20 ppm with LC50 values of 5.77 and 4.74 ppm against C. quinquefasciatus and A. aegypti. Methyl-p-hydroxybenzoate, which was reported for the first time with our best knowledge of V. trifolia can be further explored to control mosquito populations	[6]
7.	Development of nanoemulsion from Vitexnegundo L. essential oil and their efficacy of antioxidant, antimicrobial and larvicidal activities (Aedesaegypti L.)	Vitex negundo L	Vitex negundo L leaf (made in the form of nanoemulsion essential oil)	Polysorbate80 and Anhydrous sodium sulfate	Antioxidant, bactericidal, andlarvisidal activity against dengue vector Aedes aegypti L.	V. negundo EO and showed good antimicrobial, antioxidant, and larvasid activity against A. aegypti vectors due to high surface area and stability whereas essential oils contain less surface area and stability.	[7]
8.	Larvicidal potential of some plants from West Africa against Culexquinquefasciatus (Say) and Anopheles gambiae Giles (Diptera: Culicidae)	Vitex grandifolia	DaunVitex grandifolia	Ethanol	Culexquinquefasciatus (Say) and Anopheles gambiae Giles (Diptera: Culicidae)	shows that plants from Ivory Coast have real potential for malaria, yellow fever, filaria and dengue vector control. They can be used as sources or provide lead compounds for the development of safe plant biocides.	[8]
9.	Studies on Larvicidal activity of laleucas Aspera, Vitex	Vitex Negundo	Vitex Negundo leaf	Petroleum ether, Water, Acetone and	Culex quinquefasciatus	The findings of this investigation revealed that Eucalyptus and Vitex negundo had good	[9]

	negundo and Eucalyptus Against Culex Quinquefasciatus Collected from Coovum River of Chenni, India			Ethyl acetate		larvicidal activity against Culex quinquefasciatus and Leucas aspera showed poor mortality against mosquito larvae. This crude extract can be used effectively in mosquito control by replacing chemical pesticides which cause environmental pollution and other burdens.	
10.	Synergistic and individual efficacy of certain plant extracts against dengue vector mosquito, Aedes aegypti	Vitex negundo	Vitex negundo leaf	Petroleum ether	Terhadap Aedes aegypti	The results revealed that Vitex negundo, an individual Clerodendrum inerme leaf plant and / or a combination with P. Glabra extract can be used as a potential source of natural mosquito larvicidal agents.	[10]
11.	Larvicidal activity of selected plant hydrodistillate extracts against the house mosquito, Culexpipiens, a West Nile virus vector	Vitex agnus castus L.	Leaves (Made in the form of essential oils)	100 ml akuades yang mengandung 0,3% Tween 80	West Nile vektor, Culex pipiens L.	Larvae toxicity of the distillate at 24 hours (LC50 from the most toxic to the least toxic) is as follows: P.terebinthus palaestina (59.2 ppm)> H. scabrum (82.2 ppm)> V. agnus castus (83.3 ppm)> C. coronarium (311.2 ppm). But when LC90 values were compared, the relative toxicity level was changed as follows: H. scabrum (185.9 ppm)> V. Aguscastus (220.7 ppm) > P. terebinthus palaestina (260.7 ppm)> C. coronarium (496.3 ppm). Original extracts of Turkish plants continue to provide many potential sources for biologically active agents that can be applied to human and animal arthropod pests.	[11]
12.	Larvicidal and pediculicidal activity of synthesized TiO2 nanoparticles using Vitex negundo leaf extract against blood feeding parasites	Vitex negundo	Vitex negundo leaf	Distilled water	Anopheles subpictus Grassi and filariasis vector, Culex quinquefasciatus Say (Diptera: Culicidae) and the head louse, Pediculus humanus capitis De Geer (Phthiraptera: Pediculidae)	NP TiO2 showed no apparent toxicity to Poecilia reticulata after 24 hours of exposure. These findings reveal that the synthesized NP TiO2 has excellent larvicidal and anti-flea activity. These results indicate that NP TiO2 green synthesis has the potential to be used as an environmentally friendly approach that is ideal for vector control and head lice.	[12]
13.	Larvicidal efficacy of medicinal plant extracts against Anopheles stephensi and Culex quinquefasciatus (Diptera: Culicidae)	Vitex negundo	Vitex negundo leaf	Heksana, kloroform, etil asetat, aseton dan metanol	Anopheles stephensi Liston and lymphatic filariasis vector, Culex quinquefasciatus Say (Diptera: Culicidae)	That the methanol extract of S.torvum leaves and the ethyl acetate extract of A. squamosa bark from South India has the potential to be used to control mosquitoes.	[13]
14.	A study on larvicidal assay on Duranta Repens Linn. and Vitex Negundo Linn. against Culex Quinquefasciatus say	Vitex Negundo Linn	Vitex negundo leaf	Ethanol, methanol and distilled water	Culex Quinquefasciatus	Among the three solvents (methanol, distilled water, ethanol) used, distilled water and methanol showed a higher percentage of deaths.	[14]
15.	Chemical Compositions, FTIR and Larvicidal Activity of Essential Oils Extracted from Aromatic Plants	Vitex trifolia	Vitex trifolia seeds	Distilled water	A. aegypti, A. dirus, and C. quinquefasciatus	The results of larvicidal activity revealed that essential oils extracted from Citrus limon linn, Vitex trifolia and Cananaga odorata can function as insecticides and can be used as strong insecticides to control mosquitoes.	[15]
16.	Facile preparation of Silver nanoparticles from Vitex negundo leaf extract with multiple applications	Vitex negundo	Vitex negundo leaf	Heavy metal solutions such as HgCl2, Pb (NO3) 2, NiSO4, CdSO4	Aedes aegypti	Larvicidal toxicity of A. aegypti mosquitoes produced by nanoparticles is also estimated to follow standard methods. Silver nanoparticles prepared using negundo Vitex leaf extract appear to be very effective for use as an environmentally friendly and cost-effective	[16]

						mosquito-killing agent.	
17.	Larvicidal activity of silver nanoparticles synthesized from Vitex negundo leaf against dengue vector aedes albopictus (SKUSE)	Vitex negundo	Vitex negundo leaf	Ethanol	Aedes albopictus	That death rate is two orders of magnitude higher for silver nanoparticles compared to plant extracts. With this approach, it is suggested that this fast synthesis of nanoparticles will be appropriate for developing biological processes for mosquito control.	[17]
18.	Insect growth regulatory activity of Acalypha alnifolia (Euphorbiaceae) and Vitex negundo (Verbenaceae) leaf extracts against Aedes aegypti (Diptera: Culicidae)	Vitex negundo	Vitex negundo leaf	Diethyl ether	Aedes aegypti	The combination treatment of the two extracts showed a significantly higher extension of larvae, cocoons and the duration of adulthood and reached up to 7 days. The period of adult emergence is extended to 28 days, while the control reaches 12 days. Therefore, this study clearly shows that larvae, pupae and adult appearance are strongly inhibited by active compounds in plants.	[18]
19.	Test Of Liligundi Oil (Vitex Trifolia Linn) Oil Repellant Activities On Aedes Aegypti	Vitex trifolia	Vitex trifolia fruit	Ethanol	Aedes aegypti	The results of the Tukey / HSD test showed that the repellant's ability in essential oils concentrations of 15% and 20% was comparable to positive control at the beginning of the test and the ability to repel essential oil concentrations of 20% was comparable to positive controls in the first hour. Based on the above results it can be concluded that the essential oil of Vitex trifolia has the ability to repel against Aedes aegyptii mosquitoes.	[19]
20.	The Effectiveness Of Larvasida Extract Of Legundi Leaves (Vitex Trifolia) On Larva Aedes aegypti	Vitex trifolia	Vitex trifolia leaves	Ethanol	Larva Aedes aegypti	At a concentration of 1% the test larvae mortality reached 95% at 4320 minutes. It was found in the Mann-Whitney test that the effectiveness of 1% legundi leaf extract with abate had no difference ($p > 0.05$). LC50 values indicate a decrease in the concentration value with increasing time (minutes 480-2880), namely 0.837% to 0.346%. While the LT50 value shows a decrease in the time required as an increase in concentration (0.5% -1%), from 2233,197 minutes to 321,181 minutes. These results indicate that the legundi leaf extract has the effectiveness of larvicides against Aedes aegypti larvae.	[20]

any mortality, whereas the same treatment resulted in 45.3% EO P. amboinicus for 12 hours (720 minutes) did not produce mortality for Cx. quinquefasciatus larvae. EO M. requienii and V. rotundifolia are also stronger against Cx. quinquefasciatus, as indicated by higher LC50 values for both Aedes mosquitoes. In contrast, C. chinense EOs showed similar larvasidal activity for all three mosquito species, as evidenced by the insignificant difference in the LC50 values for all three mosquitoes [1].

Larvicidal activity of flavonoid extracts from various parts of Negiteo Vitex against Aedes aegypti larvae and Anopheles stephensi (Liston) using standard methods to test the susceptibility of mosquito larvae to insecticides. Flavonoid extracts from various plant parts selected were used at 300, 400, 500 and 600 ppm dilution and 50, 75, 100 and 200 ppm. In total, 20 larvae were exposed to the extract at each concentration, in the final volume of 100 ml the formulation was taken in a 250 ml beaker. Three replications for each concentration and control (with acetone and emulsifiers) were tested for larval bioefficiency. Larval mortality at different concentrations and controls was recorded after 24 hours of continuous exposure. Death data were analyzed by the log-probit26 method and lethal concentration (LC) values (50 and 90) were calculated. Among the various flavonoid extracts (leaves, stems, roots and flowers) of V. negundo flower bud flavonoid extracts have shown the highest mortality rate (100%) at concentrations of 600 ppm (LC50 - 323.59 and LC90 - 478.63) for end III or instar larvae. early Ae. Aegypti and at a concentration of 200 ppm (LC50 - 58.88 and LC90 - 120.22) for late or early IV instar larvae. Flavonoid extracts from other parts of V. negundo (leaves, stems and roots) were found to be relatively inactive for Ae larvae. aegypti compared to An larvae. Stephensi [2]. The methyl-phydroxybenzoate crystal compound was isolated from the methanol extract of Vitex trifolia leaves and identified with 1H and 13C NMR and a single crystal X-ray diffractometer. The larvicidal potential of the isolated compound was evaluated against the early 4th instar larvae of Culex quinquefasciatus and Aedes aegypti. This compound showed 100% larval death from both mosquitoes, 20 ppm with LC50 values of 5.77 and 4.74 ppm, respectively against C. quinquefasciatus and A. aegypti. Methyl-p hydroxybenzoate, which was reported for the first time with the best knowledge of V. trifolia for controlling mosquito populations [3].

Acetone and methanol extracts from different parts of three species of Vitex (Vitex trifolia leaves and bark, leaves, bark and root bark of Vitex schiliebenii and bark and root of Vitex payos) were evaluated for their potential to control Anopheles gambiae Giles sslarvae (Diptera: Culicidae). The extract gives different levels and mortality rates of larvae. Some (methanol extract of Vitrifolia leaves, acetone bark extract and V. schiliebenii leaf, acetone root bark extract of V. payos) caused 100% mortality at 100 ppm in 72 hours, with those from V. schiliebenii and V Payos showing higher mortality rates fast (LT50 = 8 hours) compared to V. trifolia (LT50 = 14 hours). At lower doses of this extract (≤50 ppm), most larvae fail to turn into normal pupae but provide larval-pupa intermediates between 4 and 14 days of exposure. Some pupated usually but adults who appeared looked weak and died within 48 hours. V. payos bark extract shows interesting effects on larvae. Initially, the larvae were relatively hyperactive compared to those in the control treatment. Then, those who do not turn into intermediaries for cocoon-larvae become stretched and inactive and die and float in groups on the surface. This observation shows some interesting growth-disturbing constituents in plants, with possible applications in the practical control of mosquito larvae in aquatic ecosystems [4]. Vitex schilibenii plant extracts on Anopheles gambiae larvae. The gambiae larvae exposed to acetone and methanol extracts from the bark and leaves of V. schiliebenii and their effects on the larval stages, pupae and adults were noted. Phytochemical screening of extracts was carried out using standard methods. The results showed that Anopheles gambiae larvae were susceptible to V. schiliebeinii extracts with an adult appearance of less than 20% at concentrations ≥25 ppm except for bark methanol extracts. About 11% of pupae appear in acetone V. schiliebenii (VSL 1) leaf extracts between days 6 and 10 but they do not turn into viable adults [5].

Larvicidal activity of negundo essential oils and nanoemulsion at various concentrations (25, 50, 100, 200 and 400 ppm) against the second and third stages of dengue larvae (Aedes aegypti). V. negundo essential oils and nanoemulsion are observed for 12 and 24 hours. Significant mortality after 12 and 24-hour treatment of the 2 highest instar larvae mortality was observed at 400 ppm for essential oils (73.33 ± 1.88) and (90.30 ± 2.15) while for nanoemulsion 81 respectively .00 ± 0.88 and 94.33 ± 1.20. Death of 3rd instar larvae was observed at 400 ppm for 12 and 24 hour essential oils at 400 ppm 70.33 ± 2.60 and 80.66 ± 0.66 while for nanoemulsion 79.00 ± 3.70 and 93.00 ± 1.25. Larvicidal activity of 2nd instar larvae after 12 hours of exposure period was LC50 = 118.15 LC90 924.14 ppm (essential oil), LC50 = 64.54 LC90 = 908.13 ppm (nanoemulsion), and 24 hours exposure period was LC50 = 77.35 LC90 = 513.99 ppm (essential oils), LC50 = 28.84 LC90 = 298.06 (nanoemulsion). Larvicidal activity of 3rd instar larvae after 12 hours. the exposure period is LC50 = 92.63 LC90 = 1817.04 ppm (essential oils), LC50 = 70.31 LC90 = 915.31 ppm (nanoemulsion), and the 24 hour exposure period is LC50 = 56.3 LC90 = 807.35 ppm (essential oil), LC50 = 43.29 LC90 = 379.12 ppm (nanoemulsion) (Table 5). Then, very important, some insecticidal compounds (terpeniods) that bind to nanoemulsion show the highest larvicidal activity better than essential oils. Nanoemulsion may interact with mosquito larvae cells and cause death [6].

This study found the highest effect of toxicity on V. trifolia extracts on C. quinquefasciatus larvae (LC50 = 9.26 and LC90 = 21.28 ppm). The study also assessed the effectiveness of V. trifolia and V. negundo essential oils against C. quinquefasciatus and Ae larvae. Aegypti [7]. Showed that Vitex grandifolia plant has real potential for controlling malaria, yellow fever, filaria and DHF vectors [8]. He results of this study revealed that Vitex negundo has good larvicidal activity against Culex quinquefasciatus and Leucas aspera showing poor mortality against mosquito larvae. This crude extract can be used effectively in mosquito control by replacing chemical pesticides that cause environmental pollution and other burdens [9]. Did research to evaluate the effectiveness of larvacidal Vitex negundo, against the early

vector mosquito dengue vector instar, Aedes aegypti. In the acute toxicity test for the mortality of the fourth initial instar A. aegypti larvae increased with increasing extract concentration. The results showed that, C. inerme was found to be more toxic to plants when tested individually. The results revealed that Vitex negundo, can be used as a potential source of natural mosquito larvicidal agents [10].

Larvae toxicity of the distillate at 24 hours (LC50 from the most toxic to the least toxic) is as follows: P.terebinthus palaestina (59.2 ppm)> H. scabrum (82.2 ppm)> V. agnus castus (83.3 ppm)> C. coronarium (311.2 ppm). But when LC90 values were compared, the relative toxicity level was changed as follows: H. scabrum (185.9 ppm)> V. Aguscastus (220.7 ppm) > P. terebinthus palaestina (260.7 ppm)> C. coronarium (496.3 ppm). Original extracts of Turkish plants continue to provide many potential sources for biologically active agents that can be applied to human and animal arthropod pests [14]. Another research of Vitex negundo (Verbenaceae) leaf extract on the fourth instar larvae of malaria vector, Anopheles subpictus Grassi and filariasis vector. , Culex quinquefasciatus Say (Diptera: Culicidae) and head louse, Pediculus humanus capitis De Geer (Phthiraptera: Pediculidae) to determine the larvicidal and pediculicidal activity of titanium dioxide nanoparticles (TiO2 NPs). The synthesized TiO2 NP was characterized by UV, XRD, FTIR and SEM-EDX. Mosquito larvae and head lice were exposed to various concentrations of synthesized NP TiO2, V. Negundo leaf water extract and titanium tetrachloride (TiCl4) for 24 hours. Maximum activity was observed in NP TiO2 synthesized against A. subpictus, C. quinquefasciatus and ticks, (LC50 = 7.52, 7.23 and 24.32 mg / L; $\chi 2$ = 0.161, 2.678 and 4.495; r2 = 0.663, 0.742 and 0.924), respectively. NP TiO2 showed no apparent toxicity to Poecilia reticulata after 24 hours of exposure. This shows that the synthesized NP TiO2 has excellent larvicidal and anti-mosquito flea activity [11]. The combined treatment of the two extracts showed significantly higher extension of larvae, cocoon and duration of adulthood and reached up to 7 days. The period of adult appearance is extended to 28 days, while the control reaches 12 days. Therefore, this study clearly shows that the appearance of larvae, pupa and adults is severely inhibited by the active compounds in Vitex negundo plants [12]. for acetone, ethyl acetate, methanol and hexane extracts of vitex negundo leaves were in the range of 70.38-210.68 ppm. The results show that Negiteo vitex extract has the potential to be used to control mosquitoes [13].

Larvicidal test on Vitex Negundo Linn. against Culex Quinquefasciatus. This test is done by soaking dried leaf powder in the same proportion of two species in different solvents (distilled water, methanol and ethanol). Initially, determine the range of activity of each extract with concentrations of 10ml, 15ml, 20ml and 25ml. The test is carried out at a temperature of 25 ± 2 ° C and a relative humidity of 75 ± 5%. The number of larvae that died was calculated after 24 hours of exposure and the percentage of deaths was calculated using the Abbott formula. Among the three solvent extracts, distilled water and methanol showed a higher percentage of deaths than ethanol extract. Of the 20 larvae, at a concentration of 10% of extracted distilled water, methanol and ethanol; larvae found dead were 17, 16 and 13. At a concentration of 15% distilled water and methanol, 20 inserted larvae were found dead. And at a concentration of 15% ethanol extract 15 larvae were found dead. In a concentration of 20% distilled water and methanol extract, the total number of larvae found dead is 20; whereas in 20% ethanol extract is 18. In the concentration of 25% distilled water, methanol and ethanol extract the total number of dead larvae is found as 20. At a concentration of 10% distilled water, methanol and ethanol, mortality 85, 80 and 65%. In 15% distilled water, methanol and ethanol, the mortality is 100, 100, and 75%. The use of 20 and 25% distilled water and methanol extract produces 100% mortality, while the use of 20% ethanol produces 90% mortality and 25% produces 100% mortality. All extracts showed 100% mortality at a concentration of 25%. Methanol extract and distilled water showed maximum activity even at low concentrations. Therefore research proves that negiteo Vitex extract is a suitable material for mosquito repellent [14].

The chemical composition and larvicidal activity of essential oils extracted from Vitex trifolia seeds were tested using FTIR, GC-MS, and Vitex trifola larvicidal activity tests produced essential oils (0.7 ml) after 3 hours of oil refining. The results obtained from the infrared spectrum show functional groups of compounds present in Vitex trifolia. GC-MS analysis identified, 13, 12 and 24 chemical constituents each present in the essential oil of Vitex trifolia. The three main essential oils and compositions are Sabinene (39.14%), Caryophyllene (26.45%) and 1 R-α Pinene (15.20%). However, the results of larvicidal activity revealed that the essential oil extracted from Vitex trifolia can function as an insecticide and can be used as a strong insecticide to control mosquitoes [15]. Silver nanoparticles that are made using negundo Vitex leaf extract appear to be very effective as an environmentally friendly and cost-effective mosquito-damaging agent. This property can be credited with the characteristic capacity of silver nanoparticles to penetrate easily through the cell walls of A. aegypti larvae and ultimately result in cell death [16]. The activity of silver nanoparticle larvicides synthesized from Vitex Nigundo leaf extracts against Aedes albopictus larvae which are the main vectors for transmission of dengue fever. The characterization of synthesized silver nanoparticles was carried out using a UV-vis spectrophotometer and transmission electron microscopy (TEM) Fourier Transform Infrared (FTIR). To find out the presence of compounds responsible for larvicidal activity, GC-MS analysis has been carried out. Parasitic larvae were exposed to various concentrations of water extract and silver nanoparticles were synthesized for 24 hours according to WHO protocol. From the results it was observed that mortality was two orders of magnitude higher for silver nanoparticles compared to plant extracts. This rapid synthesis of nanoparticles will be appropriate for developing biological processes for mosquito control [17].

The combined treatment of the two extracts showed significantly higher extension of larvae, cocoon and duration of adulthood and reached up to 7 days. The period of adult appearance is extended to 28 days, while the control reaches 12 days. Therefore, this study clearly shows that the appearance of larvae, pupa and adults is severely inhibited by the active compounds in Vitex negundo plants [18]. Research

on the isolation of Legundi (Vitex trifolia) essential oils and repellant testing of Aedes aegypti mosquitoes using a steam distillation method that produced 7.6 mL of essential oil with a yield of 0.0418% ± 0.01% (w / w) and weight type 0.819 ± 0.05 g / mL. The concentration of essential oils is 7.5%, 15%, and 20% in 96% ethanol solvent and 15% DEET positive control. ANOVA data analysis results showed a significant difference between the protective power of each essential oil concentration for 6 hours of testing. The results of the Tukey / HSD test showed that the repellant's ability in essential oils concentrations of 15% and 20% was comparable to positive control at the beginning of the test and the ability to repel essential oil concentrations of 20% was comparable to positive controls in the first hour. Based on the above results it can be concluded that the essential oil of Vitex trifolia has the ability to repel against Aedes aegyptii mosquitoes [19].

Larvicidal activity test of Legundi leaf extract (Vitex Trifolia) against Aedes aegypti larvae using a completely randomized design method with a concentration of 0%, 0.25%, 0.5%, 0.75%, and 1% with abate 1% as a positive control . The data obtained were then tested using the Kruskall-Wallis test and Mann Whitney post hoc test to find out the differences in each concentration. The results found: At a concentration of 1% mortality of test larvae reached 95% in minute 4320. Obtained in the Mann-Whitney test the effectiveness of 1% legundi leaf extract with abate had no difference ($p > 0.05$). LC50 values indicate a decrease in the concentration value with increasing time (minutes 480-2880), namely 0.837% to 0.346%. While the LT50 value shows a decrease in the time required as an increase in concentration (0.5% -1%), from 2233,197 minutes to 321,181 minutes. These results indicate that the legundi leaf extract has the effectiveness of larvicides against Aedes aegypti larvae [20].

CONCLUSION

From the comparison of several species of Vitex, which has the highest ability to control mosquito larvae, namely Vitex trifolia L. Because in the Vitex tifolia extract found the highest toxicity effect against C. quinquefasciatus and Ae larvae. Aegypti (LC50 = 9.26 and LC90 = 21.28 ppm). The compound showed strongest killing activity against mosquito larvae of both species at low concentrations.

Among the shortlisted seventy-four studies (LC50 < 100 µg/mL), around one hundred thirty-four plants were reported, which showed potency LC50 < 100 µg/mL, among which extracts or essential oils of thirty plants exhibited larvicidal activity with LC50 < 10µg/mL. Extracts of plants like Piper betle, Piper retrofractum, Annona crassiflora, Annona glabra exhibited potential larvicidal activity LC50 < 1µg/mL, particularly seed extract of Annona glabra shown potency in nanogram concentration (LC50 0.06 µg/mL). Among different types of formulations prepared and tested, recently silver nanoparticles and nanoemulsions of chosen extracts were reported as environmental friendly and potent larvicidal compared to other conventional formulations.

Present study summarized the larvicidal activity of plants based extracts published in the time frame from 2010 to 2020. Overall, synchronized data gave information about larvicidal potency of diverse vitex species against different mosquito species, including their parts used in the study and solvent system used for the extraction. Overall, the organized information in the review can be utilized for a selection of larvicidal herb, the solvent of choice as well as a methodology for extraction and preparation of formulation having potential larvicidal activity.

REFERENCE

[1]Huang, H. T., Lin, C. C., Kuo, T. C., Chen, S. J., & Huang, R. N. (2019). Phytochemical composition and larvicidal activity of essential oils from herbal plants. Planta, 1-10.

[2]autam, K., Kumar, P., & Poonia, S. (2013). Larvicidal activity and GC-MS analysis of flavonoids of Vitex negundo and Andrographis paniculata against two vector mosquitoes Anopheles stephensi and Aedes aegypti. J Vector Borne Dis 50, 171-178.

[3]Nyamoita, M. G., Ester, I., Zakaria, M. H., Wilber, L., Bwire, O. J., & Ahmed, H. (2013). Time-course effects of Vitex schiliebenii (Varbenaceae) solvent extracts on Anopheles gambiae giles s.s. larvae under simulated semi-field conditions. Novus Natural Science Research, 2(1), 27-34.

[4]Nyamoita, M. G., Ester, I., Zakaria, M. H., Wilber, L., Bwire, O. J., & Ahmed, H. (2013). Comparison of the effects of extracts from three Vitex plant species on Anopheles gambiae s.s. (Diptera: Culicidae) larvae. Acta Tropica, 199-203.

[5]Chandrasekaran, T., Thyagarajan, A., Santhakumari, P. G., Pillai, A. K. B., & Krishnan, U. M. (2019). Larvicidal activity of essential oil from Vitex negundo and Vitex trifolia on dengue vector mosquito Aedes aegypti. Journal of the Brazilian Society of Tropical Medicine, 1-5.

[6]Kannathasan, K., Senthilkumar, A., Venkatesalu, V. (2011). Mosquito larvicidal activity of methyl-p-hydroxybenzoate isolated from the leaves of Vitex trifolia Linn. Acta Tropica, 115-118.

[7]Balasubramani, s., Rajendhiran, T., Moola, A. K., & Diana, R.K.B. (2016). Development of nanoemulsion from Vitex negundo L. essential oil and their efficacy of antioxidant, antimicrobial and larvicidal activities (Aedes aegypti L.). Environ Sci Pollut Res, 1-9.

[8]Ozokou, A., Kone, M. W., Koudou, B. G., & Hanora, F.T.B. (2013). Larvicidal potential of some plants from West Africa against Culex quinquefasciatus (Say) and Anopheles gambiae Giles (Diptera: Culicidae). J Vector Borne Dis, 103-110.

[9]Karthikeyan, V., Sivakumar, K., Gokuldas, A., & Mohanasundaram. (2012). Studies On Larvicidal Activity Of Leucas Aspera, Vitex Negundo And Eucalyptus Against Culex Quinquefasciatus Collected From Coovum River Of Chennai, India. Asian Journal of Pharmaceutical and Clinical Research, 5 (3), 189-192.

[10]Yankanchi, S. R., Yadav, O. V., & Jadhav, G.S. (2014). Synergistic and individual efficacy of certain plant extracts against dengue vector mosquito, Aedes aegypti. Jbiopest, 7(1), 22-28.

[11]Cetin, H., Yanikoglu. A., & James, E. C. (2011). Larvicidal activity of selected plant hydrodistillate

extracts against the house mosquito, Culex pipiens, a West Nile virus vector. Parasitol Res, 943-948.

[12]Gandhi, P. R., Jayaseelan, C., Vimalkumar, E., & Marry, R. R. (2016). Larvicidal and pediculicidal activity of synthesized TiO2 nanoparticles using Vitex negundo leaf extract against blood feeding parasites. Journal of Asia-Pacific Entomology, 1089-1094.

[13]Kamaraj, C., Abdul, R. A., Bagavan, A., Abduz, Z. A., Elango, G., Kandan, P., Rajakumar, G., Marimuthu, S., & Santhoshkumar, T. (2011). Larvicidal efficacy of medicinal plant extracts against Anopheles stephensi and Culex quinquefasciatus (Diptera: Culicidae). Tropical Biomedicine, 27(2), 211–219.

[14]Hermavathy, J., & Anitha, T. (2016). A study on larvicidal assay on Duranta Repens Linn. and Vitex Negundo Linn. against Culex Quinquefasciatus say. International Journal of Advanced Science and Research, 1 (4), 18-20.

[15]Yahaya, M. F., Yelwa, J. M., Abdullahi, S., Umar, J. B., Abubakar, A. M., & Babakura, M. (2019). Chemical Compositions, FTIR and Larvicidal Activity of Essential Oils Extracted from Aromatic Plants. European Scientific Journal, 16(24), 110-131.

[16]Aswanthy, S. M., Pillai, A., Sreeharji, H., Sarma, S., Ajith, P., Vinod, B. S., Anil, A., & Amitha, C. S. (2018). Facile preparation of Silver nanoparticles from Vitex negundo leaf extract with multiple applications. IOP Conference Series: Materials Science and Engineering, 1-6.

[17]Singh, Y., Swarnagowreeswari, G., Sathyavathi, R., Ramachandra, R. P., & Naik, B. R. (2014). Larvicidal Activity Of Silver Nanoparticles Synthesized From Vitex Nigundo Leaf Against Dengue Vector Aedes Albopictus (SKUSE). 3(10), 1623-1633.

[18]Kamalakannan, S., Murugan, K., & Chandramohan, B. (2015). Insect growth regulatory activity of Acalypha alnifolia (Euphorbiaceae) and Vitex negundo (Verbenaceae) leaf extracts against Aedes aegypti (Diptera: Culicidae). International Journal of Mosquito Research, 2(1), 47-52.

[19]Adiyasa, I. W. S., Santi, S. R., & Manurung, M. (2014). Test Of Liligundi Oil (Vitex Trifolia Linn) Oil Repellant Activities On Aedes Aegypti. Jurnal Kimia, 8(1), 23-27.

[20]Eka, C. B., & Endah, S. (2013). Uji Efektivitas Larvasida Ekstrak Daun Legundi (*Vitex trifolia* L.) terhadap Larva Aedes aegypti. Medical Journal of Lampung University, 2(4), 52-60.