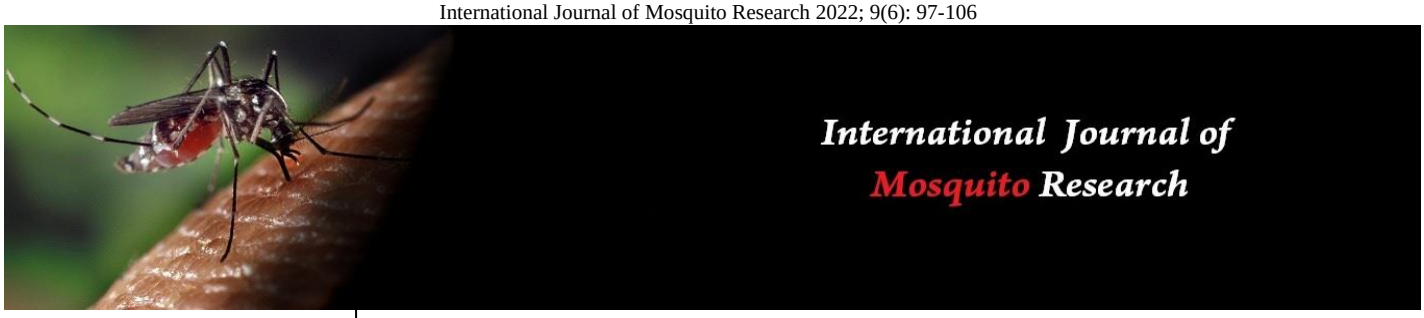

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In silico molecular docking study of plant-based compounds from medicinal plant *Lantana* camara L. against *Aedes aegypti* L. protein

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Abstract
In the present study, the ethanolic leaf extract of *Lantana camara* L. was analyzed for phytocomponents using GC-MS technique and in silico molecular docking studies of phytocompounds against sterol carrier protein-2 (1PZ4) of *Aedes aegypti* L. larvae was performed to identify the phytocompounds with larvicidal potential. Gas Chromatography-Mass Spectrometry (GC-MS) analysis of the ethanolic leaf extract of *L. camara* L. revealed the occurrence of 30 phytocompounds that are known to possess a variety of therapeutic properties. Subsequently, ten compounds were selected for the molecular docking studies, of which the phytocompounds Pectolinaringenin, Naphthalene, decahydro-2, 2-dimethyl and Gamolenic acid were predicted to have potential larvicidal property. To the best of our knowledge, this is the first study to predict the larvicidal activity of Pectolinaringenin, Naphthalene, decahydro-2, 2-dimethyl and Gamolenic from L. camara against *Ae. Aegypti*.

Keywords: *Lantana camara* L., sterol carrier protein-2, molecular docking, phytochemical analysis, GC-MS analysis

Introduction
Mosquitoes as a vector plays a vital role in the transmission of diseases [1,2]. Diseases transmitted through vector are of great menace to the human population in all tropical regions of the earth. In the view of global warming, investigators have projected the raising risk of mosquito-transmitted diseases in a warmer and highly populated area of the world [3]. The vector, *Ae. Aegypti* L. is known for transmitting viruses such as yellow fever, chikungunya, dengue, and zika [4]. A lot has been invested in the development of drugs, vaccines and alternative tools to combat the vector transmitted diseases [5]. In spite of investing more in the discovery of drugs for treating such diseases, it is preferable to control the vector population, though it is considered as a great challenge to control the mosquito dissemination in poor and developing countries [6]. In these circumstances, plants used in traditional medicine have become a favorable tool to be used to avoid the spreading of mosquitoes [7]. Various phytocompounds from several plant families are identified with larvicidal property against the mosquito species. Some of them has been used as a bio control agent against *An. stephensi*, even the secondary metabolites from the plants of the family Meliaceae such as neem *Azadirachta indica* A. Juss [8, 9], Indian white cedar, *Dysoxylum malabaricum* Bedd [10], *D. beddomei* and chinaberry tree, *Melia azedarach* L. [11, 12], *Eucalyptus tereticornis* Sm. (forest redgum, Myrtaceae), the crude leaf extracts of *Acanthospermum hispidum* were proved to be effective against *An. stephensi* and other mosquitoes species [13, 14]. Many other plant extracts along with their chief chemical constituents proved effective in inhibiting the metabolism of the insect and in stimulating enzymes which aids in the digestion [9, 15, 16]. Like synthetic chemicals, plant metabolites doesn't provide any emergence of resistance in mosquitoes so far. This is possibly due to the combination of several secondary metabolites with their unique mechanisms of action making it difficult for the mosquito vectors to develop resistance [17, 18]. There are several new phytocompounds yet to be discovered from plant species, for that suitable screening methods and identification of the compounds are very essential. Generally, for finding the suitable active compounds, the extraction and characterization methods are used [19, 20].

Subsequently, GC-MS technique has been used for the identification of the compounds including alkaloids, alcohols, nitro compounds, long chain hydrocarbons, steroids, esters, amino acids and organic acids and detection of the functional groups in a small fraction of crude plant extract [21, 22, 23, 24].

Due to the problems encountered during the detection of biological property and economic cost of the experimental methods, computational methods such as molecular docking are desired for predicting the binding of the protein and ligand, and their affinities [25, 26, 27, 28, 29, 30, 31]. Computer tools such as molecular docking techniques gives the understanding on the interaction of phytochemical compound and receptor, that predicts the binding of the target protein to the ligand with the orientation in the targeted binding site [32, 33, 34]. These techniques make the discovery of effective bioactive compounds with larvicidal and mosquitocidal property easier. Keeping this in view, the present study was carried to understand the interaction mechanism of sterol carrier protein-2 (1PZ4) of *Aedes aegypti* L. larva with the selected phytoligands of the plants *L. camara* L.

Materials and Methods

Collection of plant material

L. camara L. leaves were collected in Nagercoil, Kanniyakumari district, Tamil Nadu, India. The collected plant sample was authenticated by Dr. S. Jeeva, Department of Botany, Scott Christian College (Autonomous), Nagercoil and was processed for the further studies in the Department of Zoology and Research Centre, Scott Christian College (Autonomous), Nagercoil.

Preparation of plant extract

The leaves of *L. camara* L. were washed under running tap water and finally surface- sterilized with distilled water, and then the samples were shade dried at room temperature for 14 days. The shade-dried leaves were crushed and powdered, 20g of the powdered leaves were extracted by 200ml of ethanol solvent in a Soxhlet apparatus at moderate temperature of 40-50 ºC for 12 cycles. The extract was collected, filtered and evaporated with rotary evaporator. The concentrated extracts were stored at 4 °C in refrigerator for further analysis.

Gas chromatography-mass spectrometry (GC–MS) analysis

The phytoconstituent of the extract of *L. camara* L. was identified using GC-MS equipment, Thermo Scientific Co., The GC-MS system model was Thermo GC-TRACE ultra, version 5.0, Thermo MsDsq II. Ethanolic leaves extract of *L. camara* L. of 100µl was dissolved in 1ml of solvent, mixed and filtered using membrane filter. The chromatography was performed on DB 35-MS capillary standard non-polar column of dimension 30m, 0.25 µm film thickness and 0.25 mm ID. Helium was used as the carrier gas at flow rate of 1.0 ml/min throughout the column. The injection volume of the sample was 1µl in the split mode at a ratio of 1:10. The injector temperature were 240 ºC and the transfer line temperature was 280 ºC. Initially the instrument column temperature was programmed at 50 ºC for 2 min and then increased 5 ºC per minute to 260 ºC and hold at 260 ºC for 10 min. The instrument was operated at 70eV. The sample was scanned, Mass spectral range was set at 42-350 (m/z). The peak obtained compounds of GC-MS were analyzed with NIST (National Institute of Standard and Technology).

Molecular Docking

Ligand Selection and Drug Docking

The identified phytocompounds of *L. camara* L. using the GC-MS analysis were selected based on Lipinski rule of five parameter for the docking studies. The phytocompounds chemical structure were retrieved from PubChem-NCBI database (http://www.pubchem.ncbi.nlm.nih.gov/) and converted into 3D structure using online smiles translator for the study.

Selection of Target Protein

In order to perform protein modeling studies, 3D structure of sterol carrier protein-2 (1PZ4) of *Aedes aegypti* L. larvae were retrieved from Protein Data Bank (http://www.rcsb.org/) and viewed through Discovery Studio software.

Molecular-Docking analysis

Finally docking studies for the target protein 1PZ4 and phytocompounds (ligands) of *L. camara* L. Were performed using Auto Dock Vina (version 4).

Result

In the GC-MS analysis of the leaf extract of the *L. camara* L., a total of 30 peaks were observed (Figure 1). Each peak denotes the phytocompound that were identified by relating their peak retention time, molecular weight, molecular formula to that of the known components based on the NIST library. The identified compounds are listed in (Table 1).

Further, ten potentially active phytocompounds were selected from the GC-MS result of *L. camara* by Lipinski's rule of five parameters and subjected to molecular docking with sterol carrier protein-2 (1PZ4) (Figure 2). The 2D structure of the phytocompounds retrieved from the PubChem database are presented in Figure 3. The binding affinity of protein with phytoligands are shown in Table 2 and the amino acid residues involved in the best interaction of sterol carrier protein of *Ae. Aegypti* (1PZ4) with phytoligands of *L. camara* L. are given in the Table 3. The best interaction images of the protein 1PZ4 with phytoligands are shown in Figure 4. The phytocompound Pectolinaringenin revealed a best affinity (-8.7Kcal/mol) with protein 1PZ4 followed by Naphthalene, decahydro-2,2-dimethyl with binding energy -7.9 Kcal/mol and Gamolenic Acid with -7.8 Kcal/mol binding affinity.

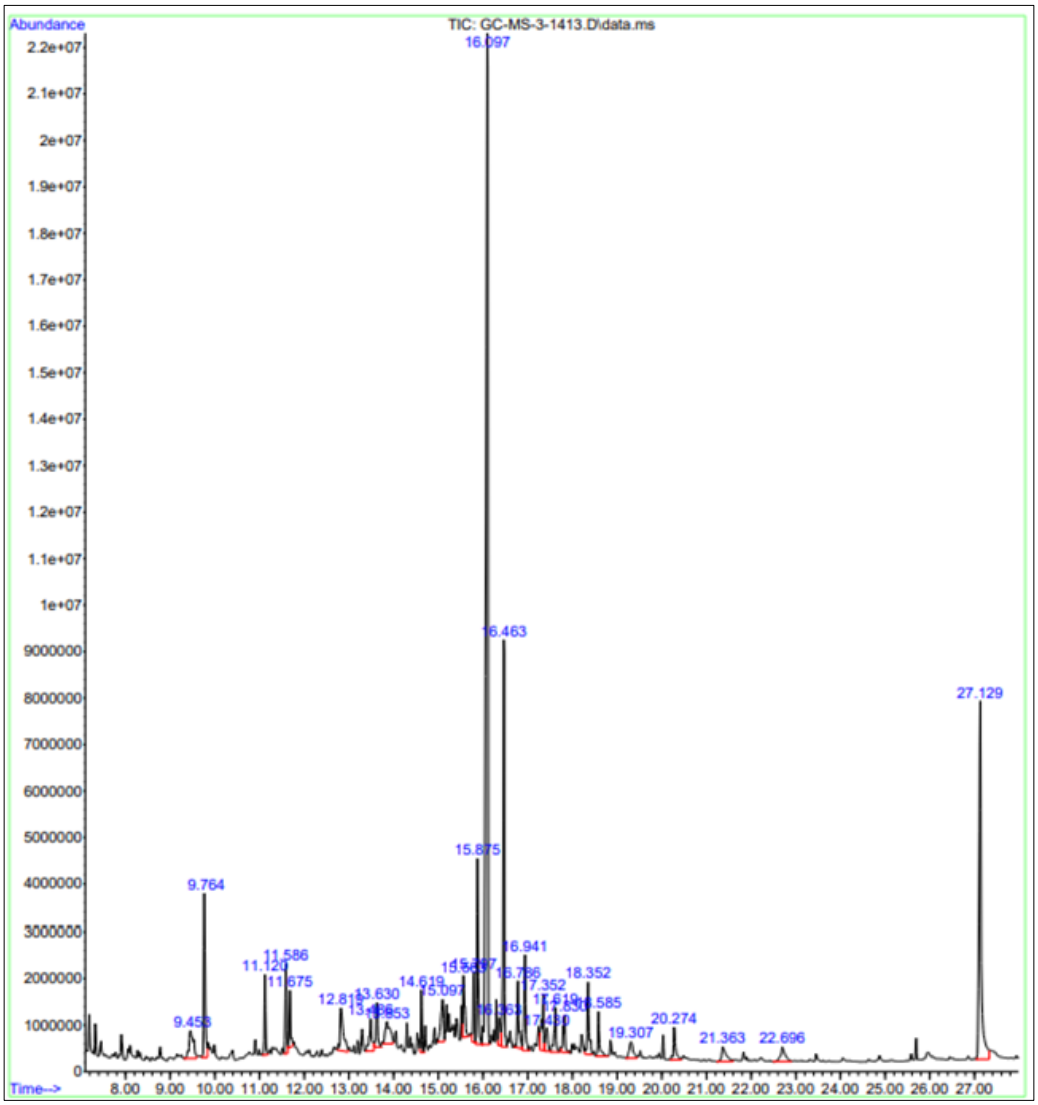


Fig 1: Gas chromatogram of leaf extract of *L. camara* L

Table 1: Phytochemical constituents identified in the ethanolic extract of *L. camara* L**.**

S. No.	Retention Time (min)	Compound Name	Molecular Formula	Molecular Weight (g/mol)	Percent area
1.	9.453	1, 2-Benzenediol	$C_6H_6O_2$	110.11	2.02
2.	9.764	Benz furan, 2, 3-dihydro-	C_8H_8O	120.15	3.70
3.	11.120	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	150.17	1.50
4.	11.586	Phenol, 2, 6-dimethoxy-	$C_8H_{10}O_3$	154.16	1.82
5.	11.675	Phenol, 2-methoxy-3-(2-propenyl)-	$C_{10}H_{12}O_2$	164.2	1.30
6.	12.819	2, 1, 3-Benzothiadiazole	$C_6H_4N_2S$	136.18	2.42
7.	13.486	Naphthalene, decahydro-2, 2-dimethyl-	$C_{12}H_{22}$	166.3	1.34
8.	13.630	2-(1-Hydroxybut-2-enylidene) cyclohexanone	$C_{10}H_{14}O_2$	166.22	1.23
9.	13.853	D-Allose	$C_6H_{12}O_6$	180.16	1.78
10	14.619	1H-Cycloprop[e]azulen-7-ol, decahydro-1, 1, 7-trimethyl-4-methylene-, [1ar-(1a.alpha., 4a.alpha., 7.beta., 7a.beta.7balpha)	$C_{15}H_{24}O$	220.35	1.08
11	15.097	2, 7-Octadiene-1, 6-diol, 2, 6-dimethyl-	$C_{10}H_{18}O_2$	170.25	1.83
12	15.563	Phenol, 2, 4-bis(1-methylethyl)-	$C_{12}H_{18}O$	178.27	1.64
13	15.797	Lilac alcohol B	$C_{10}H_{18}O_2$	170.25	1.43
14	15.875	Lilac alcohol A	$C_{10}H_{18}O_2$	170.25	4.37
15	16.097	1-(3-Ethoxy-2-methyl-acryloyl)-3-(2-hydroxy-ethyl)-urea	$C_9H_{16}N_2O_4$	216.23	33.23
16	16.363	4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol	$C_{10}H_{12}O_3$	180.2	0.94
17	16.463	6-Bromomethyl-5-methyl-bicyclo[3.1.0] hexan-2-one	$C_8H_{11}BrO$	203.08	8.45
18	16.786	1-Methyl-3-n-propyl-2-pyrazolin-5-one	$C_7H_{12}N_2O$	140.18	1.92
19	16.941	2-Cyclohexen-1-one, 4-hydroxy-3, 5, 6-trimethyl-4-(3-oxo-1-butenyl)-	$C_{13}H_{18}O_3$	222.28	2.46
20	17.352	9-Octadecyne	$C_{18}H_{34}$	250.5	1.73
21	17.430	Bicyclo [5.2.0] nonane, 4-methylene-2, 8, 8-trimethyl-2-vinyl-	$C_{15}H_{24}$	204.35	0.96
22	17.619	Acetic acid, 10, 11-dihydroxy-3, 7, 11-trimethyl-dodeca-2,6-dienyl ester	$C_{17}H_{30}O_4$	298.4	1.42

23	17.830	1, 4-Methanoazulen-9-one, decahydro-1, 5, 5, 8a-tetramethyl-, [1R-(1.alpha., 3a.beta., 4.alpha.,8a.beta.)]-	$C_{15}H_{24}O$	220.35	1.19
24	18.352	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha. 2. alpha., 5.alpha.)-	$C_{10}H_{20}O$	156.26	2.01
25	18.585	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256.42	1.24
26	19.307	3-Hexene, 1-[1-ethoxyethoxy]-, (E)-	$C_{10}H_{20}O_2$	172.26	1.06
27	20.274	Gamolenic Acid	$C_{18}H_{30}O_2$	278.4	1.17
28	21.363	Benzyl .beta.-d-glucoside	$C_{13}H_{18}O_6$	270.28	1.12
29	22.696	4,8,13-Cyclotetradecatriene-1, 3-diol, 1, 5, 9-trimethyl-12-(1-methylethyl)-	$C_{20}H_{34}O_2$	306.5	1.11
30	27.129	Pectolinaringenin	$C_{17}H_{14}O_6$	314.29	12.52

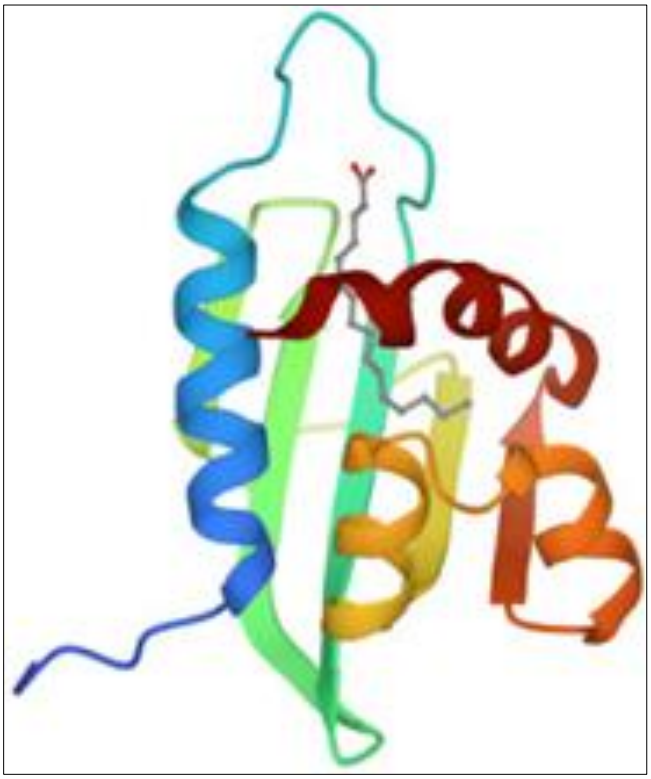
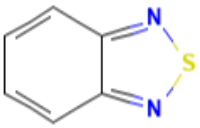
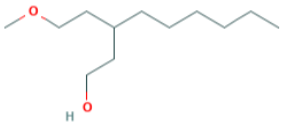
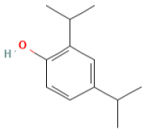
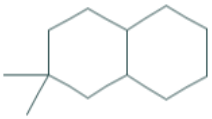
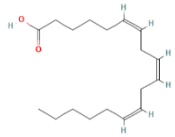
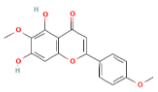
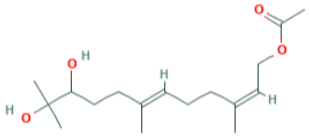
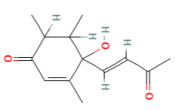


Fig 2: The target protein 1PZ4- Sterol Carrier Protein-2 of mosquito *Ae. Aegypti* (Photo Courtesy: Protein Data Bank, http://www.rcsb.org/).

2,1,3-Benzothiadiazole 	**1-Methoxy-3-(2-hydroxyethyl)nonane** 
Phenol, 2,4-bis(1-methylethyl)- 	**Naphthalene, decahydro-2,2-dimethyl-** 
Gamolenic Acid 	**Pectolinaringenin** 
Acetic acid, 10,11-dihydroxy-3,7,11-trimethyl-dodeca-2,6-dienyl ester 	**2-Cyclohexen-1-one, 4-hydroxy-3,5,6-trimethyl-4-(3-oxo-1-butenyl)-** 

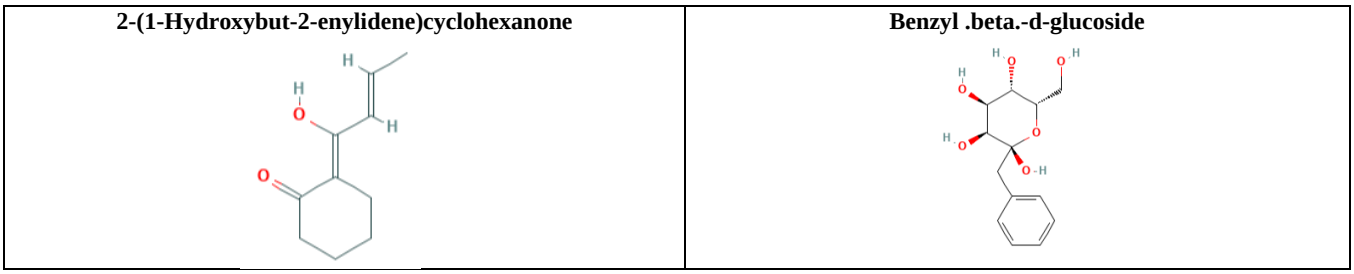


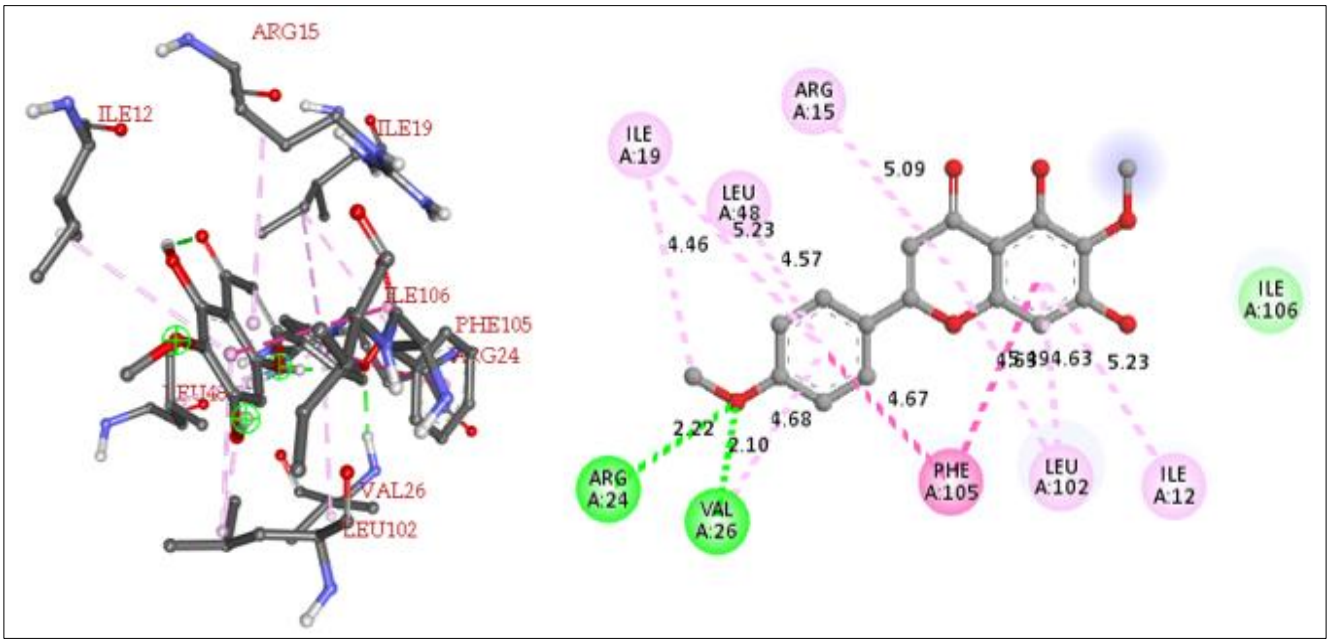
Fig 3: The Chemical structure of phytocompounds identified from *L. camara* L. for the molecular docking analysis. (Photo Courtesy: http://www.pubchem.ncbi.nlm.nih.gov/)

Table 2: Docking score of phytoligands on sterol carrier protein of *Ae. Aegypti* (PDB ID: 1PZ4).

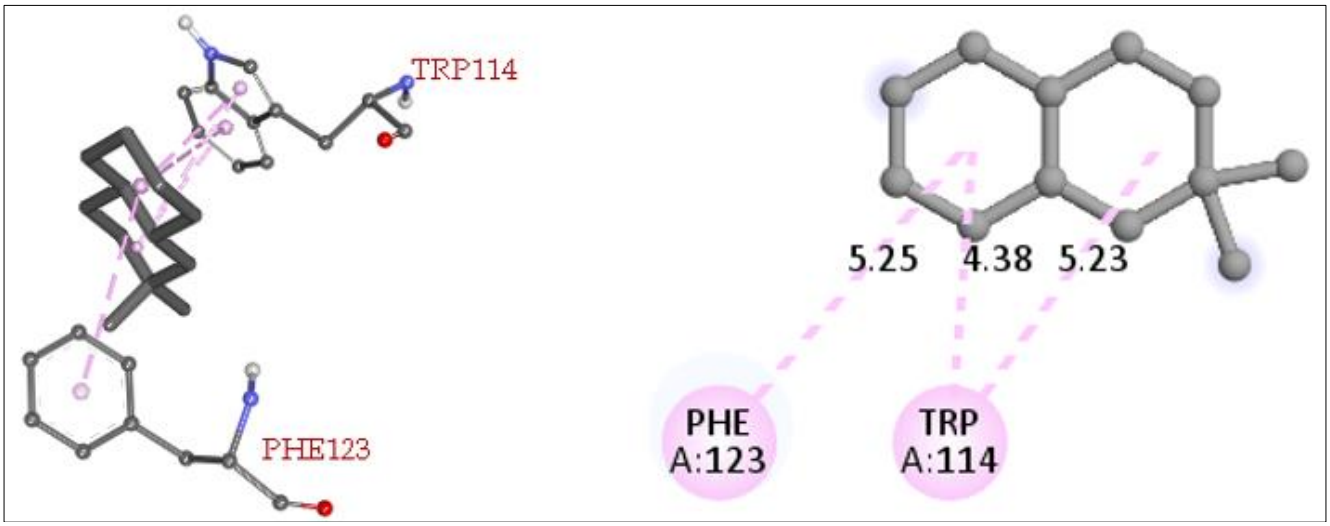
S. No.	Ligand	PubChem ID	Binding energy (Kcal/mol)
1.	2, 1, 3-Benzothiadiazole	67502	-5.7
2.	1-Methoxy-3-(2-hydroxyethyl)nonane	542174	-6.0
3.	Phenol, 2, 4-bis(1-methylethyl)-	18048	-7.6
4.	Naphthalene, decahydro-2,2-dimethyl-	591982	-7.9
5.	Gamolenic Acid	5280933	-7.8
6.	Pectolinaringenin	5320438	-8.7
7.	Acetic acid, 10, 11-dihydroxy-3, 7, 11-trimethyl-dodeca-2,6-dienyl ester	5363508	-7.8
8.	2-Cyclohexen-1-one, 4-hydroxy-3, 5, 6-trimethyl-4-(3-oxo-1-butenyl)-	5371378	-7.6
9.	2-(1-Hydroxybut-2-enylidene)cyclohexanone	5373219	-7.6
10.	Benzyl .beta.-d-glucoside	91699476	-7.6

Table 3: The best interaction complex of sterol carrier protein of *Ae. Aegypti* (PDB ID: 1PZ4) with identified phytoligands of *L. camara* L.

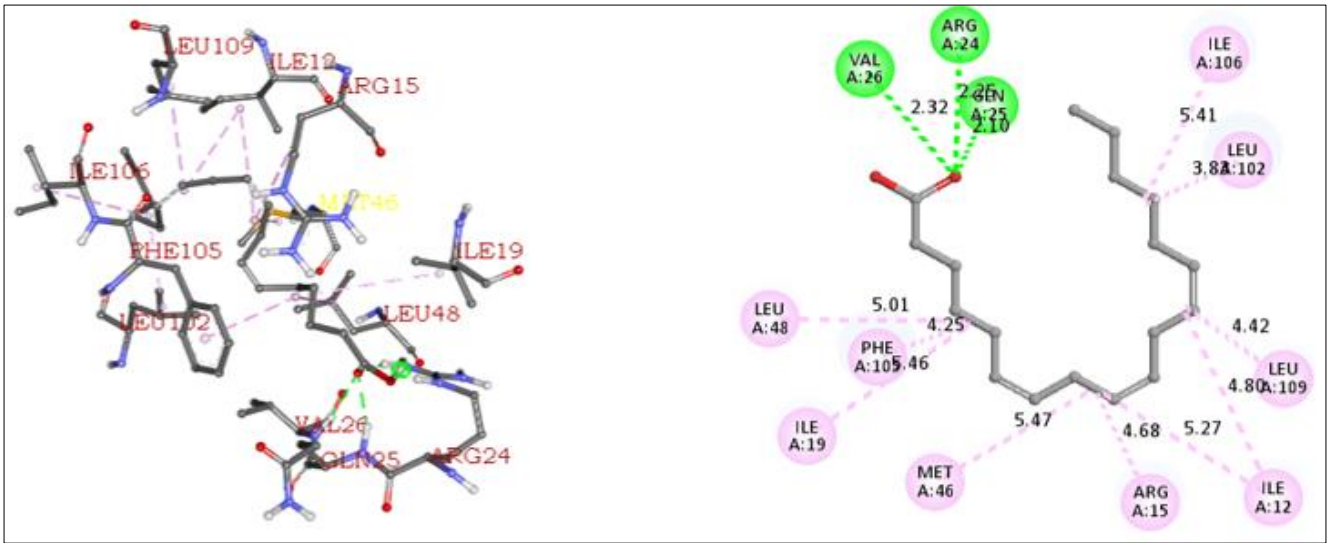
Complex		Docking Score (-kcal/mol)	No of H Bonds	No of Alkyl Bonds	Residues involved in Bonded Interactions	Residues involved in Non-Bonded Interactions
Protein	Phytoligand					
1PZ4-5320438	Pectolinaringenin	-8.7	3	6	Arg24, Val26, Ile106	Ile12, Arg15, Ile19, Leu48, Leu102, Phe105
1PZ4-591982	Naphthalene, decahydro-2,2-dimethyl-	-7.9	-	2	-	Trp11, Phe123
1PZ4-5280933	Gamolenic Acid	-7.8	3	9	Arg24, Gln25, Val26	Ile12, Arg15, Ile19, Met46, Leu48, Leu102, Phe105, Ile106, Leu109
Standard compound						
1PZ4-	Azadiractin	-5.4	1	-	Leu53	-



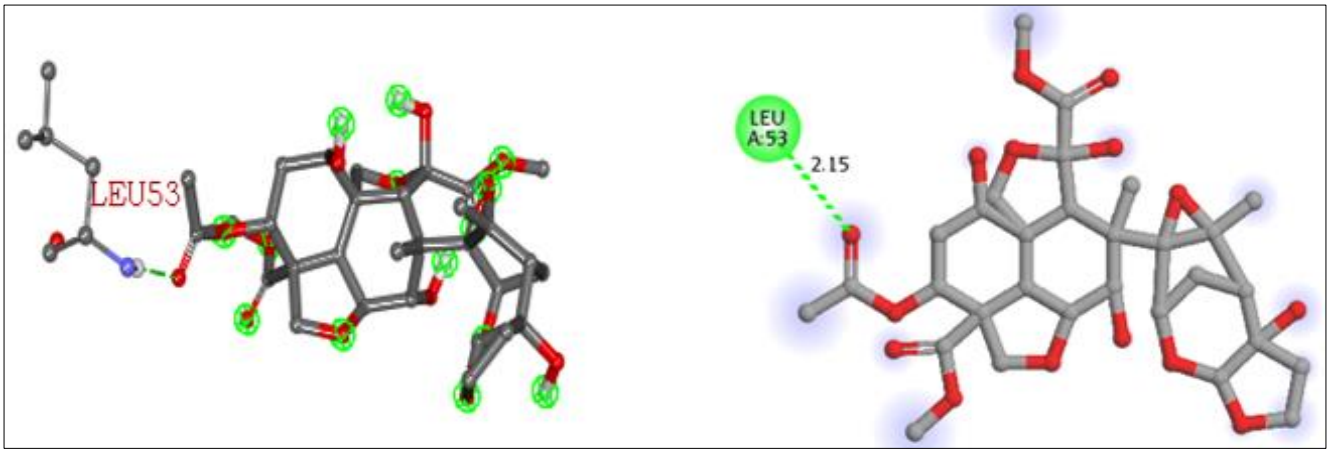
a) 1PZ4 and Pectolinaringenin complex (-8.7 Kcal/mol)



b) 1PZ4 and Naphthalene, decahydro-2,2-dimethyl complex (-7.9 Kcal/mol)



c) 1PZ4 and Gamolenic acid complex (-7.8 Kcal/mol)



d) 1PZ4 and Azadiractin complex (Standard compound) (-5.4 Kcal/mol)

Fig 4: The 2D interaction and 3D docked complex of the sterol carrier protein of *Ae. Aegypti* (AeSCP-2) (PDB ID: 1PZ4) with phytoligands of *L. camara* L. and Standard compound, Azadiractin

Discussion

Vector borne diseases causes more human suffering than any other diseases. In worldwide, more than seven million deaths accounts annually due to vector borne diseases, of which mosquito borne diseases are the most dangerous as they not only act as a carrier but also transmit several diseases [35,36,37]. Naturally, the plant-based compounds have various potentials including larvicides, insect growth regulators, repellents and

oviposition attractants [38]. So, in the present study, a step has. Been taken to identify phytocompounds with larvicidal potential through in silico molecular docking. The GC-MS analysis of ethanolic extract of *L. camara* L. revealed the presence of 30 compounds, of which the majority of the compounds have been reported to have significant biological activities in the previous studies. 1,2-Benzenediol isolated from the methanolic extract of persimmon (*Diospyros kaki*) roots of Korea reported to exert potent antimicrobial activity against eight food borne bacteria *Bacillus cereus, Listeria monocytogenes, Staphylococcus aureus, S. epidermidis, S. Intermedius, Salmonella enterica, S. typhimurium and Shigella sonnei* [39]. It was also reported to have antioxidants activity in eukaryotic cells by preventing degenerative diseases caused by free radicals [40, 41]. Another compound Benzofuran, 2, 3-dihydro, a lead compound predicted by molecular docking and experimental verification of biochemical interference to have some potential inhibitors of microsomal prostaglandin E_2 synthase (mPGES)-1 [42]. Similarly, it also possesses strong biological activities such as anti-tumor, antibacterial, anti-oxidative, and anti-viral activities [43]. A phenolic compound, 2-Methoxy-4-vinylphenol from chloroform extract of *Brassica oleracea* L. var. capitate F, rubra (Red cabbage) revealed the activity of antimicrobial and antioxidant [44]. The compounds also exhibit antiproliferative activity by exerting a dose dependent inhibitory effect on cell growth in Benzo[a] pyrene-treated NIH 3T3 cells [45]. The experimental data of Yang *et al.* (2005) [46] reported the presence of 2-(1-Hydroxybut-2-enylidene) cyclohexanone in Rutaceae oil, that showed adulticidal activity against *Culex pipiens quinquefasciatus*. A study showed a rare sugar, D-Allose, possess anticancer effects [47, 48, 49, 50, 51]. It was also reported to have anti-proliferative activity against MOLT-4F and DU-145 human cancer cell line [52]. Recently, 1H-Cycloprop[e]azulen-7-ol, decahydro-1, 1, 7-trimethyl-4-methylene-, [1ar- (1a.alpha. 4a.alpha. 7. beta., 7a.beta.7balpha) reported to have antibacterial activity against bacteria *Escherichia coli* and *S. aureus* [53]. Based on Duke's phytochemical and ethnobotanical database 4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol a phenolic compound reported to possess antimicrobial, antioxidant anti-inflammatory and analgesic [54]. An insecticidal potential of Acetic acid, 10, 11-dihydroxy-3, 7, 11-trimethyl-dodeca-2,6-dienyl ester- a constituents of *Litsea cubeba* fruit chloroform have been reported against the maize weevil, *Sitophilus zeamais Motschulsky* [55].

While on the other side, Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha. 2. alpha., 5.alpha.), a monoterpene known as menthol reported to have antioxidant, anti-inflammatory and analgesic effects [56]. Another study also reported the anti-apoptotic, antioxidant, anti-inflammatory activity of menthol when tested against ethanol induced gastric ulcers in wistar rats [57]. A common saturated fatty acid, n-hexadecanoic acid which is also known as palmitic acid was proved to have anti-inflammatory activity by inhibiting phospholipase A_2 [58]. Palmitic acid also reported to have the property of antioxidant, hypocholesterolemic, nematicide, pesticide, lubricant activities and hemolytic [59, 60]. Palmitic acid identified in *Millettia pinnata* seed showed the insecticidal activity by acting in the active site of acetylcholinesterase towards third instar larvae of *Ae. Aegypti* as well as wild *A. albopictus* [61]. The ethanolic extract *A. indica* determined the presence of compound palmitic acid reported to have larvicidal against *Ae. Aegypti* [62]. Gamolenic acid, or gamma-linolenic acid (γ-Linolenic acid) or GLA, is an essential fatty acid (EFA) reported to have antimicrobial activities against serval oral pathogenic bacteria including A*ggregatibacter actinomycetemcomitans*, *Candida albicans*, *Fusobacterium nucleatum* subsp. *vincenti* and *Streptococcus mutans* [63]. Pectolinaringenin a flavonoid compound of *Clerodendrum phlomidis* L. (Lamiaceae) showed larvicidal activity against the early fourth-instar larvae of the filarial vector *Cx. quinquefasciatus* Say and dengue vector *Ae. Aegypti* L. [64] One of the major proteins that helps in the development of mosquito from their larval stage is Sterol carrier protein-2 (AeSCP-2). AeSCP-2 of *Ae. Aegypti* larvae is an intracellular lipid carrier protein that involved in cholesterol delivery and uptake through the cellular barrier between the hemocoel and the midgut [65, 66, 67]. In an insect, cholesterol plays a crucial in the growth, development and reproduction of the organism [68]. Especially in larval and adult mosquitoes, AeSCP-2 plays a major role in cholesterol as well as fatty acid uptake [69]. Inhibition of the AeSCP-2 expression causes reduction in cholesterol uptake, which subsequently leads to mortality in larval stage as well as diminish fecundity in mosquitoes [67,70]. However, many studies have been attempted to anticipate the larvicidal activity of different compounds. Also several studies have reported the inhibition of AeSCP-2 through compounds that showed toxicity on *Cx. pipiens*, *Cx. quinquefasciatus*, and *Anopheles gambiae* [71, 72]. Recently, Al-keridis *et al.* (2022) [73] reported the best binding confirmation of Isofucosterol 4 from *Phoenix dactylifera* against three different target proteins 1YIY, 1PZ4, and 3UQI of *Ae. Aegypti.* Rathna and Thiyagaraj (2018) [74] suggested that the tangeritin-1 of *Lantana indica* and *Vitex negundo* plant extracts as a potential larvicidal compound since it showed inhibitory effects against acetylcholine esterase (AChE) and sterol binding protein. In the present study, phytocompounds of *L. camara* L. is docked with Sterol carrier protein-2 (1PZ4) to anticipate the larvicidal activity. The studies signify the fact that out of 10 phytoligands, 3 phytoligands showed the best interaction with the protein 1PZ4. Pectolinaringenin has shown the highest binding affinity of -8.7 Kcal/mol followed by Naphthalene, decahydro-2,2-dimethyl of -7.9 Kcal/mol, subsequently of -7.8 Kcal/mol by the phytoligand Gamolenic Acid with 1PZ4 protein, whereas the standard compound Azadiractin showed docking score of -5.4 Kcal/mol. The phytoligand, Pectolinaringenin binds at Arg24, Val26, Ile106 amino acids of 1PZ4 by hydrogen bonds and binds with Ile12, Arg15, Ile19, Leu48, Leu102, and Phe105 through non-bonded interactions. The second compound with best affinity is Naphthalene, decahydro-2, 2-dimethyl showed two non-bonded interactions with amino acid residues Trp11 and Phe123. Gamolenic acid also showed three hydrogen bond interaction with amino acid residues Arg24, Gln25, Val26 and nine non-bonded interactions with amino acid residues Ile12, Arg15, Ile19, Met46, Leu48, Leu102, Phe105, Ile106, and Leu109. When compared with the standard compound Azadiractin, the phytocompound from the plant *L. camara* L. proved to be effective.

Conclusion

In the study, 30 phytocompounds were identified from the ethanolic leaf extract of *L. camara* L. The ten compounds were selected and subjected to molecular docking studies. The

compounds showed significant interaction with Sterol carrier protein-2. Therefore, the findings of this study have clearly illustrated the fact that the plant compound of *L. camara* L. have the potential to inhibit the activity of the Sterol carrier protein-2 (AeSCP-2) of *Ae. Aegypti* larvae by binding with the amino acid residues in its active site. The compound Pectolinaringenin showed strong binding affinity than Azadiractin. Furthermore, in-vitro studies should be conducted to understand the effect of promising inhibitors of molecular docking study, and the feasibility of using these inhibitors in the fields.

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