IPOMOEA CAIRICA: CHEMICAL COMPOSITION AND THERAPEUTIC POTENTIAL

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Abstract
About 700 species of *Ipomoea* are present in tropical and subtropical regions of the world. In this work we mainly focus on *Ipomoea cairica* species. This plant is found in waste areas, rainforest margins, open woodlands, bush-land, gardens, fences, coastal sand dunes and vegetation growing near water way. It belongs to Convolvulaceae family and this plant is used as food, medicines, and as ornamental plants in religious ritual. In this work we mainly focus on chemical constituents and biological activity of *Ipomoea cairica*. The extractof *I. cairica* contains alkaloids, flavonoids, lactone, glycoside, tannins, phenols, amino acid, and tannins. Extraction of plant was done by maceration or soxhlation with methanol, ethanol, chloroform, acetone, pet ether solvent. *Ipomoea cairica* extract having several medicinal properties such as anti-microbial, anti-cancer, anti-HIV, anti-oxidant, anti-inflammatory, mosquitos' larvicidal properties and neuroprotective.

Keywords: *Ipomoea cairica*, Anti-HIV, Anti-cancer, Larvicidal, Neuroprotective.

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1. Introduction

The use of plant-based product has been increasing day byday because plant-based products are healthier and safer compared to synthetic product. The demand of herbal product increased day by day in various countries. In current era of drug discovery ofnewer drug molecules, lots of plant products are identify for biological activity based on their traditional uses.

In this article we mainly focus on *Ipomoea cairica* plant due to their good therapeutic activity. *Ipomoea cairica* is a recurrent herb of unnamed origin, possibly tropical Africa and Asia. The genus Ipomoea have approximately 500-600 species (Austin and Huaman, 1996). It is generally growingin side way of roads and wasteurban areas. In this plant flowers are coming all over the year.

Scientific name of this plant is *Ipomoea cairica* (L.) Sweet. *Convolvulus cairicus* L., *Convolvulus pendulus* (R. Br.) Spreng., *Ipomoea palmate*, *Ipomoea pendula* R. Br., *Ipomoea tuberculata* (Desr.) Roem. are synonyms of *Ipomoea cairica*. It belongs to Convolvulaceae family.

Common names of *Ipomoea cairica*

Cairo morning glory, coastal morning glory, five-fingered morning glory,coast morning glory, mile-a-minute vine, five-leaf morning glory, ivy-leaved morning glory, Messina creeper, mile a minute, mile a minute vine, morning glory, railroad creeper.

The extract of whole plant (flowers, leaves, stems, fruits) showed many therapeutic activities such as antinociceptive, anti-microbial, anti-cancer, anti-inflammatory, anti-oxidant, anti-HIV, larvicidal etc (Deepa Srivastava et al 2015).

*Ipomoea cairica*plant is very similar to *Ipomoeapurpurea*, *Ipomoeaindica* and *Ipomoeahederacea*species of*Ipomoea*. There is following difference between these species (Queensland Government, 2018):

(a) *Ipomoeacairica* has glabrous stems, leaves have five to sevenlobe,5-8 cm long flowers, sepals 4-7 mm long and it contain capsules with four seeds.

(b) *I. indica* has pubescent stems, heart-shaped leaves with 3 lobed, seven to ten cm long flowers and 14-22 mm longsepals.

(c) *I. purpurea* has stems and leaves like *I. indica*. Flowers are 3-7 cm long, sepals are 10-15 mm long and capsules with six hairless seeds.

(d) I. hederacea has stems and leaves like *I. indica*. Flowers are 3-5 cm long with 20 mm long curved sepals and capsules are similar to *I. purpurea*.

2. Chemical constituents

Ipomoea cairica has been use from traditional time as nutritional, medical agent, rituals and in agriculture. The aerial part of *Ipomoea cairica* contains coumarins, lignans and trachelogenin (Olga et al., 1997). Indole alkaloids are also isolated from the leaves (Mohamed andKarawya, 2010).

The plant extract of *Ipomoea cairica*showed the presence of various glycosides, alkaloids, flavonoids,esters,reducing sugars, fatty acid, alcohol and tannin. The leaves extract contains hexadecanoic acid, saponins, stearic acid, 1, 2 diethyl phthalate, phenolic compounds, n-octadecanol, octacosane, hexatriacontane, tetracontane, 3-diethylamino-1- propanol, xanthoproteins and flavonoid (Ikeda Kyoko et al 2003, Afifi M.S. et al 1998, Tirkey K et al 1988, Adsul Vaishali et al 2009, Khatiworal E et al 2010).The most common biologically active constituents of *Ipomoea cairica*areshown in **Table 1.**

Table1. Chemical constituents present in extract of *Ipomoea cairica*

S. No.	Chemical Constituents	*Ipomoea cairica* Leaves			*Ipomoea cairica* Flower		
		Pet ether	Chloroform	Methanol	Pet ether	Chloroform	Methanol
1.	Alkaloids	-	-	+	-	-	-
2.	Sterols	+	-	+	+	+	+
3.	Flavonoids	+	+	+	-	-	+
4.	Gums	-	-	-	-	-	-
5.	Reducing sugars	-	+	-	-	+	+
6.	Tannins	-	-	+	-	-	+
7.	Saponins	-	-	+	-	-	+
8.	Terpenoids	+	+	-	+	+	-
9.	Anthraquinones	-	+	+	-	-	-
10.	Glycosides	+	+	-	+	+	-
11.	Phenols	-	-	+	-	-	+
12.	Amino-acids	-	-	-	-	-	-

The extract of*Ipomoea cairica* tuber had showed the presence of saponin, cyanogenic glycoside, flavonoid, alkaloid, tannin, carbohydrate, protein, lipid and fibre. The tuber of*Ipomoea cairica*are used as a substitute for carbohydrate foods like yam and cocoyam (OHN GODSON N et al 2021**)**.

3. Biological Activity

Ipomoea cairica extract having several medicinal properties showed in **Figure 1.**

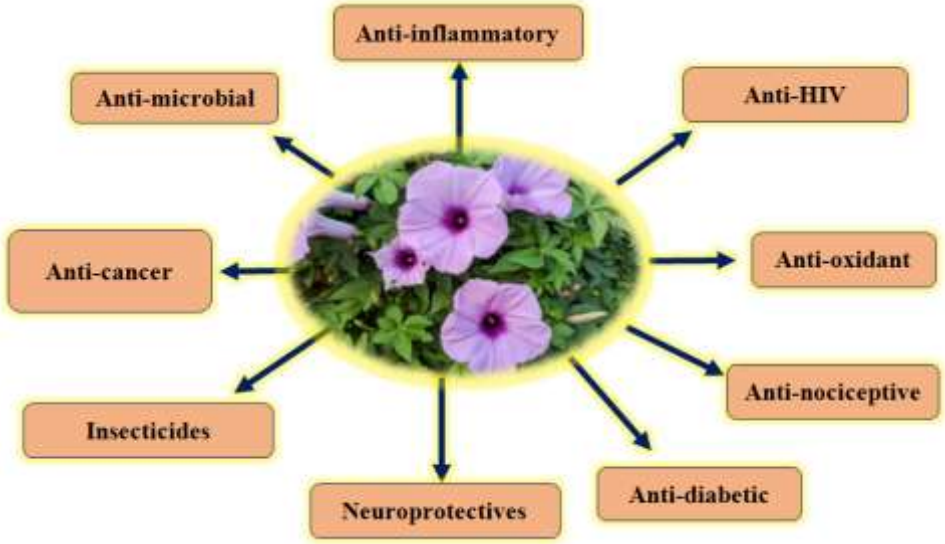
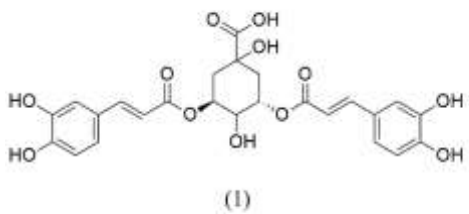


Figure 1: Medicinal Properties of*Ipomoea cairica*

3.1. Anti-nociceptive/Anti-inflammatory activity

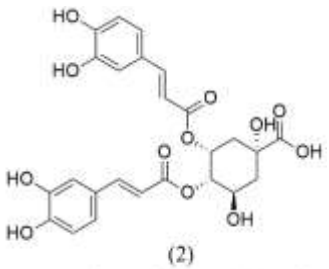
In chronic inflammation condition generally used steroidal and non-steroidal anti-inflammatory drugs, but these drugs are not potent as much difficult to manage the inflammation. Development of newer and safe approachesfor the treatment of inflammation is needed. The natural compounds obtained from plant are gaining more attention for the treatment of inflammation. Literature review revealed that extract of *Ipomoea cairica* showed potent anti-inflammatory activity (Mohamed S. Karawya et al 2010).

Ethanolic extract of *Ipomoea cairica* reduced inflammation in formalin test in mice. Anti-inflammatory activity increase with increasing dose of extract. This extract contained3,5-di-O-caffeoylquinic acid **(1)**and 4,5-di-O-caffeoylquinic acid**(2)**. Anti-nociceptive effect is due to reduction of histamine release which is dissimilar to carrageenan-induced edema. *Ipomoea cairica*polar extract contains caffeoylquinic acids, which inhibit the release of histamine and showed antinociceptive effect. *Ipomoea cairica* are generally used as anti-inflammatory agent in aetiologies in Brazilian folk drug (A.A. Ferreira et al 2006).



(1)

3,5-di-O-caffeoylquinic acid



(2)

4,5-di-O-caffeoylquinic acid

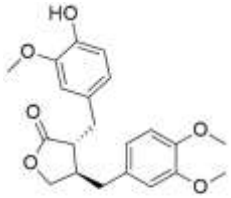
3.2. Anti-cancer

Yu et al 2013 have extracted the aerial parts of *Ipomoea cairica*with ethanol and isolated six glycoresins, cairicosidescompounds. Chemical constituents present in extractare characterization by various chemical and spectroscopy methods. All compoundswere subjected for evaluation of cytotoxicity study against Breast cancer (MCF-7), Cervical cancer (Hela), Gastric cancer (SGC-7901), liver cancer (Hep-G2) and Lung cancer (A549) cancer line. Among them five cairicoside showed potent cytotoxic activity with reference to doxorubicin showed in **Table 2 (**Bangwei Yu et al 2013).

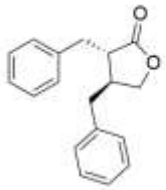
Table 2. Cytotoxicity of five different Cairicosides extracted from aerial part of *Ipomoea cairica*

Cairicosides	MCF-7	Hela	SGC-7901	Hep-G2	A549
Cairicosides 1	7.63	7.17	5.72	6.99	4.28
Cairicosides 2	6.96	6.32	5.94	6.85	4.91
Cairicosides 3	6.01	6.49	6.34	6.24	5.55
Cairicosides 4	6.68	5.78	4.69	6.80	4.46
Cairicosides 5	8.67	14.31	9.29	8.58	6.53
Doxorubicin	0.52	1.62	0.85	0.22	0.16

Lin et al 2008 have reported thecytotoxicity of methanolic extract of the *Ipomoea cairica* against prostate cancer (LNCaP) and Lung cancer (A549) cell line. The dried whole plant*I. cairica*are extracted with methanol at room temperature. Total fourteen different compounds were obtained, which were subjected for cytotoxicity study against LNCaP and A549 cancer cell line by MTT assay. Arctigenin**(3)** and trans-2,3-dibenzylbutyrolactone **(4)** showed potent activity against LNCaP cell line with pIC_{50} value 4.49 ± 0.08 and 5.14 ± 0.01 respectively. Compound 2 also showed potent cytotoxic activity against A549 cell lines with pIC_{50} 5.09 ± 0.01 (RONG-JYH LIN et al 2008).



(3)
Arctigenin



(4)
trans-2,3-dibenzylbutyrolactone

3.3. Anti-oxidant activity:

Arora et al 2013 have reported anti-oxidant property of methanolic extracts of leaves and flower of *Ipomoea cairica*. DPPH method are used to measure anti-oxidant activity with using ascorbic acid as standard. Anti-oxidant activity of extract is increase in dose dependentmanner. At 50µg/ml leaves extract showed 69.23 % activity and flower extract showed 0.322 %. Leaves and flowers extract of *Ipomoea cairica* at 500 µg/ml concentration showed highest anti-oxidant activity 82.58 % and 81.44 % respectively (Shefali Arora et al 2013).

3.4. Anti-microbial/ Antibacterial/Antifungal Activity

Dhule et al 2022 have reported anti-fungal activity of Methanol, Ethanol and Chloroform extract of *Ipomoea cairica*. Extract showed potent activity against *Penicillium notatum, Rhizopus stolonifer* and *Streptomyces griseus* fungi. Methanolic extract showed more potent activity compared to ethanol and chloroform extract. Methanolic extract have MIC value 50, 30 and 40 mg/ml for *Penicillium notatum, Rhizopus stolonifer* and *Streptomyces griseus* respectively (Datta A Dhale et al 2022).

Arora et al 2013 have reported the methanolic extraction of *Ipomoea cairica*leaves and flower. Chemical constituents of methanolic extract were analysed by various chemical test. Chemical tests were identified alkaloids, carbohydrates, tannins, phenolic compounds, proteins, amino acid, terpinoids, sterols and saponinsasphy to constituent. This leaves and flower extract showed potent antimicrobial and anti-fungal activity against bacterial strain *Escherichia coli,Klebsiella pneumoniae, Salmonella typhi, Bacillus subtilis, Staphylococcusaureus* and the fungal strains of *Aspergillus niger, Penicillium chrysogenum, Sacchromyces cerevisiae, Candida albicans*respectively. For antimicrobial activity chloramphenicol and for anti-fungal activity ketoconazole used as standard drug, results of leaves and flower extract are shown in **Table 3 ansd 4** (Shefali Arora et al 2013).

Table 3. Anti-microbial activity of *Ipomoea cairica*leaves, flower extract

S. No.	Organism	Inhibition zone (mm)		
		Leave extract	Flower extract	Chloramphenicol
1.	*E. coli*	22	11	25
2.	*K.pneumoniae*	11	10	16
3.	*B. subtilis*	10	15	26
4.	*S. typhi*	13	11	25
5.	S. aureus	8	13	34

Table 4. Anti-fungal activity of leave and flower extract of *Ipomoea cairica*

S. No.	organism	Inhibition zone (mm)		
		Leave extract	Flower extract	Ketoconazole
1.	*A. niger*	16	14	19
2.	*B. Albicans*	24	18	12
3.	*S. Cerevisiae*	25	21	30
4.	*P. Chrysogenum*	20	18	21

Ipomea cairica leaves are collected, dried in air and extracted in soxhlet apparatus with water and ethanolin 70:30 ratio. Anti-fungal activity of this extract is measured against fungal strain *Candida albicans*, usingamphotericin B as standard anti-fungal drug. Hydroalcoholic extract showed maximum anti-candid activity and may be use in gynaecological disorder (Shweta Shriwas et al 2021).

3.5. Anti-HIV activity

Human immunodeficiency virus (HIV)induced AIDS is presently the most societal challenge in the world, mostly the teen-age and economically creative people are suffer from AIDS. The utilization of phyto-medicines for the treatment of HIV has recently gained more public attention. Currently various plants constituents such as terpenoids, coumarins, polyphenols, tannins, proteins, alkaloids, and bio-flavonoidsare isolate and reported as anti-HIV agent (Abul Barkat et al 2014).

Eich et al 1996 have isolated three lignanolides such (-)-matairesinol**(5)**,(-)-arctigenin**(6)** and (-)-trachelogenin**(7)**from epigeal part of *Ipomoea cairica*. They reported lignanolide (-)-arctigenin as HIV-1 replication inhibitor by suppression of the incorporation of pro-viral DNA into the cellular DNA genome (Eckart Eich et al 1996).

Schroder et al 1990 were isolated (-)-arctigenin**(6)**and (-)-trachelogenin**(7)**lignanolides from *Ipomoea cairica*. Both isolated lignanolides exhibited potent anti-HIV activity. Lignanolides prevent the replication of HIV virus type 1 by inhibition of topoisomerase II enzyme activity. (-)-arctigenin and (-)-trachelogenin inhibited the expression of proteins p17 and p24 HIV-1 protein about 80-90% and 60 -70 %, respectively at a dose 0.5 µM (Heinz C. Schröder et al 1990).

3.6. α-glucosidase inhibitory/ anti-diabetic activity

*Ipomoea cairica*leaves of are extracted with solvent like petroleum ether, ethyl acetate,methanol,and n-butanol. Leaves extract was evaluated for α-glucosidase and α-amylase activity. Ethyl acetate extract showed highest antidiabetic activity due to presence of flavonoids such as ombuin-3-sulphate **(8)**and rhamnetin-3-sulphate**(9)** and kaempferol 7-O-α-L-rhamnopyranoside**(10)**, kaempferol 3,7-di-O-α-L-rhamnopyranoside **(11)** and quercetin 3-O-α-L-arabinopyranoside**(12)Figure2**(Ahmed A Heraiz et al 2023).

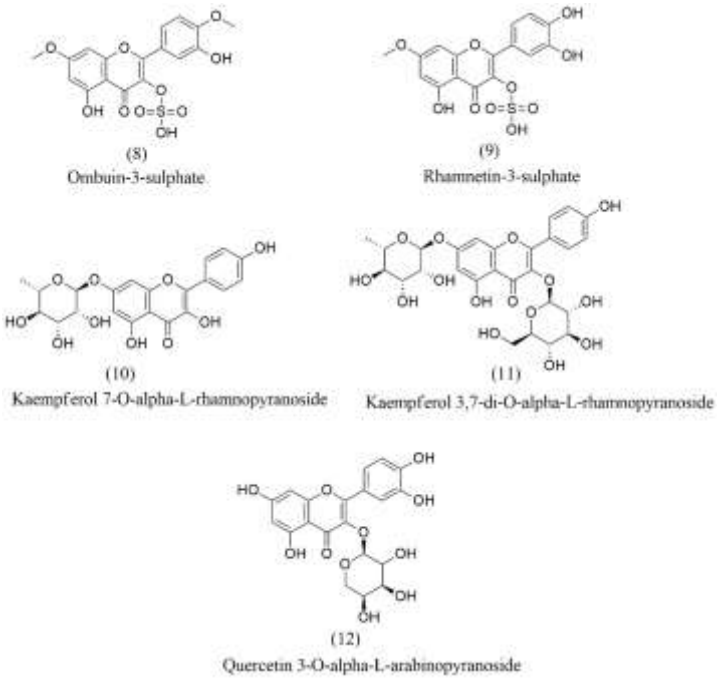
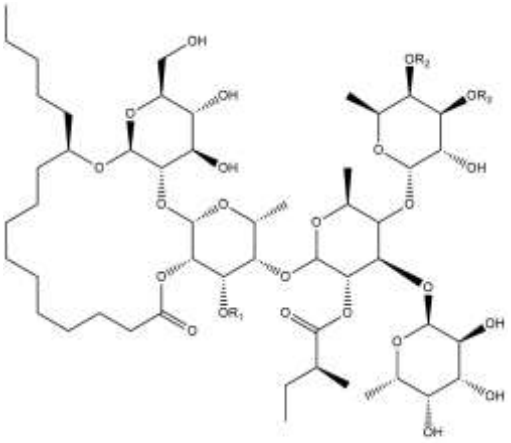


Figure 2: Flavonoids of*Ipomoea cairica* leaves showed α-glucosidase and α-amylase activity

*Ipomoeacairica*aerial part was extracted with 95% ethanol. This crude extract wassubject to column chromatography, HPLC and isolate two glycoside such as cairicoside A**(13)** and cairicoside B**(14)**.Characterization ofisolated compounds by NMR and Mass spectroscopy are reported. Evaluation of α-glucosidase enzyme inhibition action was done by the MTT method using acarbose used as control. Both compounds showed potent α-glucosidase inhibitory action with IC_{50} values 25.3 ± 1.6 and 28.5 ± 3.3 $\mu mol \cdot L^{-1}$(LI Jie-Hong et al 2016).



	R_1	R_2	R_3
(13) Cairicoside A	Deca	Ilu	Cnu
(14) Cairicoside B	Deca	Hexa	Cnu

Pan et al 2015 have isolated six pentasaccharide resin glycosides such as Cairicoside I, CairicosideII, CairicosideIII, Cairicoside IV, CairicosideA and CairicosideC was isolated from aerial part of *Ipomoea cairica* using ethanol as solvent. Four compounds showed potent inhibitory activity against α-glucosidase with IC_{50}21.4 ± 2.9,26.2 ± 4.6, 30.4 ± 3.9, 28.9 ± 1.4μMrespectively (Jie-Tao Pan et al 2015).

3.7. Insecticides (Mosquitoes Larvicidal activity)

Due to drawback of chemical insecticides, development of insecticides from plant phytoconstituents has become anareaofinterest. Mosquitoes are most dangerous insects in the planet; they could spread many deadly diseases in world. Dengue fever is the most common disease

that is spread throughout the world by mosquito's bites. Dengue virus is spreads through infected Aedes genus female mosquito bite.Still, there is no vaccine has been developed to prevent this disease (Tolle MA et al 2009).

Zuharah et al 2017 have extracted leaves of*Ipomoeacairica*by Soxhlet extraction using acetone solvent, this extract showed potent larvicidal activity in*Culex quinquefasciatus*larvae. Leaves, stems and flower buds of plant are collected and air dried at room temperature and make them powder. Powder is extracted by two different techniques maceration and Soxhlationby using two different solvent such as methanol and acetone. Soxhlet extraction provides higher percentage of *Ipomoeacairica* crude extractsin acetone compared to maceration techniques. The larvicidal activity of *Ipomoea cairica* extracts in larvae of *Culex quinquefasciatus* are shown in **Table5 (**Wan Fatma Zuharah et al 2017).

Table 5. LC_{50} value of crude extract of *Ipomoea cairica*in larvae of Culex quinquefasciatus

Methods of extraction	**Extract of *Ipomoea cairic***	**Methanol Extract LC_{50} (ppm)**	**Acetone ExtractLC_{50} (ppm)**
Maceration	Leaves	234.601	129.564
	Stem	235.548	144.533
	Buds	236.604	131.899
Soxhlet	Leaves	143.466	110.653
	Stem	191.494	127.989
	Buds	157.116	113.382

Zuharah et al 2016 have reported insecticidal activity of an ethanolic extract of *Ipomoea cairica* leaves against dengue vectors. This extract decreases the egg production and eggs fertility in Ae. Albopictus vector. In Ae. Aegypti vector less impact was observed. It mainly reduced the thickness of larval head capsule and the wing length of vectors. Considerabledecreasing the number of eggs laid by female mosquitoes was observed in Ae.albopictus mosquitoes (Wan Fatma Zuharah et al 2016).

Ahbirami et al 2014 have extracted the leaves of *Ipomoea cairica*with acetone. This extract was subjected for evaluation of oviposition deterrent activity and ovicidal assayagainsttwo Aedes aegypti and Aedes albopictus dengue vectors in three different concentrations 50, 100, and 450 ppm. Result revealed that leaves extract of *Ipomoea cairica*at100 ppm and 450 ppm concentration inhibited oviposition in Ae. Aegypti and in Ae. albopictus vector with 100% repellence respectively. Similarly, in ovicidal assay leaves extract at 100 and 450 ppm concentration showedzerohatchability for both dengue vector (Ae. aegypti and Ae. albopictus eggs)respectively (RattanamAhbirami et al 2014).

Leaves, flower, and stem of *Ipomoea cairica*were segregated, airdried, powdered, and extracted with methanol and acetone.*Ipomoea cairica* leaves extract in acetone showed most potent larvicidal action in Ae. aegypti vector with 101.94 ppm LC_{50} followed by Ae. albopictus with LC_{50} of 105.59 ppm shown in **Table6**(RattanamAhbiRami et al 2014).

Table 6. Larvicidal activity of *Ipomoea carica*extract against late third-stage larvae of tow vector of mosquitoes

Mosquito species	**Solvent**	**Parts used**	**LC_{50} (ppm)**
Ae. albopictus	Methanol	Leaves	122.12
		Flower	138.45
		Stem	231.3
	Acetone	Leaves	105.59
		Flower	132.47
		Stem	145.79
Ae. aegypti	Methanol	Leaves	114.78
		Flower	152.00
		Stem	238.37
	Acetone	Leaves	101.94
		Flower	105.53
		Stem	132.94

*Ipomoea cairica*flowers and leaves are extracted with pet ether, chloroform, and methanol solvent. Alkaloids,flavonoids, phenols, terpenes, saponins and tannins werepresent in extract. Flower and leaves extract at 500 ppm concentration showed potent larvicidal activity against third instar larvae of C. quinquefasciatus causing 77–100%mortality at 48 h (Lallianrawna Samuel et al 2014).

Ishak et al 2014 extracted the petal, leaves, and root of *Ipomoea cairica*withmethanol separately. Phytochemical analysis of all extract was done by various chemical methods. Petal showed the presence of alkaloid, glycoside, saponin, phenol and flavonoids. Leaves contain alkaloid, saponin, tannins, flavonoids, protein, amino acid and diterpenoids. The root extract of *Ipomoea cairica* contains tannins, flavonoids, protein, amino acid and diterpenoids phytoconstituents. These phytochemicals found in extract was responsible for larvicidalactivity to kill the mosquito's larvae (Kabaru&Gichia, 2009). All three-extract showed potent LC_{50} and LC_{90} values againsttwo different mosquito larvae (**Table 7**) (Ahmad Razali Ishak).

Table 7. Larvicidal activity of *Ipomoea cairica*extract against mosquitos' vector in 24 Hours

Mosquito Species	Extract of *Ipomoea cairica*	LC_{50}(mg/L)	LC_{90}(mg/L)
Aedes albopictus	Petal	31.8	174.4
	Leaves	21.7	118.2
	Root	37.6	114.8
Aedes aegypti	Petal	18.0	180.4
	Leaves	12.2	82.8
	Root	37.5	121.1

Rajkumar S et al 2007 have reported the extraction of essential oils by steam distillation from leaves of *Ipomoea cairica*. This essential oil contains P-cymene and Carvone chemical constituent in major portion. They also evaluated repellent property of essential oil in malarial vector A. stephensi. Six percent concentration of essential oil extracted showed potent mosquito's repellent activity (Rajkumar S et al 2007).

Thomas et al 2004 have reported larvicidal activity of *Ipomoea cairica*essential oil.This oil extract showed larvicidal activity against four vectors of mosquitoes such as Culex tritaeniorhynchus, Aedes aegypti, Anopheles stephensi, and Culex quinquefasciatus at concentrations 100, 120, 120 and 170 ppm respectively (Thekkevilayil George Thomas et al 2004). The Lethal concentration required to kill 90% of the population (LC_{90}) values are reported for all the four vectors in **Table 8**.

Table 8. LC_{90}value of *Ipomoea cairica*essential oil in larvae of four different mosquitos' vector species
ppm: parts per million,

S. No.	Mosquito species	LC_{90} value (ppm)
1.	*Culex tritaeniorhynchus*	78.3
2.	*Aedes aegypti,*	92.7
3.	*Anopheles stephensi,*	109.9
4.	*Culex quinquefasciatus*	161.6

3.8. Neuroprotectives

Ipomoea cairica leaves are collected dried at room temperature and make them powdered. Soaked this powder in 2.5 L (80%) methanol with continuous stirring for about 2 days. Methanol was removed by lyophilization. This methanol free extract administered incadmium chloride treated rats for evaluation of neuroprotective activity. Cadmium chloride increased acetylcholinesterase, lipid peroxidation, beta-amyloid aggregation, caspase 3 and 9, p53, and glutamate in rates.

Ipomoea leaves extract reduced the neuron damage of cadmium chlorideby acting as an anti-oxidant, anti-apoptotic, anti-cholinesterase, and anti-excitotoxicity (Ilesanmi, O.B., et al 2022).

3.9. Anti-oxidant property

Ipomoea cairica flowers was extracted with methanol and evaluated for anti-oxidant activity. This extract showed potent anti-oxidant activity by inhibiting DPPH and hydroxyl radical, nitric oxide and super oxide anion scavenging, hydrogen peroxide scavenging, activities. (Ralte and Lallianrawna, 2014; Arora et al., 2013).

4. Formulation of *Ipomoea cairica*

Dwivedi et al 2022, have prepared herbal cream of root extract of*Ipomoea cairica* for the

treatment of fungal infection of vaginal candidiasis. Aqueous and ethanolic extracts of root are used for formulation of cream by using Stearic acid, Cetyl alcohol, Almond oil, Glycerol, Methyl paraben, Triethanolamine ingredients. Various parameterswere evaluated of prepared cream such as pH, Viscosity, Homogeneity, Spreadibility, Wetness, type of smear and Emolliency. Drug released profile also checked by In-vitro method using UV Visible spectrophotometer. Ethanolic extract showed more potent activity compared to aqueous extract (Sumeet Dwivedi et al 2022).

5. Conclusion

*Ipomoea cairica*weed plant has wide range of medicinal properties. Various parts of this plant contains different chemical constituents which showed various pharmacological activities such as anti-microbial, anti-cancer, anti-HIV, anti-oxidant, anti-inflammatory, anti-diabetic and hepatoprotective. *Ipomoea cairica*also showed herbicide and larvicide properties against different vectors of mosquito. Based on this study it is concluded that *Ipomoea cairica* has a great potency for the designing of newer potent drug moleculeswith various biological activity.

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