Bulletin of Arunachal Forest Research, Vol. 33(2), 01-14: 2018 ISSN 0970-9487

CUPHEA CARTHAGENENSIS: A REVIEW OF ITS ETHNOBOTANY, PHARMACOLOGY AND PHYTOCHEMISTRY

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Abstract

Medicinal herbs and plant extracts are now generally considered as effective medicines to be respected, appreciated and they play a major role in modern health care system. Genus Cuphea is a largest of the 32 genera of Lythraceae family with about 260 species. It is herbaceous perennial small shrubs, native to warm temperature to tropical regions. Commonly they are known as 'Cuphea' and/or 'Cigar plants'. The Cuphea plants are generally used for traditional medicinal value. In native countries, the plants of this species are collected and are used as anti protazoal, blood purifier, diuretic, emmenagogue, hypotensive, laxative, purgative, viral diseases, cardiovascular diseases and menstruation problems. Species of Cuphea are important source of seed lipids, rich in short and median chain fatty acids. In this communication, one of the potential species of this genus *Cuphea carthagenensis* (Jacq.) J.F. Macbr. has been reviewed for their pharmacognostical, ethnomedicinal, pharmacological and phytochemical profile.

Keywords: *Cuphea*, Ethnobotany; Pharmacology; Phytochemical

INTRODUCTION

The Genus *Cuphea* distributed all over the World and used in traditional medicine in many regions. Medicinal herbs and plant extracts are now generally considered as effective medicines to be respected, appreciated and they play a major role in current scenario. It has been widely used in ancient traditional medicine in South and Central America (Graham, 1988). In native countries the plants of *Cuphea pinetorum* are used as an antiprotozoal in Mayan (Calzada et al., 2005). The leaves and stems of *Cuphea glutinosa* are a blood purifier, diuretic, emmenagogue, hypotensive, laxative and purgative (Uphof, 1959). They are used in treatment of high blood pressure, menstrual disorders, pailpitations (Sülsen et al., 2006). *Cuphea aequipetala* is used as antibacterial against *Helicobacter pylori* (Palacios et al., 2013). It is also used as anti-hypertensive (Krepsky et al., 2010) and antinociceptive (Schuldt et al., 2004). It is a potent antioxidant as because it inhibits lipoperoxidation and TNF-α release (Campana et al., 2015). Species of *Cuphea* have been deserved much attention as a potential source of seed lipids rich in short and median chain fatty acids. The seeds oil of some species is very rich in one particular fatty acid i.e. caprylic acid. *Cuphea painteri* oil contains about 3/4 caprylic acid. *Cuphea carthagenensis* oil consists of about 80% lauric acid. *Cuphea koehneana* oil may be the richest natural source of single fatty acids with 95% of capric acid (Graham, 2016). .

Cuphea carthagenensis is a natural herbaceous weed of Lythraceae family, commonly known as 'Colombian waxweed' (Graham, 1975). It is mostly used to treat diseases like hypertension, cardiovascular diseases, fever, viral diseases like herpes etc. *Cuphea carthagenensis* has always been confused with *Cuphea viscosissima* a species native to eastern USA (Graham, 1988; Graham 1975). They can be distinguished by the colour

of the floral tube which is green in *Cuphea Carthagenensis* and the purple-green in *Cuphea viscoissima*. *Cuphea strigulosa*, a species from tropical America, is similar to *Cuphea carthagenensis* which can be distinguished by having creeping, rooting stems (Graham, 1988).

MATERIALS AND METHODS

Extensive literature search has been done using search engine *viz.* Pub Med, Scopus, Web of science and Google Scholar from March 2018 to May 2018, using the term(s) '*Cuphea carthagenensis*'or '*Cuphea'* along with ethnobotany, pharmacology, phytochemical. A range of articles has been retrieved. Some of the important articles have been selected to compile the ethnobotanical, phytochemical as pharmacological indications of the plant.

Plant Profile

Taxonomical classification

Kingdom: Plantae
Phylum: Spermatophyta
Sub Kingdom: Tracheobionta
Super Division: Spermatophyta
Division: Magnoliophyta
Class: Dicotyledonae
Order: Myrtales
Family: Lythraceae
Genus: Cuphea
Species: *Cuphea carthagenensis*
Synonyms: *Lythrum carthagenense*, *Cuphea balsamona*

Common names

Assam: Pani Jetuka
Brazil: Sete-sangrias (Anonymous, 2015g)
Fijian: Kerisi, Lasahia (Smith, 1985)
Spanish: Escobilla (Anonymous, 2015g)
English: Colombian cuphea, Colombian waxweed, Tarweed (Welsh, 1998)

Distribution

The plant is widely distributed worldwide (table 1). It is generally found in Asia, Oceania, South America, North America, Africa, Central America and Caribbean.

Table 1: The distribution of *Cuphea carthagenensis*

Sl.	Country / region	Inva-Sive	Citation
1.	China	Yes	Xu et al., 2012
2.	East Timor	Yes	Acevedo et al., 2015
3.	India		
	Arunachal Pradesh	Yes	Naithan and Bennet, 1990
	Assam	Yes	
	Nagaland	Yes	
	West Bengal	Yes	Paul and Kumar, 2012
4.	Indonesia	No	Anonymous, 2015d; Solfiyeni et al., 2013
	Irian Jaya	No	Anonymous, 2015d
5.	Japan	–	Mito and Uesugi, 2004
	Ryukyu Archipelago	–	Mito and Uesugi, 2004
6.	Malaysia	–	Kiew, 2008
7.	Myanmar	–	Anonymous, 2015c
8.	Philippines	–	Mckaughan and Macaraya, 1965
9.	Singapore	–	Chong et al., 2009
10.	Taiwan	–	Anonymous, 2015e
11.	Cameroon	–	Anonymous, 2015h
12.	Guinea	–	Anonymous, 2015e
13.	Mexico	–	Matuda, 1950
14.	USA		
	Alabama	–	Graham, 1975
	Arkansas	–	Sundell et al., 1999
	Florida	Yes	Graham, 1975
	Hawaii	–	Mann, 1866
	Louisiana	–	Correll et al., 1941
	North Carolina	–	

	South Carolina	–	Ahles et al., 1958
	Texas	–	Correll et al., 1941
	Virginia	No	DeBerry et al., 2007
15.	Barbados	–	Graham, 2003
16.	Costa Rica	–	Anonymous, 2015e
17.	El Salvador	–	
18.	Puerto Rico	No	Loigier and Martorell, 1982
19.	Nicaragua	–	Anonymous, 2015e
20.	Panama	Yes	
21.	Belize	–	
22.	Guatemala	–	
23.	Honduras	–	
24.	Martinique	–	Graham , 2003
25.	Saint Lucia	–	
26.	Argentina	–	Anonymous, 2015e
27.	Bolivia	–	
28.	Brazil	–	Anonymous, 2015e; Barroso, 1954; Anonymous, 2015b
29.	Colombia	–	Barroso, 1954
30.	Ecuador	–	
31.	French Guiana	–	
32.	Guyana	–	Anonymous, 2015e
33.	Paraguay	–	Barroso, 1954
34.	Peru	–	
35.	Venezuela	–	
36.	America Samoa	Yes	Whistler, 1998
37.	Australia	–	Downey et al., 2010
	New South Wales	–	Anonymous, 2015d
	Queensland	–	
38.	Fiji	–	Smith,1985; Franklin et al., 2008; Anonymous, 2015g
39.	New Caledonia	–	Hequet et al., 2009
40.	Samoa	–	Anonymous, 2015a
41.	Tonga	–	Space and Flynn, 2001
42.	Vanuatu	–	Anonymous, 2015g

Morphology

Cuphea carthagenensis is an erect spreading herb up to a foot tall, viscid-pilose with intermixed glandular and non-glandular hairs in the stem (Fig.1). Flowers arises from leaf apex, generally pink in colour, solitary or in small racemes, 4.5-6 mm long, floral tube has glandular hairs. Calyx 6, 3-5 mm in length, green in colour, lobes unequal, short bristle-tipped. Petals 6, slightly unequal (Fig. 2 and 3). Stamens 2-3 mm long, linear-elliptical, pale purple in colour, longer than floral tube. The branches 10-30 cm tall with stiff hairs (Fig. 4 and 5), leaves opposite, subsessile to short petiolate, apex acute base is narrow, hairy and small in size (Fig. 6 and 7). Seeds 3, 2 mm long, lenticular, olive to brown in colour (Graham, 1975).

Environment Impact

Cuphea carthagenensis is occasionally found within undistributed intact natural habitats. When it invades such ecosystem it doesn't seem to effectively displace native species or alter ecosystem functions. This is due to small in size and the low densities of invasion. *Cuphea carthagenensis* may have an effect on some crops but the severity of its impact is not well known. It is an agricultural weed in both in its native and introduced range. It is also found in the roadside rather than in the crop fields in India. It is considered as one of the important weed of crops because of its abundance and competitive effects in Sao Paulo, Brazil (Pio, 1980). In Hawaii, it is recognised as a weed in the cucumber fields (Valenzuela et al., 1994). It is a dominant weed in the puddle rice in Assam, India (Randhawa et al., 2006). In Indonesia, where it dominants corn plantings, it is considered one of the top ten weeds (Solfiyeni et al., 2013). On Vanuatu, it is a serious pest of coconut groves and in pastures (Mullen, 2009).

Resistance to paraquat in taro fields in Fiji, where it is applied as a direct spray between rows (Heap, 2015; Preston, 2015). In Australia, it is a pasture weed. It is also a weed in taro in Fiji (Robert, 1970). In Louisiana USA, *Cuphea carthagenensis* has caused crop impactions in bobwhite quail an important game species (Hurst, 1978). This could indicate hunting yields in South-Eastern USA.

Traditional Indication

In Assam, it is known as 'Pani Jetuka' used as a medicine during menstruation pain. The leaves of the plant are crushed and the juice is taken raw. This procedure of treating pain is practiced in "Karbi Anglong" district in Assam, India. It is used to treat disorders like circulatory disorders, cardiovascular disorders, arterial hypertension, arteriosclerosis etc. It is used also as diaphoretic and diuretic. Leaves decoction of *Cuphea carthagenensis* is taken orally and used for treatment of vaginal infections and weakness (Coe, 2008). *Cuphea carthagenensis* is used as weight control remedy in traditional practice in south Brazil (Dickel et al., 2007).

Phytochemical Profile

It is rich in different phytoconstituents like phenolic, triterpenoids, flavonoids, tannis, unsaturated fatty acids, steroids, polyphenolic compounds, etc., (table 2). Their chemical structures are presented in table 3.

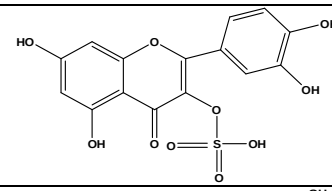
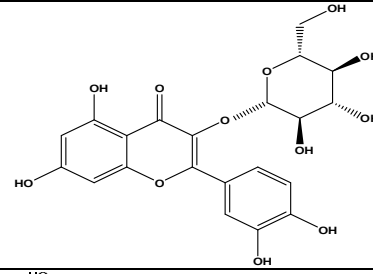
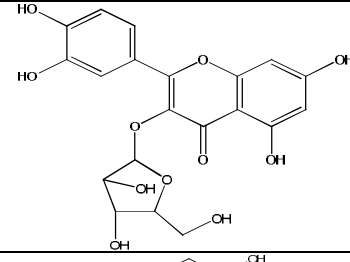
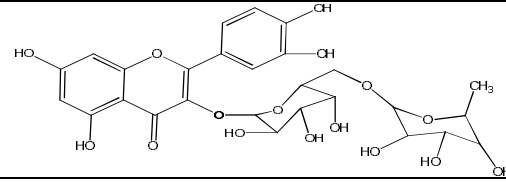
Table 2: Phytochemical and pharmacological actions of *Cuphea* species

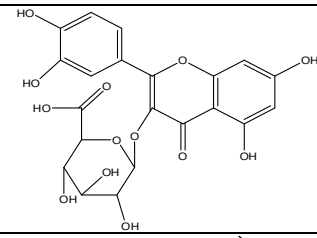
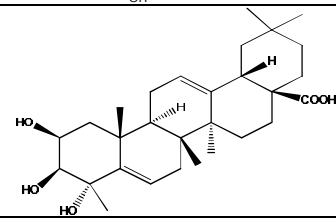
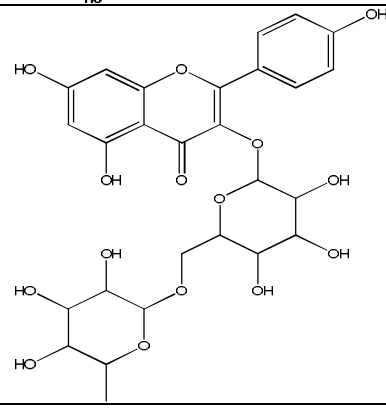
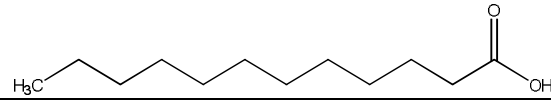
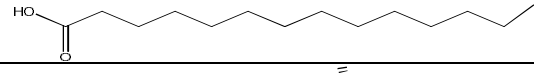
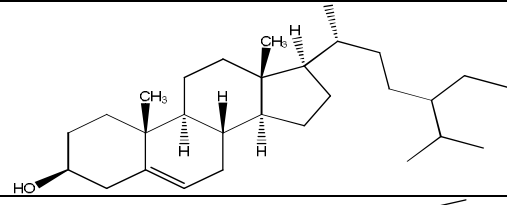
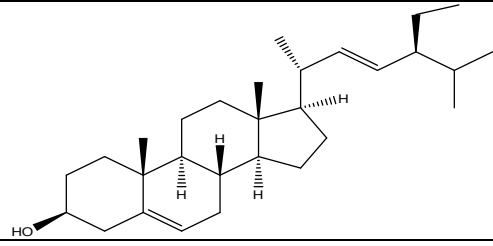
Sl.	Species	Plant part used	Type of extract	Phytochemical	Pharmacological properties	References
1.	*Cuphea aequipetala*	AE	Aqueous	Phenolic; flavonoid	Gastroprotective, Antibacterial	Palacios et al., 2013
2.	*Cuphea glutinosa*	AE	Ethyl acetate, Aqueous	B-sitosterol-3-o-β-glucoside; kaempeferol; quercetin; isoquercetin; gallic acid; methyl ester;	Antioxidant, Treatment of cardiac disorder	Zago et al., 2018
3.	*Cuphea calophylla*	AE	Ethanol, Methanol, Aqueous	Not reported	Anti-oxidant, Anti-inflammatory	Ramirez et al., 2018
4.	*Cuphea pinetorum*	AE, roots	Not reported	Flavonoid glycoside; quercetin-3-o-rhamnopyranoside; luteolin-7-O-glucopyranoside; squalen; β- sitosterol; kaempferol; quercetin	Antiamoebic, Antigiardial activity	Calzada et al., 2005
5.	*Cuphea wrightii*	AE, seeds	Not reported	Friedelan-3-β-ol; ferneol; germanicol; ursolic acid; 3-O-β-glucopyranosyl-β-sitosterol; glucoluteolin; hyperin; mannitol	Respiratory illness	Uphof, 1959
6.	*Cuphea hyssopifolia*	AE	Aqueous, Methanol	Friedelan-3β-ol, ursolic acid; quercetin; quercetin-3-O-α-rhamnopyranoside; 1,2,3,4,6-penta-O-galloyl-β-D-glucose; mannitol; methyl gallate; 1,3-	Antioxidant and Cytotoxic effect	Elgindi et al., 2012; Uphof, 1959

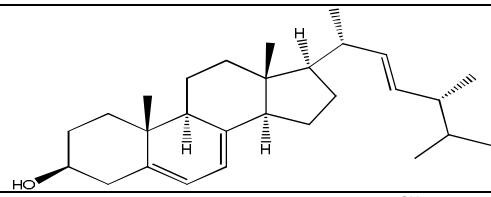
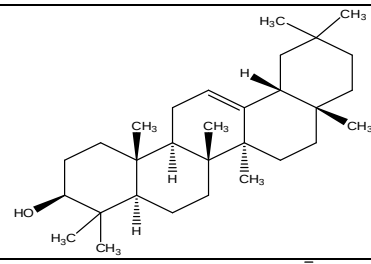
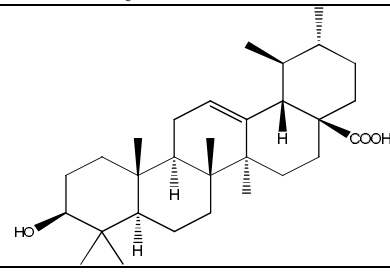
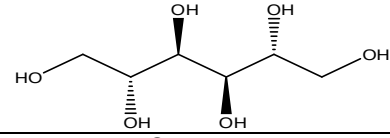
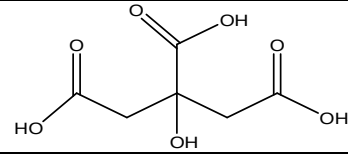
				Odigalloyl-4-6-hexahydroxydiphenoyl – β-D-4C1-glucopyarnose; gallic acid		
7.	*Cuphea ignea*	AE	Aqueous, Ethanol	Phenolic; coumarin	Antioxidant and Anti cancer	Moustafa et al., 2018
8.	*Cuphea palustris*	Seeds	Not reported	Not reported	Accumulation of fatty acids in *Yarrowia lipolytica*	Stefan et al., 2015
9.	*Cuphea aequipetala*	Roots, stems and leaves	Menthol	Phenolic; flavanoid	Antioxidant	Blanca et al., 2012

[Legend: AE- Aerial part]

Table 3: Phytochemical constituents of *Cuphea carthagenensis* and its chemical structures

Sl.	Phytochemical	Structures	Citation
1.	Quercetin-3-sulfate		Krepsky et al., 2010; Isidorio et al., 2012
2.	Quercetin-5-O-β-glucopyranoside		Krepsky et al., 2012; Barbozal et al., 2016
3.	Quercetin 3-O-α arbinofuranoside		Krepsky et al., 2012
4.	Rutin		Barbozal et al., 2016

5.	Quercetin-glucoronide		Barbozal et al., 2016
6.	Triterpenoids		Schuldt et al., 2000
7.	Kaemferol-3-O-rutinoside		Schuldt et al., 2000
8.	Lauric acid		Crane et al., 2006
9.	Myristic acid		Crane et al., 2006
10.	β-sitosterol		Biavatti et al., 2004
11.	Stigmasterol		Lima et al., 2015

12.	Ergosterol		Biavatti et al., 2004
13.	β-amyrin		Coe, 2008
14.	Ursolic acid		Coe, 2008
15.	Mannitol		Coe, 2008
16.	Citric Acid		Lima et al., 2015

Pharmacological Profile

Many of the systematic pharmacological activity has been explored using different types of extracts of *Cuphea carthagenensis* viz. antiviral, antimicrobial and anti-inflammatory, antinociceptive, cardiovascular activities (table 4).

Table 4: Pharmacological profile of *Cuphea carthagenensis*

Sl.	Plant part	Extracts	Phytochemicals	Action	Pro-cess	Model used/ parts of the model	Citation
1.	AP	Aqueous	Quercetin-3-sulfate	No vasorelaxant activity	In-vitro	Pre-contracted rat aortic rings	Krepsky et al., 2010
2	Leaves	Crude hydro	Phenolic	Inhibit deoxy	In -	Rat liver	Schuldt et

		alcoholic	compounds	ribose degradation	vitro		al., 2004
3	Leaves	Butanolic fraction and ethyl acetate fraction	Phenolic compounds	Inhibition of lipoperoxidation	In - vitro	Rat liver	Schuldt et al., 2004
4.	Leaves	Butanolic and ethyl acetate fraction	Phenolic compounds	Vasorelaxant activity	In-vitro	Endothelium intact rings of rat thoracic aorta	Schuldt et al., 2004
5.	AP	Aqueous and alcoholic	Quercetin-3-sulfate, quercetin-5-O-β-glucopyranoside, quercetin-3-O-α arbinofuranoside	Vasodilation	In-vitro	Male wistar Rats (Thoracic aorta)	Krepsky et al., 2012
6.	Leaves	Alcoholic	Flavanol glycosides (kaempferol, quercetin & myricetin); quercetin-5-O-β-glucopyranoside; rutin; quercetin-glucoronide; quercetin-3-sulfate	Reduces arterial thickness; reduces triglycerides; Antiatherogenic effect; Lipid lowering antioxidant	In-vitro	Male New Zealand Rabbits (aorta segment)	Barbozal et al., 2016
7.	AP	Crude hydro alcoholic dichloromethane, Ethyl Acetate & butanolic fraction	Triterpenoids, flavonoids; tannis	Vasodilation	In-vitro	Male wistar rats (thoracic aorta)	Schuldt et al., 2000
8.	AP	Ethanolic extract: Dichloromethane, Ethyl Acetate, butanolic fraction	Polyphenolic compounds; flavanoids	Antiherpes (action against HSV-1 strain Kos)	In-vitro	*Herpes simplex* virus type-1	Andrighetti et al., 2005
9.	Leaves	Aqueous	Steroids; triterpenes	Vasodilation	In-vitro	Lungs and Liver	Biavatti et al., 2004
10.	Leaves	Aqueous	Steroids; triterpenes	Reduction in cholesterolemia; Inhibits HMG-	In-vitro	Rats	Biavatti et a., 2004

				CoA reductase; Reduced plasma albumin			
11.	AP	Aqueous	Quercetin; glycosides	Anti-oxidant; No diuretic action	In-vivo	Male wistar rats	Lima et al., 2015
12.	AP	Aqueous	Not reported	Antinociceptive; Inhibition of TNF-α release	In-vivo	Mice	Campana et al., 2015
13.	AP	Aqueous	Not reported	Antimicrobial and anti-inflammatory	In-vitro	*Staphylococcus aureus* and *Salmonella choleraesuis*	Cesar et al., 2008
14.	AP	Organic and Aqueous	Not reported	Trypanocidal activity	In-vitro	Epimastigote forms of *Trypanosoma cruzi*	Sülsen et al., 2006
15.	Leaves	Aqueous	Not reported	Inhibition of ACE	In-vitro	Angiotensin I-converting (ACE) enzyme	Braga et al., 2000

[Legend: AP- Aerial parts]

CONCLUSION

Cuphea carthagenensis is one of the widely available weedy herbs. Its aerial parts have been used effectively in traditional medicine for antiviral activities, antimicrobial and anti-inflammatory activities, cardiovascular diseases, antinociceptive and also used in weight reduction. Some of the pharmacological reports also reveal its potential relating with available phytoconstituents *viz.* phenolic compounds, triterpenoids, flavanoids, tannis, lipids, unsaturated fatty acids and steroids. Despite of these facts, holistic exploration of *Cuphea carthagenensis* for their traditional potential is not systematically validated. Therefore, this compilation may help in triggering the research community to involve substantially in the investigations using this potential weed to develop safe and cost effective therapeutic lead for the betterment of the mankind.

ACKNOWLEDGEMENT

Authors are grateful to Department of Pharmaceutical Sciences, Dibrugarh University for providing the platform and all the possible resources to carry out the work.

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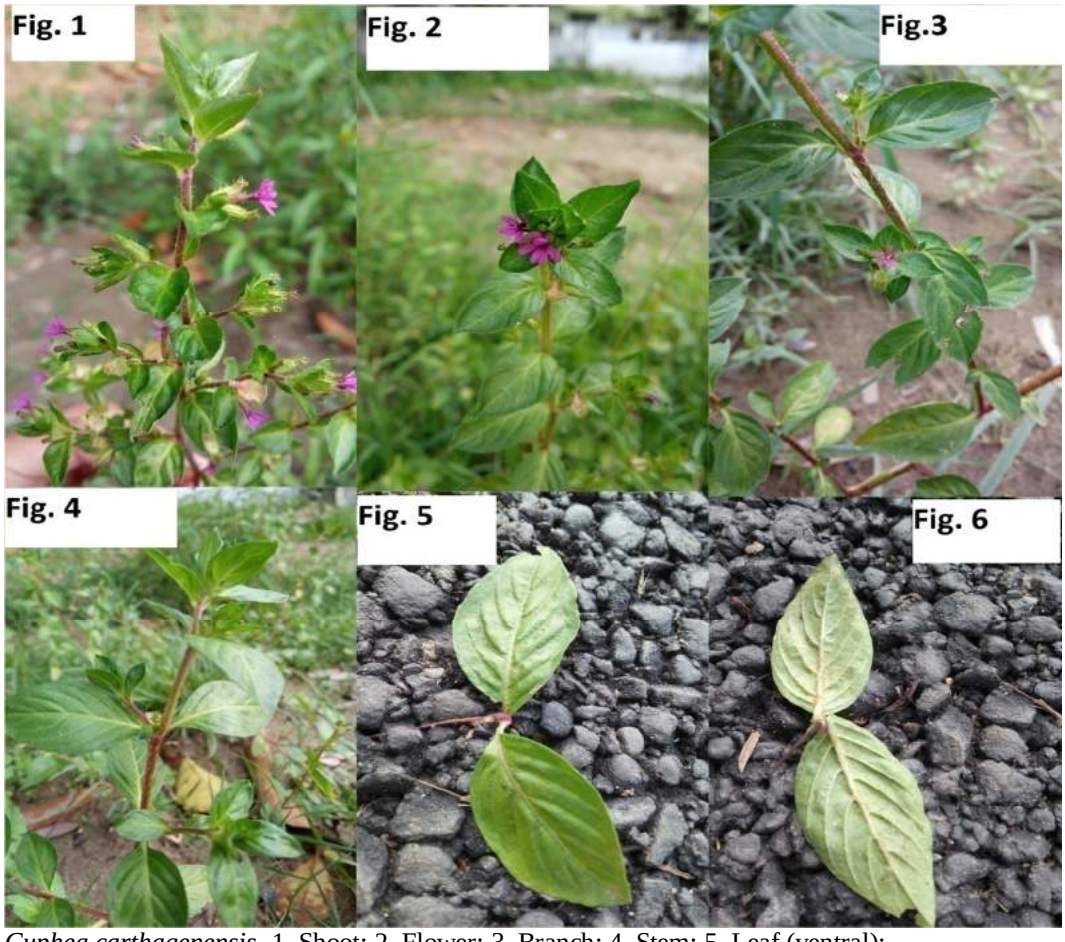
Photo Plate



Cuphea carthagenensis- 1. Shoot; 2. Flower; 3. Branch; 4. Stem; 5. Leaf (ventral); 6. Leaf (dorsal)