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MORPHOLOGICAL, ANATOMICAL AND PHYTOCHEMICAL STUDIES ON A FEW SPECIES OF *IPOMOEA*

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Abstract
Ipomoea are used in different parts of the world for the treatment of several diseases. The present study is an attempt to find out the species diversity, morphological features including vegetative and floral characters, anatomical characters and presence of some phytochemical constitutes. Twelve species of Ipomoea, (I. cairica, I.obscura, I. hederifolia, I. pes-caprae, I. purpurea, I. batatas, I. carnea, I. quamoclit, I. marginata, I. aquatica, I. nil and I. triloba) were used for the present study. Morphological analyses included the study of vegetative parts and floral parts like the number and shape of petals, number of stamens, petal size and the number and arrangement of styles and ovaries. Anatomical features of the stem were observed. Qualitative analysis to detect the presence of phytochemical constituents like proteins, terpenoids, coumatrins, steroids, carbohydrates, saponins, glycosides, and phenols were performed using the leaf extracts of all 12 species of Ipomoea. Considerable variations were observed in the morphological, anatomical and phytochemical characteristics of all the twelve species of Ipomoea.

Key words: *Ipomoea*, phytochemical, treatment

Introduction

Convolvulaceae, the morning glory family comprises nearly 1650 predominantly tropical species. It is defined as a family of twining vines, erect herbs, shrubs, or trees, having alternate leaves and regular pentamerous flowers with plaited corollas. *Ipomoea* is the largest genus in the family Convolvulaceae, with over 600 species. The genus *has* been in continuous use for different purposes, such as, nutritional, medicinal ritual and agricultural (Deepa and Neha, 2020). Several species are known as morning glories and are cultivated as ornamental plants for their attractive flowers. The sweet potato is an important food crop. Some species are used in different parts of the world for treatment of several diseases such as diabetes, hypertension, dysentery, constipation, fatigue, arthritis, rheumatism, hydrocephaly, meningitis, kidney ailments and inflammation.

Phytochemicals protects plants from pathogens and various diseases. Biochemical analysis is done mainly for the identification of phytochemicals. It helps in the qualitative analysis of starch, carbohydrate, steroids, caumarins, phenols, terpenoids contents present in plants. Various species of Ipomoea are used for their content of medical and psychoactive compounds, mainly alkaloids. Some species are renowned for their properties in folk medicine and herbalism.

Materials and Methods

The following materials and the methodology were used in the present study on the floral morphology, anatomy of stem and biochemical analysis of 12 different species of *Ipomoea*.

Materials

Plant materials used

Twelve species of *Ipomoea,* (*I. cairica***,** *I. obscura, I. hederifolia, I. pes-caprae, I. purpurea, I. batatas I.carnea*, *I. quamoclit, I. marginata, I. aquatica, I. nil, I. triloba*) were used for the present study.

Study site and duration

The plant materials in the flowering stage were collected from various places in Kozhikode -

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district, Kerala, during September 2020 to March 2021. Stem samples for anatomical studies were collected from the same plants growing in the same location and used for anatomical studies.

Methods followed

Morphological Analysis

Primary analysis on the vegetative and floral morphology were done from the field itself and photographs were taken. Sample specimens were collected and used for the preparation of herbarium. A field book were maintained to note down the characters obtained during the primary analysis of the specimens. Details like colour of flowers, length of flowers, leaves, pedicel, petiole, stamen, pistil and number of stamens, sepals etc. were noted from the field. The longitudinal sections of flowers were taken.

Anatomical Studies

For anatomical studies, fresh stems were collected from the field, sprayed some water and placed in a polythene bag. Anatomical studies were conducted by taking free hand sections. The microslides prepared were scanned under stereomicroscope and images were captured using attached camera. Stain used was safranin

Phytochemical Analysis

Preparation of Methanolic extract

Leaves collected were dried under shade and powdered. Methanolic extracts from of the dried leaf powders were taken with the help of a soxhlet apparatus. After 4 hours, it is filtered and centrifuged (4 Degree celsius), supernatant kept in hot air oven (30 degree celsius) until methanol was evaporated. The extract obtained after evaporation of methanol was used for biochemical analyses.Extract was transferred to amber coloured bottle and kept at 4 degree Celsius From this different dilutions like 0.05%, 0.1%, 0.2%, 0.3% etc. were prepared according to necessity.

Qualitative analysis

The following eight parameters were used for biochemical analyses.

Proteins

2 ml of 1% extract was mixed with 3 ml of biuret reagent.

Terpenoids

5 ml of Plant extract (1%) was mixed with 2 ml of Chloroform, added 3 ml of concentrated Sulphuric acid along the sides. Noted the Colouration at the junction (Treare & Evan, 1985).

Caumarins

3 ml of 19% NaoH was added to 2 ml of plant extract (1%) and mixed well. Colour was noted (Rizk, 1982)

Steroids

10 mg of the extract dissolved in 10 ml chloroform and equal volume of concentrated sulphuric acid is added along the sides. Colour of the upper and lower layer was noted (Gibbs, 1974).

Carbohydrates

Molisch test: 2 ml of test solution was taken in a test tube & 2 drops of Naphthol was added. About 2 ml of concentrated sulphuric acid was added carefully along the sides.

Saponins

5 ml of extract (1%) was mixed with 20 ml distilled water & was agitated in a graduated cylinder. Presence of foam is observed (Kumar *et al*., 2009)

Glycosides

5 ml of plant extract (1%) was taken, 2ml of Glacial Acetic Acid and 2 ml of 2% ferric chloride solution was added and mixed well. 2 ml of concentrated sulphuric acid was added along the sides. Presence of brown ring at the Interphase was noted (Harborne, 1973).

Phenol

10ml of plant extract 1% was mixed with 5 drops of 2% Ferric chloride solution. The colour change noted (Treare & Evan, 1985).

Results and Discussion

Species Diversity

A detailed description of all the 12 species were made and their vegetative floral characters were summarized intables 1-4.

Morphological studies

During the investigation, 12 species of *Ipomoea* were collected from different localities in Kozhikode district. Morphological details of the species collected were analyzed and recorded (Plates 1-3).

Considerable variations were observed in the morphology of the stem and leaves. Some species showed a glabrous stem (*I. cairica, I. hederifolia, I. pes-caprae, I. quamoclit,* I*. marginata, I. aquatiaca* and *I. triloba*), while some other species showed pubescent nature (*I. obscura, I. purpurea, I. batatas, I. carnea* and *I. nil*). All species except *I. carnea* possessed a soft climbing stem. (Table 1).

Wide variations were observed in the nature of leaves among all the 12 species. (Table 2). Major differences were noted in the case of leaf size, leaf shape, nature of lobes, presence of hairs etc.

In all the species of *Ipomoea* studied, 5 sepals were present mostly arranged in quincuncial aestivation. Quincuncial aestivation is the arrangement in which there are five parts of the flower in which two petals or sepals are positioned internally and two petals or sepals are placed externally and the fifth part is situated externally at the margin. Sepals are typically green and protect the inner floral parts in buds. Petals are typically brightly coloured and assist in attracting pollinators. 5 petals of *Ipomoea* are fused forming a corolla tube. Androecium consists of five epipetalous stamens and gynoecium consists of 5 carpels, present in the syncarpous condition. (Tables 3-4)

Much variations were observed in the colour and size of corolla. Floral characters play a major role in the identification of the species in the case of the genus *Ipomoea*.

A detailed morphometric analysis of the 12 species of *Ipomoea* is required to reveal the phylogenetic relationship among the species.

Anatomical studies

The stem anatomy of *Ipomoea* contains uniseriate epidermis which is covered with cuticle, followed by collenchyma hypodermis, followed by *sclerenchyma* patches which in turn followed by vascular bundles. Anatomical features are represented in Table 5 & Plate 4.

Epidermis of all the species showed similar characters like uniseriate cells, covered with cuticle. Minor variations were observed in the cortical region among all the 12 species studied. Conjoint, collateral, open vascular bundles were observed in all the 12 species. Variations were found in the case of pith. Anyway, all the species showed typical dicot stem characteristics, hence there were no significant differences in the anatomy between the 12 species studied. The detailed knowledge of plant anatomical characters and their variation among closely related taxa is key to understanding their evolution and function.

Phytochemical analysis

Qualitative analysis to detect the presence of phytochemical constituents like proteins, terpenoids, coumatrins, steroids, carbohydrates, saponins, glycosides, and phenols were performed using the leaf extracts of all 12 species of *Ipomoea*. Results of phytochemical analyses are represented in table 6.

In *I. cairica*, all the tested phytochemicals were found to be present. *I. obscura* showed the presence of three phytochemical constituents (proteins, coumarins and phenols). *I. hederifolia* howed the presence of four phytochemical constituents including proteins, steroid, saponins, phenol). *I. pes-caprae* showed the presence all except coumarins and carbohydrates. Proteins, carbohydrates and glycosides were present in *I. purpurea*. All the tested constituents except coumarins, carbohydrates and saponins were present in *I. batatas*. coumarins, saponins and -

steroids were found to be absent in *I. carnea*. Glycosides, phenols and proteins only were found to be presentin *I. quamoclit*. *I. marginata* contained all components except coumarins. Among the 8 phytochemical constituents tested, *I. aquatica* showed the presence of 4 components (proteins, steroids, saponins, glycosides). Terpenoids, coumarins and carbohydrates were absent in *I. nil*. Proteins, steroids and saponins only were found to be present in I. *triloba*..

Among the phytochemical constituents analysed for, proteins were observed in all the 12 species studied. Terpenoids were found only in five species. Coumarins were detected from two species and steroids were found in8 species. Only 4 species were tested positive for carbohydrates. 7 species showed the presence of saponins. All species except three showed the presence of glycosides. Phenols also were found to be present in all except 3 species.

Almost all the species studied showed the presence of phytochemical constituents which have medicinal and nutritive values.

Table 1. Morphological details of stem of 12 species of *Ipomoea*

Sl no	Species	Nature	Soft/woody	Colour	Trichomes
1	*I. cairica*	Climbing	Soft	Green	Glabrous
2	*I. obscura*	Climbing	Soft	Green	Pubescent
3	*I. hederifolia*	Climbing	Soft	Green	Glabrous
4	*I. pes-caprae*	Climbing	Soft	Green	Glabrous
5	*I. purpurea*	Climbing	Soft	Green	Pubescent
6	*I. batatas*	Climbing	Soft	Green	Pubescent
7	*I. carnea*	Erect	Woody	Green	Pubescent
8	*I. quamoclit*	Climbing	Soft	Brown	Glabrous
9	*I. marginata*	Climbing	Soft	Green	Glabrous
10	*I. aquatica*	Climbing	Soft	Brown	Glabrous
11	*I. nil*	Climbing	Soft	Green	Pubescent
12	*I. triloba*	Climbing	Soft	Green	Glabrous

Table 2. Morphological details of leaf of 12 species of Ipomoea

Sl. No.	Species	Petiole	lamina						
		Length in cm	Length in cm	Width in cm	Simple / compound	Entire / lobbed	Shape	Pubescence/ glabrous	Texture
1	*I. cairica*	5.2	7	5	Simple	palmately lobed	ovate	glabrous	Soft
2	*I. obscura*	5	4.2	3.6	Simple	entire	cordate	pubescent	Soft
3	*I. hederifolia*	5	7	6.2	Simple	entire		glabrous	Soft
4	*I. pes-caprae*	12	5	3.8	Simple	bilobed	kidney shaped	Glabrous	leathery
5	I. purpurea	6.	7.2	6	Simple	entire	Cordate	pubescent	Soft
6	*I. batatas*	10	9.2	8.5	Simple	deeply lobed	Ovate	pubescent	Soft
7	*I. carnea*	6.8	8.5	7	Simple	cordate		pubescent	Soft

8	*I. quamoclit*	4	6	4.2	Simple	pinnate		Glabrous	Soft
9	*I. marginata*	3.8	6.4	5	Simple	cordate		pubescent	Soft
10	*I. aquatica*	8.5	8.3	4	Simple		Spear shaped	glabrous	Soft
11	*I. nil*	8	7	2.3	Simple	cordate		pubescent	Soft
12	*I. triloba*	7.6	6.2	4.3	Simple	cordate		glabrous	Soft

Table 3. Morphological details of *Ipomoea*: Floral characters- Calyx & Corolla

Sl. No.	Species	Calyx			Corolla					
		No.	Length in cm	Width in cm	No	Length in cm	Diameter in cm	Colour	Shape	Aestivation
1	*I. cairica*	5	0.6	0.4	5	6.	2	purple	Infundibuliform	twisted
2	*I. obscura*	5	0.3	0.2	5	2.5.	1.5	light yel-low	Infundibuliform	twisted
3	*I. hederifolia*	5	0.2	0.1	5	4.	1.1	red	Infundibuliform	twisted
4	*I. pes-caprae*	5	0.4	0.2	5	6	3.3	pink	Infundibuliform	twisted
5	*I. purpurea*	5	2	0.8	5	7.6	3.8	violet	Infundibuliform	twisted
6	*I. batatas*	5	0.9	0.3	5	5.1	2.4	white with purple	Infundibuliform	twisted
7	*I. carnea*	5	0.3	0.2	5	8	3.5	white with pink	Infundibuliform	twisted
8	*I. quamoclit*	5	0.6	0.2	5	6	2.1	red	Infundibuliform	twisted
9	*I. marginata*	5	1	0.5	5	4.8	2.5	pink	Infundibuliform	twisted
10	*I. aquatica*	5	0.4	0.2	5	6	2.2	white with pink	Infundibuliform	twisted
11	*I. nil*	5	2	0.8	5	6.6	3.1	Light blue with white corolla tube	Infundibuliform	twisted
12	*I. triloba*	5	0.5	0.3	5	1.8	0.9	pink	Infundibuliform	twisted

Table 4. Morphological details of *Ipomoea*: Floral characters- Androecium & Gynoecium

Sl. No.	Species	Androecium			Gynoecium				
		No	Filament	Anther	No	Ovary	Position	Style cm	Stigma
1	*I. cairica*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	1.2	2 lobed
2	*I. obscura*	5	Hairless	unequal, dithecous	1	Glabrous	Superior	0.8	2 lobed
3	*I. hederifolia*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	3.2	capitate
4	*I. pes-caprae*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	1.6	2 lobed
5	*I. purpurea*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	2.9	capitate
6	*I. batatas*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	1.9	2 lobed
7	*I. carnea*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	1.2	capitate
8	*I. quamoclit*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	5.8	2 lobed
9	*I. marginata*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	3.6	2 lobed
10	*I. aquatica*	5	Hairy	unequal, dithecous	1	Glabrous	Superior	0.8	2 lobed
11	*I. nil*	5	hairy	unequal, dithecous	1	Glabrous	Superior	2.2	capitate
12	*I. triloba*	5	Hairless	unequal, dithecous	1	Glabrous	Superior	1	Single

Table 5. Anatomical features of *Ipomoea*

no		Epidermis	Cortex	Vascular tissues	Pith
1	*I. cairica*	Uniseriate, covered with cuticle	A layer of chlorenchyma with parenchyma cells.	Conjoint, Collateral,Open	Parenchymatous pith with hexagonal cells.
2	*I. obscura*	Uniseriate, covered with	Patches of chlorenchyma followed by 2-3 layer of	Conjoint, collateral,	Parenchymatous pith
		cuticle, with epidermalhairs	parenchyma cells	open	
3	*I. hederifolia*	Uniseriate, covered withcuticle	A layer of chlorenchyma followed by 3 layer ofparenchyma	Conjoint, collateral,open	Large parenchymatous pith
4	*I. pes-caprae*	Uniseriate, covered with Cuticle	Single layer of chlorenchyma followed by 10-12 layer of parenchyma	Conjoint, collateral, open	Large parenchymatous pith
5	*I. purpurea*	Uniseriate, covered withcuticle	2 layer of chlorenchyma followed by 5-6 layers ofparenchyma cells.	Conjoint, collateral,open	Parenchymatous pith

6	*I. batatas*	Uniseriate, covered withcuticle	A layer of chlorenchyma followed by hexagonal parenchyma cells.	Conjoint, collateral,open	Large parenchymatouspith
7	*I. carnea*	Uniseriate, covered with cuticle, with epidermalhairs	A layer of chlorenchyma followed by 5-6 layers ofparenchyma cells.	Conjoint, collateral,open	Large parenchymatous pith
8	*I. quamoclit*	Uniseriate, covered withcuticle	A layer of chlorenchyma followed by parenchymacells.	Conjoint, collateral,open	Pith made up ofhexagonal parenchyma cells
9	*I. marginata*	Uniseriate, covered with cuticle	Epidermis followed by 10 layers of parenchyma cells.	Conjoint, collateral, open	Large parenchymatous pith
10	*I. aquatica*	Uniseriate, covered withcuticle	Epidermis is followed by hexagonal parenchyma cells	Conjoint, collateral,open	Central hollow pith
11	*I. nil*	Uniseriate, covered with cuticle, with epidermal hairs	A layer of parenchyma followed by hexagonal parenchyma cells	Conjoint, collateral,open	Large parenchymatous pith
12	*I. triloba*	Uniseriate, covered withcuticle	A layer of chlorenchyma followed by parenchymacells.	Conjoint, collateral,open	Parenchymatous pith

Table 6. Phytochemical analysis of leaf extract of *Ipomoea*

Sl. No.	Species Name	Protein	Terpenoids	Coumarin	Steroid	Carbohydrates	Saponins	Glycoside	Phenols
1	*I. cairica* (L.) Sweet	+	+	+	+	+	+	+	+
2	*I. obscura* (L.) Ker Gawl.	+	--	+	--	--	--	--	+
3	*I. hederifolia* L.	+	--	--	+	--	+	--	+
4	*I. pes-caprae* (L.) R.Br.	+	+	--	+	--	+	+	+
5	*I. purpurea* (L.) Roth	+	--	--	--	+	--	+	--
6	*I. batatas* (L.) Lam.	+	+	--	+	--	--	+	+
7	*I. carnea* Jacq.	+	+	--	--	+	--	+	+
8	*I. quamoclit* L.	+	--	--	--	--	--	+	+
9	*I. marginata* (Desr.) Verdc.	+	+	--	+	+	+	+	+
10	*I. aquatica* Forskk.	+	--	--	+	--	+	+	--
11	*I. nil* (L.) Roth	+	--	--	+	--	+	+	+
12	*I. triloba* L.	+	--	--	+	--	+	--	--

Plate 1. (**A-L**): Habit of 12 species of *Ipomoea*:
A: *I. cairica***, B:** *I. obscura,* **C:** *I. hederifolia,* **D:** *I. pes-caprae,* **E:** *I. purpurea,* **F**: *I. batatas*
G:*I.carnea***, H:** *I. quamoclit***, I:** *I. marginata***, J:** *I. aquatica***, K:** *I. nil,* **L:** *I. triloba*

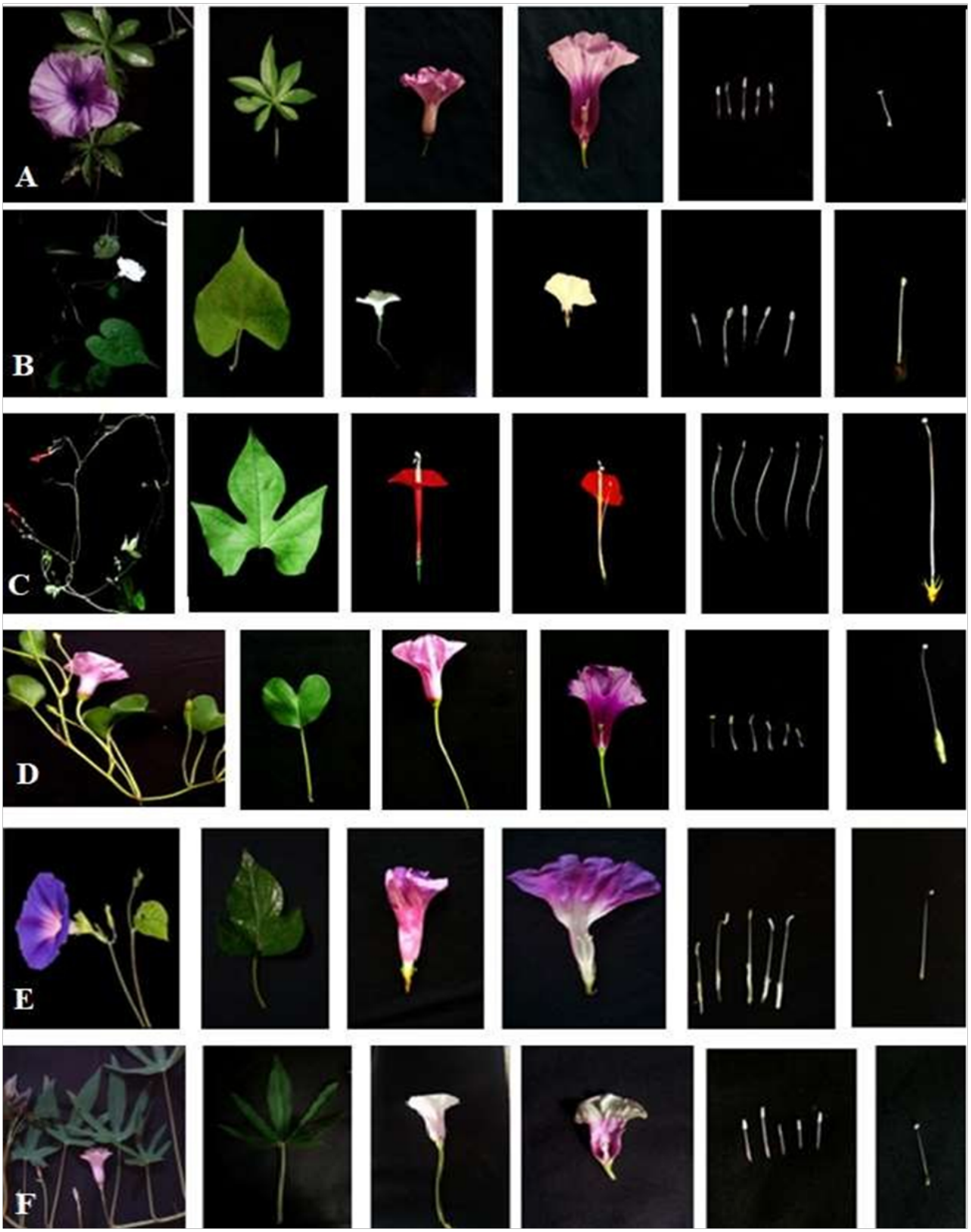

Plate 2. (**A-F**) : Vegetative and reproductive parts of 6 species of *Ipomoea*: (Twig with flower,single leaf, single flower, flower LS, androecium, gynoecium)
A: *I. cairica***, B:** *I. obscura,* **C:** *I. hederifolia,* **D:** *I. pes-caprae,* **E:** *I. purpurea,* **F**: *I. batatas*

Plate 3. (G-L) : Vegetative and reproductive parts of 6 species of *Ipomoea*: (Twig with flower,single leaf, single flower, flower LS, androecium, gynoecium)
G: *I.carnea*, H: *I. quamoclit,* I: *I. marginata,* J: *I. aquatica,* K: *I. nil,* L: *I. triloba*

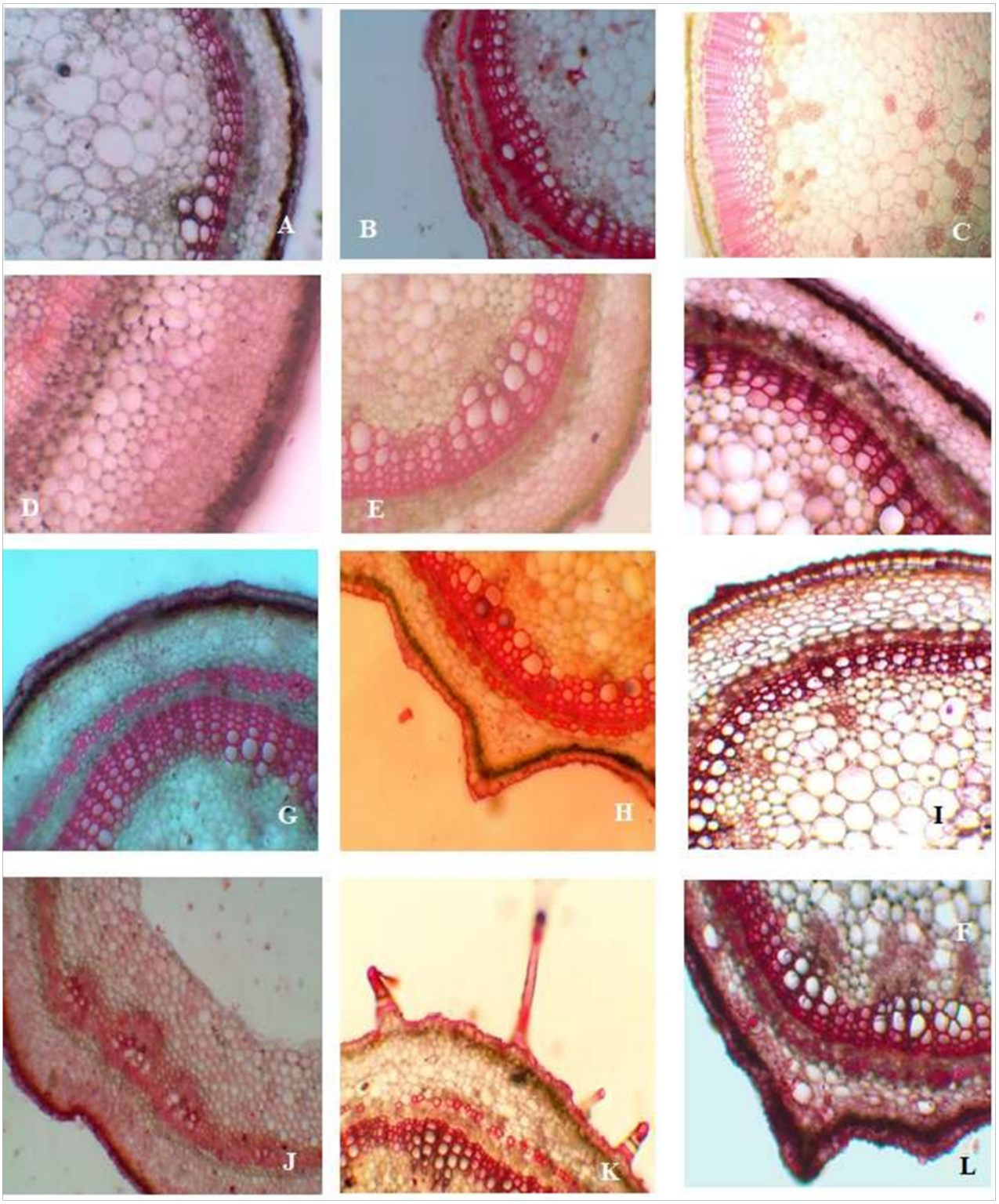

Plate 4. (**A-L**): Stem anatomy of 12 species of *Ipomoea*:
A: *I. cairica*, **B:** *I. obscura,* **C:** *I. hederifolia,* **D:** *I. pes-caprae,* **E:** *I. purpurea,* **F**: *I. batatas*
G:*I.carnea*, **H:** *I. quamoclit*, **I:** *I. marginata*, **J:** *I. aquatica*, **K:** *I. nil,* **L:** *I. triloba*

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