# PHYTOCHEMICAL AND BIOLOGICAL STUDIES ON CERTAIN *IPOMOEA* SPECIES BELONGING TO FAMILY CONVOLVULACEAE CULTIVATED IN EGYPT

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## Introduction:

The plant kingdom, for a long time, has been considered as an essential source of many drugs for alleviation and treatment of different diseases.

Despite of the great advances in synthetic drugs, their adverse side effects revived an increasing interest in the traditional systems of medicine which rely heavily on plant sources. Although, for a while, much of the medical community ignored or perhaps disdained plant medicine as old fashioned. Lately the trend in medical science has called out to the return of the natural methods of healing. Therefore, the use of plant products has once again become essential.

Plants belonging to the family Convolvulaceae contains several classes of phytochemical constituents including flavonoids, alkaloids, coumarins, tannins, resin glycosides, anthocyanins and polysaccharides. Genus *Ipomoea* is considered to be the largest genus in this family together with other genera as *Rivea,, Convolvulus, Argyreia*, Cuscuta, and *Stictocardia*[1]

The plants belonging to genera *Convolvulus* and *Ipomoea* are widely spread in different districts in Egypt especially near the canals and in Eastern Desert. Genus *Ipomoea* comprises about 400 species, the most widely spread in Egypt are *Ipomoea palmata* Forsk., *Ipomoea carnea* Jacq. and *Ipomoea tricolor* Cav.

Reviewing the current literature, botanical study was carried out on *Ipomoea palmata* [2] but not on *Ipomoea carnea* and *Ipomoea tricolor*. On the other hand, little work was established on the phytochemistry of the aerial parts of *Ipomoea palmata* Forsk. and the biological or chemical studies of the seeds.

Therefore, it was deemed of interest to carry out:

1- Botanical study including macro and micromorphology of *Ipomoea carnea* Jacq. and *Ipomoea tricolor* Cav. stems and leaves family Convolvulaceae

2- Investigation of the biological activities of the aqueous ethanolic extract of the aerial parts of *Ipomoea palmata* Forsk. family Convolvulaceae to determine whether it provides significant biological interest that might be an added value in pharmaceutical industry.

3- Since nothing was reported regarding the biological activity of the different extracts of the seeds of *Ipomoea palmata* Forsk., it was felt necessary to carry out an intensive biological study including anti-inflammatory, antioxidant and antidiabetic effects of the seed extracts in order to explore its biological importance as part of this work and also to decide future or up-coming work regarding its chemical composition.

4- Preliminary phytochemical screening of the aqueous ethanolic extract of the aerial parts of *Ipomoea palmata* Forsk., *Ipomoea carnea* Jacq. and *Ipomoea tricolor* Cav. family Convolvulaceae.

5- Preliminary phytochemical screening of the aqueous ethanolic extract of different organs (leaves, stems and seeds) of *Ipomoea palmata* Forsk.

6- Phytochemical investigation of the lipid content of the seeds of *Ipomoea palmata* Forsk.

7- Phytochemical investigation of the aqueous ethanolic extract of the aerial parts of *Ipomoea palmata* Forsk. family Convolvulaceae, in order to explore the chemical constituents responsible for the biological activity that might be observed.

# Literature Review:

## A- Family Convolvulaceae:

Family Convolvulaceae (morning glory family) is one of the largest plant families enclosing up to 55 genera and 2000 species. The most important known genera are *Ipomoea*, *Calystegia*, *Convolvulus*, *Rivea*, *Argeria*, *Cuscuta* and *Stictocardia* [1, 3].

Plants belonging to the family Convolvulaceae are distributed in all parts of the world, especially in tropical regions of Asia, America and California; some genera are extended into warm temperate regions.

*Ipomoea batatas* is one of the most widely distributed food plants in tropical and subtropical regions. The tuberous lateral roots are rich in starch and suger, forming the sweet potato [4].

*Ipomoea orizabensis* (Orizaba Jalap, Mexican scammony root) is a convolvulaceous twining plant with a fusiform root. The drug is collected in the Mexican state of Orizaba and is exported from Vera Cruz [1].

## B- Botanical description of family Convolvulaceae:

The family Convolvulaceae includes annual or perennial herbs, often twining more rarely shrubby growing mainly in the warmer parts of the world.The most predominant anatomic features are the presence of latex cells, bicolateral vascular bundles and frequently abnormal vascular development as found in *Ipomoea* [1].

**Leaves**:

Leaves are simple, exstipulate, alternate with entire, lobed or dissected laminae and mostly cordate.

**Flowers**:

The flowers are usually bisexual rarely unisexual, actinomorphic generally pentamerous except the gynaecium, bracteate with bracts usually in pairs, sometimes forming an involucre .The calyx consists of five persistent, imbricate sepals. The corolla is formed of five united campanulate or funnel shaped petals, with five lobes or entire. Stamens are five distinct, epipetalous at the base of the corolla tube and alternate with it. The anther is bilobed, dorsifixed and dehiscing longitudinally. The ovary is superior, bilocular (sometimes 4 locules with a false septum), formed of two carpels (rarely 3-5 carpels). The ovules are erect, anatropous, sessile, 1-2 ovules in each locule and with axial placentation.

The style is usually filiform and simple. The stigma is terminal, capitate and sometimes bilobed. The inflorescence of the convolvulaceous plants are usually compound axillary dichasial cymes, becomes monochasial scorpioid in higher branches.

**Fruits**:

The fruits are septifragally opened capsule. The seeds are albuminous, smooth or hairy; the endosperm is horny and surrounding the straight embryo[5,6,7].

**C-Botanical description of the genus *Ipomoea*:**

Genus ***Ipomoea*** comprises about 500 species. The species belonging to this genus are usually annual or perennial herbs and shrubs. They are twining or climbing plants. The genus *Ipomoea* is represented in the Egyptian flora by the common species viz, *Ipomoea palmata* Forsk. , *Ipomoea carnea* Jacq. , *Ipomoea tricolor Cav. Ipomoea. stolonifera* Gmel. and *Ipomoea pescaprae* Roth.

**The leaves** are usually petiolate, simple with entire or dissected margin e.g. *I. cairica* Hort. Branching forms compound axillary dichasia. The flowers are regulary pentamerous solitary in the leaf axils, with the two bracteoles scale-like or one of them becomes much enlarged in fruit, forming a membranous wing to which the fruit is attached. The corolla is somewhat uniform in shape, with entire or slightly lobed margin, funnel shaped, with five distinct limited strips. The style is solitary, with globose, bilobed stigma. Pollen grains are spherical with spiny exine [4].

**The fruit** is a capsule, dehiscent, usually four seeded. The testa is generally smooth but sometimes warty or hairy.

**The seed** is small, three or four sided with flat ventral surface and dorsal convex surface. The seed has hard fracture, with no odour and taste.

**D- Botanical description of *Ipomoea palmata* Forsk. :**

*Ipomoea palmata* Forsk. is a perennial , twining plant ,widely distributed in Egypt for ornamental purposes.The leaves are deeply palmate-lobed. The plant flowers in June to November, carrying violet funnel shaped corolla.

The main **stem** and old branches are cylindrical, woody, brown in colour and have rough surface. The young branches are herbaceous, green

in colour, slightly hairy and flexible. They break with short fracture. Branching is monopodial. The stem is odourless and tasteless.

**The leaf** is simple, alternate, exstipulate and petiolate. The petiole is long, cylindrical, more prominent on the lower surface and has a groove on the upper surface.The leaf is deep palmate-lobed in shape, with symmetric base. The laminae of each lobe have an acute apex, entire margin and showing reticulate pinnate venation. It is slightly hairy on both surfaces.

**The flowers** are axial solitary or arranged in monochasial scorpoid cymose inflorescence, pedicellate, with violet funnel shaped corolla, with no characteristic odour and taste. The flower is actinomorphic, hermaphrodite. The pedicel is flexible, cylindrical, slightly hairy, green in colour. The calyx is persistent, consisting of five free sepals. The sepals are ovate, with entire margin, symmetric bases and acute apices. They are green in colour and nearly glabrous, with no odour and taste. The corolla is funnel shaped formed of five united (sympetalous).

**The androecium** is formed of five free epipetalous stamens, which are unequal in length, two of them being longer than the others. They are united to the base of the petals. The basal part of the filament is hairy, violet in colour and swollen, while the upper part is filiform in shape, and white in colour. The anther is yellowish white in colour, oblong, basifixed and bilobed. The anther lobes open laterally and disclose yellowish brown pollen grains.

**The gynaecium** shows a superior, bicarpellery and bilocular ovary. Each locule contains two small anatropous basally placented ovules. The ovary is conical in shape, white in colour and carried on yellowish green hypogenous disc. The style is cylindrical, yellowish white in colour, ending with a bilobed stigma.

**The fruit** is simple, dry, dehiscent septifragal capsule and derived from a superior gynacium. It is green in colour, becoming brown on ripening, pedicellate, subglobular in shape with pointed apex and spherical base. The fruit shows five persistent sepals and contains four dark brown seeds densely covered with hairs. The pericarp is thin, smooth and glabrous. It has a short fracture with no odour and taste.

**The seed** is small, dark brown to black in colour and derived from anatropous ovule. It is usually three sided, with two flat ventral surfaces and one convex dorsal surface. The seed is covered with white, long trichomes. The micropyle is represented by a paler scar near the hilum in the central depression of the ventral surface. The raphe is represented by a raised ridge which extends from the hilum at the base to the chalaza at the apex of the seed on the ventral side. The seeds have hard fracture with no odour and taste. Internally, it is albuminous and shows a large straight embryo, which is formed of two wavy cotyledons and small radicle. The embryo is surrounded by a narrow green endosperm. [2]

**Taxonomical classification of *Ipomoea palmata* Forsk., *Ipomoea carnea* Jacq. and *Ipomoea tricolor* Cav.:**

**Kingdom:** *Plantae.*
**Phyllum**: *Angiospermae.*
**Subphyllum***:* *Dicotyledons.*
**Grade**: *Sympetale.*
**Order**: *Convolvulales.*
**Family**: *Convolvulaceae.*
**Genus**: *Ipomoea.*
**Species**: *palmata, carnea, tricolor* [2].

**E- Ecology and distribution of genus *Ipomoea*:**

**1) Geographic distribution:**

*Ipomoea* the largest genus of family Convolvulaceae, comprises about 400 species, widely grown as ornamental plants and present in the warmer parts of the earth e.g. West Mexico, the home of the species, Indian coast and Brazil. Some species are present in southern Europe [4].

**2) Adaptation:**

*Ipomoea* species commonly grow in full sun warm conditions; the soil should be moist to moderately dry, well drained. Morning glory is a perennial plant, but being frost tender, this makes it annual in temperate zones.

Species belonging to the genus *Ipomoea*, are native to tropical Mexico, north and south America, Brazil and Paraguay. They are adaptable to most soils and positions and is drought resistant although the frost tender, when protected, they will reshoot in spring modern day.

**3) Propagation:**

They are propagated from seeds (soaked or nicked), tubers or rooted cuttings. Germination may be assisted by chipping or soaking the seeds before sowing [8].

**4) Ecomonic uses:**

One of the best-known economic products is the sweet potato, which consists of the tubers of *Ipomoea batatas* Poir, a plant widely cultivated in tropical countries. The tubers are usually regarded as roots or stems.

Jalap "*Ipomoea orizabensis*", used in medicine as a powerful purgative; it consists of the dried tubers of *Ipomoea purga* Hayne.Tampico Jalap, derived from *Ipomoea simulans*, is sometimes substituted for true jalap. Another substitute is Brazilian Jalap derived from *Ipomoea tuberosa* "syn. *Merremia tuberose*".

Kaladana or Pharbitis seed, consists of the seeds of *Ipomoea hederacea* Jacq. from India, possesses properties similar to those of Jalap.

Whole roots of *Ipomoea* species are rarely imported, and the drug usually consists of transverse or oblique slices, the outer surface is covered with a greyish-brown, wrinkled cork. *Ipomoea* species are mainly used for the preparation of *Ipomoea* resin. It resembles Jalap in medicinal uses [9].

**5) Traditional uses:**

In the sixteenth century the Spaniards in Mexico reported the use of sacred hallucinogenic seeds known as Ololiuqui. The climbing plant, from which they are obtained, was subsequently identified as *Rivea corymbosa*. Closely related in constituents and action are the seeds of

*Ipomoea tricolor* "*syn.I.violaceae*". The name "Morning glory" is not applied only to *Ipomoea tricolor* but also to a number of other species e.g. *I.purpurea* and to the Japanese Morning Glory, *I.hederacea*. The seeds of *I. hederacea* have been long used in the east as a purgative and were formerly official in the British Pharmacopoeia under the name Kaladana or Pharbitis seed [9].

**F- Biological activities of plants belonging to family Convolvulaceae:**

**1) Hypotensive activity:**

*Ipomoea carnea* leaf extract was studied for its effect on peripheral blood vessels. Resin, β-sitosterol, triacontane and a saponin, probably triterpenoid in nature, were isolated from the leaves. The pharmacological action of the aqueous and alcoholic extracts of the saponin (ipomotocin) were tested in isolated frog heart, frog rectus muscle, rabbit gut, rat uterus and in anesthetized dog. The compounds appear to act directly on peripheral blood vessels [10].

The ether-soluble fraction of *I.digitata* possessed hypotensive and muscle relaxant activity, on injection, it slowed frog heart beat in situ. The amplitude of averge blood pressure of dogs was decreased by 15-20 mm. the amplitude of rabbit jejunum decreased and relaxation of the horn of rat uterus occurred [11, 12].

**2) Antimicrobial activity:**

*Ipomoea alba, Ipomoea muricata, Ipomoea fistulosa*, and *Ipomoea batatas* revealed activity against Gram-positive *Staphylococcus aureus ATCC 25923* and could be used as antibiotics. The alkaloid content of *Ipomoea* seeds varied from one species to another. This could be used as index to differentiate species using TLC finger-printing investigation.

The leaf extract of *I.alba* inhibits the Gram–positive *B.subtilis ATCC 6633* and *Mycobacterium tuberculosis* 607 [13].

From the classical plant *Ipomoea orizabensis*, a complex glycolipid (scammonin I) active against methacillin-resistant staphylococci was characterized [14].

**3) Adenylate cyclase agonistic activity:**

Topical preparations for the treatment of superfacial fat deposits contain extracts of *Ipomoea hederacea*. The compounds are topically applied on areas where fat accumulate to decrease fat deposits. Thus *I. hederacea* seeds were grounded extracted with ethanol-water and the adenylate cyclase agonistic activity of the extracts was assayed on the bases of formation of cAMP from ATP [15].

**4) Antinociceptive activity:**

*Ipomoea pescaprae* is a medicinal plant used in many countries for the treatment of several aliments including inflammation and pain. Lately, the antinociceptive effect of the methanol extract and two of its subfractions obtained from the aerial parts of this plant was studied. Both extracts produced considerable antinociceptive activity against two classical models of pain in mice. The methanol extract has ID50 of 3.8 mg/kg in the writhing test and it also inhibited both phases of pain (neurogenic and inflammatory) in the formalin test, with ID50 values of 37.7, 12.5 mg/kg for the first and second phases [16].

Another study describes the isolation and identification of several constituents from *Ipomoea pescaprae*, results demonstrate that some of these compounds, such as betulinic acid, alpha- and beta-amyrin acetate, isoquercitrin, etc. showed pronounced antinociceptive properties in the writhing test and formalin test in mice [17].