

Review

Received 21 Aug 2011
Accepted 16 Dec 2011
Available online 3 Feb 2012

Keywords:

biological activities
chemical constituents
Convolvulaceae
Ipomoea
review
traditional uses

ISSN 0102-695X
<http://dx.doi.org/10.1590/S0102-695X2012005000025>

Review of the genus *Ipomoea*: traditional uses, chemistry and biological activities

Marilena Meira,^{*,1*} Eliezer Pereira da Silva,² Jorge M. David,² Juceni P. David³

¹Instituto Federal de Educação, Ciência e Tecnologia da Bahia, Campus Simões Filho, Brazil,

²Instituto de Química, Universidade Federal da Bahia, Brazil,

³Faculdade de Farmácia, Universidade Federal da Bahia, Brazil.

Abstract: Approximately 600-700 species of *Ipomoea*, Convolvulaceae, are found throughout tropical and subtropical regions of the world. Several of those species have been used as ornamental plants, food, medicines or in religious ritual. The present work reviews the traditional uses, chemistry and biological activities of *Ipomoea* species and illustrates the potential of the genus as a source of therapeutic agents. These species are used in different parts of the world for the treatment of several diseases, such as, diabetes, hypertension, dysentery, constipation, fatigue, arthritis, rheumatism, hydrocephaly, meningitis, kidney ailments and inflammations. Some of these species showed antimicrobial, analgesic, spasmolytic, spasmogenic, hypoglycemic, hypotensive, anticoagulant, anti-inflammatory, psychotomimetic and anticancer activities. Alkaloids, phenolics compounds and glycolipids are the most common biologically active constituents from these plant extracts.

Introduction

The Convolvulaceae comprise nearly 1650 predominantly tropical species. The genus *Ipomoea*, with approximately 500-600 species, comprises the largest number of species within the Convolvulaceae (Austin & Huáman, 1996). This family is dominated by twining or climbing woody or herbaceous plants that often have heart-shaped leaves and funnel-shaped flowers (Austin, 1997). The genus *Ipomoea* occurs in the tropics of the world although some species also reach temperate zones (Cao et al., 2005). The species of this genus are mainly distributed throughout the South and Central America countries, and Tropical Africa territories (Austin & Huáman, 1996). One of the most noticeable anatomical characteristics of the Convolvulaceae is the existence of cells, which secrete resin glycosides in the foliar tissues and in the roots of the plants. These glycoresins constitute one important chemotaxonomic marker of this family (Wagner, 1973) and are responsible for the purgative properties of some species of the Convolvulaceae (Pereda-Miranda & Bah, 2003). The focus of this review is to provide information on the structures and pharmacological activities of compounds isolated and identified from *ipomoea*.

Material and Methods

The pharmacological activities of compounds isolated and identified from *Ipomoea* were searched through SciFinder that is one search tools. SciFinder retrieves information in databases produced by Chemical Abstracts Service (CAS) as well as the MEDLINE database of the National Library of Medicine. The CAS databases are: CAPLUS (reference database), REGISTRY (chemical structure database), CASREACT[®] (chemical reaction database), CHEMCATS[®] (commercial source database), and CHEMLIST[®] (regulatory database). The data were updated in January 2011, using biological activities or chemical constituents and *Ipomoea* as keywords.

Results and Discussion

Traditional uses

The genus *Ipomoea* since time immemorial have been in continuous use for different purposes, such as, nutritional, medicinal, ritual and agricultural. The knowledge constitutes a rich source of ethnomedical information for effective selection of plants to be evaluated by chemical studies (Pereda-Miranda & Bah, 2003). With regard to these nutritional purposes, it is necessary highlight the importance of the *I. batatas* (L.) Lam. This species originated from Central America, was widely cultivated and consumed almost throughout

the world (Zhao et al., 2005; Bovell-Benjamin, 2007). *I. aquatica* Forsk is consumed as food in Sri Lanka, Hong Kong, Taiwan e China (Prasad et al., 2005a; Malalavidhane et al., 2000). *I. aquatica* is one of the richest sources of carotenoids and chlorophylls (Wills & Azhari, 1996). The leaves of *I. aquatica* contain adequate quantities of most of the essential amino and are comparable to conventional foodstuffs such as soybean or whole egg, indicating the potential of *I. aquatica* for utilisation as a food supplement. Moreover, the leaves of *I. aquatica* are an excellent source of bioelements such as calcium, magnesium, iron, zinc, and copper (Rao et al., 1990). Other species consumed for purposes nutritional are *I. alba* L., *I. albivenia* (Lindl.) Sweet., *I. involucrata* P. Beauv. and *I. leptophylla* Torr.

Several species of the genus *Ipomoea*, as well as, of the Convolvulaceae family have the property of phytotoxicity, which mean suppressing the growth of other plants including invasive weeds. In Mexico, farmers make use of *I. tricolor* Cav. for this purposes (Bah & Pereda-Miranda, 1997).

Due to their content of ergot type alkaloids, several species of *Ipomoea* are used as hallucinogenics. Some of them were used in pre-Columbian times by ancient people to attain a state of mind suitable for divination during religious ceremonies and magical healing practices (Daló & Moussatché, 1978; Taber et al., 1963). Two species of *Ipomoea* are detached in the entheogen use. They are *I. corymbosa* (Rivea corymbosa) and *I. violaceae* L. The seeds these *Ipomoea* were known respectively as “ololiuhqui” and tlitiltzin in Aztecs lingua and they are still used even today by certain natives in Mexico (Halpern, 2004; Daló &

Moussatché, 1978). Today, the ritual incorporates many elements from Catholic religion, including the names given to the plants, such as, “Seeds of the Virgin”, Holy Mary Herb” and “Virgin’s Cloak”. Demonstrating the syncretism with the Christian traditions and that for natives *Ipomoea* species are gift from the gods (Pereda-Miranda & Bah, 2003). To the resemblance of the natives in Mexico, still today, in the candomble, the “father of saint” also uses seeds and leaves of *Ipomoea* species, such as, *I. alba*, *I. pes-caprae* and *I. purpurea* in the preparations that are offered to the adept of the religion, to attain a state of mind suitable for divination in the ceremonial religious (Camargo, 1998).

Various species of *Ipomoea* have been used extensively, in many countries, in the traditional medicine for the treatment of several diseases (Chater 1). The most common use of the roots of *Ipomoea* species is to treat constipation (Pereda-Miranda & Bah, 2003).

Chemistry and biological activities

The phytochemistry of the *Ipomoea* genus has been studied since 1950. Some species of *Ipomoea* showed antimicrobial, analgesic, spasmolytic, spasmogenic, hypotensive, psychotomimetic and anticancer activities. The most common biologically active constituents from these plants (Chart 2) are ergoline alkaloids (1-12), indolizidine alkaloids (13-15), nortropane alkaloids (16-19), phenolics compounds (20-32), coumarins (33-36) norisoprenoids, diterpene, isocoumarin and benzenoids (37-43) flavonoids and antocianosides (44-56), glycolipids (57-102), lignan (103) and triterpenes (104-110).

Charter 1. Traditional uses of *Ipomoea* species.

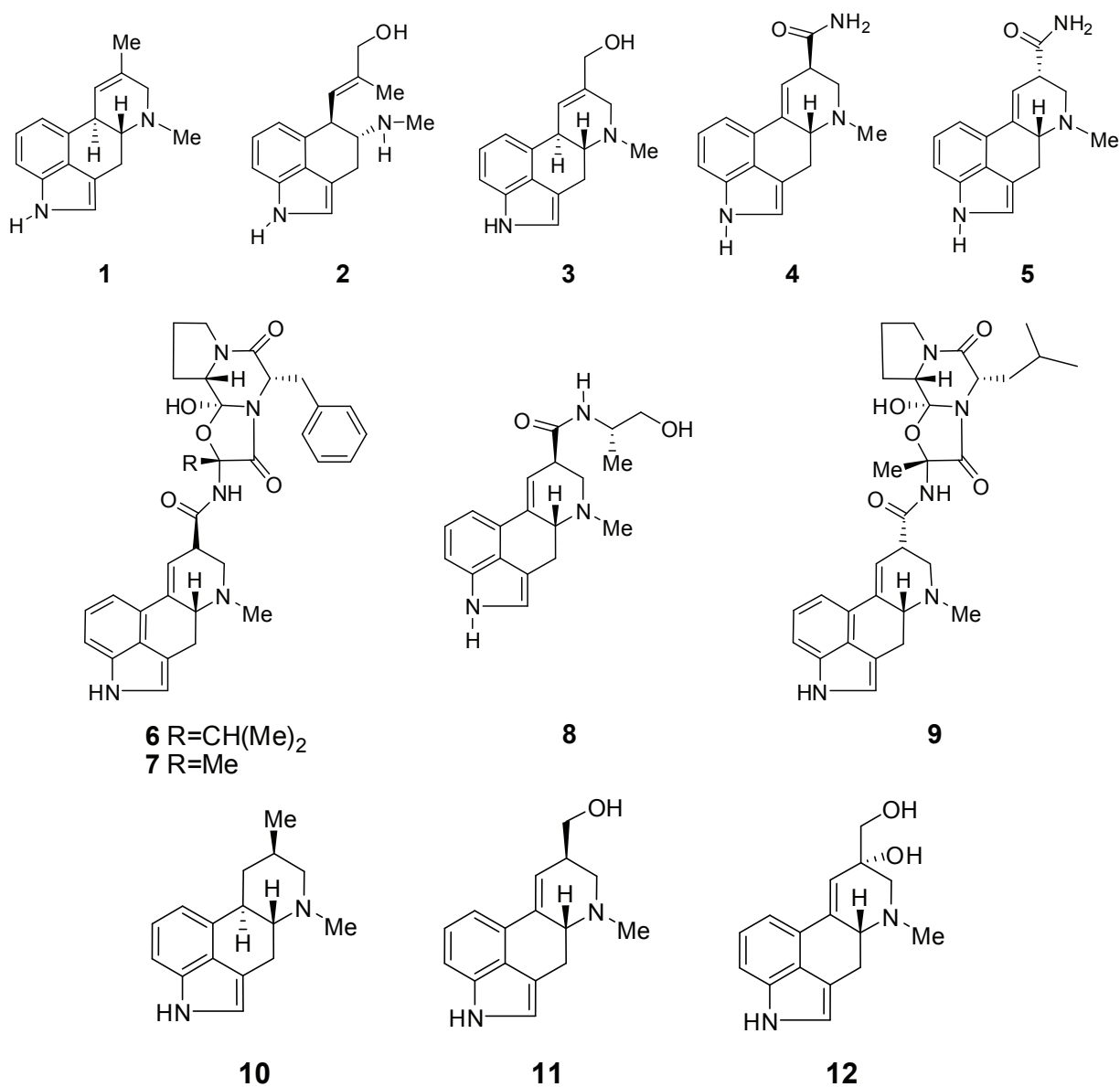
Species	Traditional uses
<i>I. aquatica</i>	Treatment of diabetes (indigenous medicine in Sri Lanka) (Jayaweera, 1982; Malalavidhane et al., 2001). Scorpion venom antidote (Uawonggul, et al., 2006), as emetic, diuretic, purgative, to treating debility, liver complaints, ringworm, leucoderma, leprosy, fever (Ghani, 1989; Mamun, et al., 2003), against nosebleed and high blood pressure (Prasad et al., 2005a).
<i>I. asarifolia</i>	Against itch (Silva, 2002).
<i>I. batatas</i>	Treatment of tumors of the mouth and throat. Leaves decoctions are used as alterative, aphrodisiac, astringent, bactericide, demulcent, fungicide, laxative and tonic. Sweetpotato is used to treating asthma, bugbites, burns, catarrh, ciguatera, convalescence, diarrhea, dyslactea, fever, nausea, renosis, splenosis, stomach distress, tumors, and whitlows (Duke & Wain, 1981). In region of Kagawa, Japan, a variety of white sweet potato has been eaten raw to treating anemia, hypertension and diabetes (Ludvik et al., 2004).
<i>I. cairica</i>	Treatment of rheumatism and inflammations (Ferreira et al., 2006).
<i>I. campanulata</i>	Antidote to snake poison (Singh et al., 2003).
<i>I. carnea</i>	Against Immunodeficiency Syndrome (AIDS) (Thailand) (Woradulayapiniij et al., 2005) and to treat hypertension (Gabon) (Lamidi et al., 2000).
<i>I. digitata</i>	The powdered root is used in emaciation of children and also as tonic, alterative, aphrodisiac, demulcent, lactagogue, and cholagogue. Decoctions of root against constipation (Singh et al., 2004).

<i>I. indica</i>	As purgative and healing broken bones (Hawaii) (Abbott & Shimazu, 1985).
<i>I. leptophylla</i>	The smoke of burned the roots in treatment of nervousness (Native Americans Pawnee) (Gilmore, 1977). The root for stomach distress (Lakota people) and tonic (early European settlers) (Barnes et al., 2003).
<i>I. muricata</i>	To treating several types of skin ailments such as chronic and gangrenous wounds, cuts and blisters due to burns (Philippines). Glycerol preparations of the crude drug of <i>I. muricata</i> are used for the treatment of pharyngitis and an otic preparation for the treatment of otitis externa (Ysrael, 2003).
<i>I. murucoides</i>	The smoke from the burned tree is used against mosquitoes (Mexico). Infusions of the leaves, bark and flowers to treat inflammations and against scorpion bites (León et al., 2005).
<i>I. nil</i>	Treatments against cancer (East Asia) (Ko et al., 2004).
<i>I. orizabensis</i>	As purgative (American and European pharmacopeas) (Pereda-Miranda, 1995), anthelmintic and to treat abdominal fever, dysentery, epilepsy, hydrocephaly, meningitis and tumors (Martinez, 1990).
<i>I. pes-caprae</i>	Treatment of inflammatory and algescic processes (Souza et al., 2000). Heated leaves are used to treating wound, skin infections, inflamed sores and stings from poisonous fish, manta-ray and insects (Australian) (Infusions have been recommended for treating hypertension, kidney ailments and decoctions to treat digestive disorders, colic, internal and external pain, dysentery, inflammations, fatigue, strain, arthritis and rheumatism. The roots are used in diuretic disorders and in constipation (Pereda-Miranda et al., 2005; Lorenzi & Abreu Matos, 2002; Diaz, 1976; Martinez, 1989).
<i>I. purga</i>	As purgative (Pereda-Miranda & Bah, 2003).
<i>I. purpurea</i>	Infusions are used as diuretic, to stop hemorrhage (Bolivia), as purgative and to treat syphilis (Africa) (Camargo, 1998).
<i>I. stans</i>	Infusions of the roots have been used for treating epileptic seizures (Mexico), nephritis, ophthalmic diseases and paralysis, as antispasmodic and sedative agent (Diaz, 1976). As purgative (Pereda-Miranda & Bah, 2003).
<i>I. stolonifera</i>	As diuretic and to treat pain after childbirth, stomach problems, inflammations, furunculosis, swelling and wound (Paula et al., 2003).

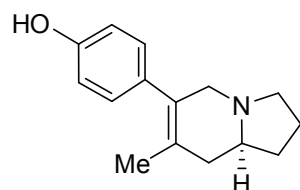
Chart 2. Bioactive compounds from the genus *Ipomoea*.

Substances	Species	Activities
Ergoline alkaloids		
Agroclavine (1)	<i>I. fistulosa</i> <i>I. muelleri</i> <i>I. tricolor</i>	Antimicrobial Cytostatic
hanoclavine I (2)	<i>I. asarifolia</i> <i>I. hederacea</i> <i>I. muelleri</i> <i>I. corymbosa</i> <i>I. tricolor</i> <i>I. violacea</i>	Psychotropic Psychotomimetic
elymoclavine (3)	<i>I. hederacea</i> <i>I. muelleri</i> <i>I. corymbosa</i> <i>I. parasitica</i> <i>I. violacea</i>	Psychotropic Psychotomimetic
ergine (LSA) (4)	<i>I. asarifolia</i> <i>I. muelleri</i> <i>I. corymbosa</i> <i>I. tricolor</i> <i>I. violacea</i>	Psychotropic Psychotomimetic
erginine (5)	<i>I. muelleri</i> <i>I. corymbosa</i> <i>I. tricolor</i> <i>I. violacea</i>	Psychotropic Psychotomimetic
ergocristine (6) ergotamine (7)	<i>I. tricolor</i>	Psychotropic Psychotomimetic

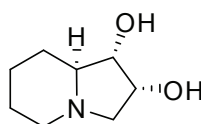
ergometrine or ergonovine (8)	<i>I. muelleri</i> <i>I. corymbosa</i> <i>I. tricolor</i> <i>I. violacea</i>	Psychotropic Psychotomimetic Vasoconstrictor Hemostatic Uterotonic
ergosinine (9)	<i>I. palmata</i>	Uterotonic
festuclavine (10)	<i>I. muelleri</i>	Antimicrobial
lysergol (11)	<i>I. hederacea</i> <i>I. muelleri</i> <i>I. parasitica</i> <i>I. petaloidea</i> <i>I. corymbosa</i> <i>I. violacea</i>	Psychotropic Psychotomimetic
penniclavine (12)	<i>I. hederacea</i> <i>I. muelleri</i> <i>I. corymbosa</i> <i>I. violacea</i>	Psychotropic



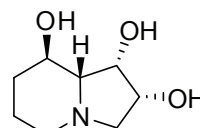
Indolizidine alkaloids		
ipalbidine (13)	<i>I. alba</i> <i>I. muricata</i> <i>I. hardwickii</i>	Analgesic Antioxidant
2- <i>epi</i> -lentiginosine (14)	<i>I. carnea</i>	Potent inhibitory activity toward rat α -mannosidase
swainsonine (15)	<i>I. carnea</i>	Immunomodulatory Antimetastatic Potent inhibitory activity toward rat α -mannosidase



13



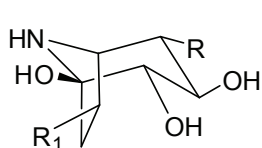
14



15

Nortropane alkaloids		
calystegine B1 (16) calystegine B2 (17) calystegine C1 (18)	<i>I. alba</i> <i>I. aquatica</i> <i>I. batatas</i> <i>I. carnea</i> <i>I. hederifolia</i> <i>I. eremnobrocha</i> <i>I. obscura</i> <i>I. pes-caprae</i> <i>I. setifera</i> <i>I. violacea</i>	Potent inhibitory activity toward rat lysosomal β -glucosidase.
calystegine B3 (19)	<i>I. alba</i> <i>I. aquatica</i> <i>I. batatas</i> <i>I. carnea</i> <i>I. hederifolia</i> <i>I. eremnobrocha</i> <i>I. obscura</i> <i>I. pes-caprae</i> <i>I. setifera</i> <i>I. violacea</i>	Moderate inhibitory activity toward rat α - and β -mannosidases
Phenolics compounds		
<i>N</i> - <i>cis</i> -feruloyl tyramine (20) 21: <i>N</i> - <i>trans</i> -feruloyl tyramine (21)	<i>I. aquatica</i>	Inhibition of prostaglandin synthesis
cafeic acid (22)	<i>I. batatas</i> <i>I. muricata</i>	Antioxidant Antimutagenic
3- <i>O</i> -caffeoyl-quinic acid (chlorogenic acid) (23)	<i>I. batatas</i> <i>I. fistulosa</i>	Hypoglycemic, antimutagenic antioxidant and inhibition of HIV replication
3,5-di- <i>O</i> -caffeoyl-quinic acid (isochlorogenic acid a) (24)	<i>I. aquatica</i> <i>I. batatas</i> <i>I. pes-caprae</i> <i>I. fistulosa</i>	Hypoglycemic, antimutagenic antioxidant and inhibition of HIV replication. Antifungal, antispasmodic Collagenase inhibitory

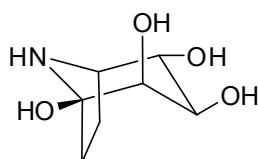
3,4-di- <i>O</i> -caffeoyl-quinic acid (25) (isoclorogenic acid b)	<i>I. aquatica</i> <i>I. batatas</i> <i>I. pes-caprae</i>	Hypoglycemic, antimutagenic antioxidant and inhibition of HIV replication. Collagenase inhibitory
4,5-di- <i>O</i> -caffeoyl-quinic acid (26) (isoclorogenic acid c)	<i>I. aquatica</i> <i>I. batatas</i> <i>I. pes-caprae</i> <i>I. fistulosa</i>	Hypoglycemic, antimutagenic antioxidant and inhibition of HIV replication. Collagenase inhibitory
3,4,5-tri- <i>O</i> -caffeoyl-quinic acid (27)	<i>I. batatas</i>	Hypoglycemic, antimutagenic Antioxidant and inhibition of HIV replication
3,5-di- <i>O</i> -caffeoyl-4- <i>O</i> -coumaroyl-quinic acid (28) 4,5-di- <i>O</i> -caffeoyl-1,3-di- <i>O</i> -coumaroyl-quinic acid (29) 4,5-di- <i>O</i> -caffeoyl-quinic acid methyl ester (30) 3,4-di- <i>O</i> -caffeoyl-quinic acid methyl ester (31) 3,5-di- <i>O</i> -caffeoyl-quinic acid methyl ester (32)	<i>I. pes-caprae</i>	Collagenase inhibitory



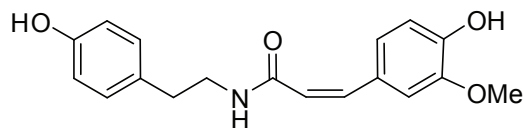
16 R=H; R₁=OH

17 R=OH; R₁=H

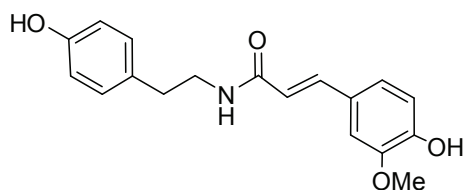
18 R=R₁=OH



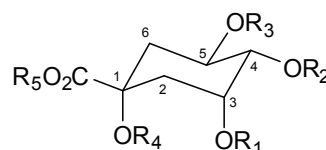
19



20



21



23 R₁=caffeoyl; R₂=R₃=R₄=R₅=H

24 R₁=R₃=caffeoyl; R₂=R₄=R₅=H

25 R₁=R₂=caffeoyl; R₃=R₄=R₅=H

26 R₂=R₃=caffeoyl; R₁=R₄=R₅=H

27 R₁=R₂=R₃=caffeoyl; R₄=R₅=H

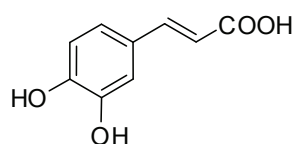
28 R₁=R₃=caffeoyl; R₂=coumaroyl; R₄=R₅=H

29 R₁=R₄=coumaroyl; R₂=R₃=caffeoyl; R₅=H

30 R₁=R₄=H; R₂=R₃=caffeoyl; R₅=Me

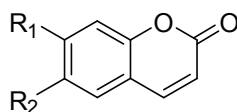
31 R₁=R₂=caffeoyl; R₃=R₄=H; R₅=Me

32 R₁=R₃=caffeoyl; R₂=R₄=H; R₅=Me



22

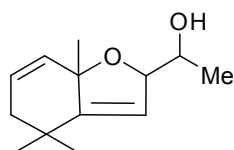
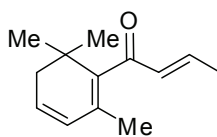
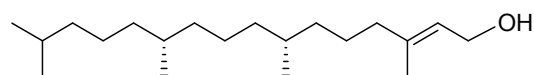
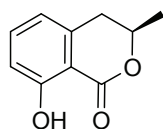
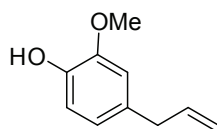
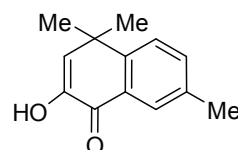
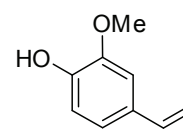
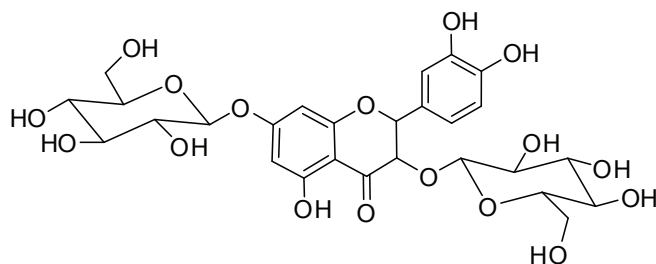
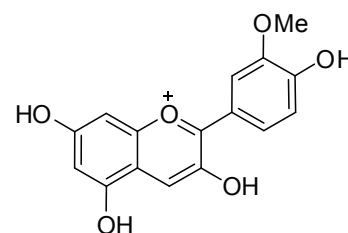
Coumarins		
coumarin (33)	<i>I. turpethum</i>	Cytotoxic, immunostimulant and antiedema
scopoletin (34)	<i>I. batatas</i> <i>I. cairica</i> <i>I. digitata</i> <i>I. stans</i> <i>I. turpethum</i>	Hepatoprotective Spasmolytic Inhibition of prostate cancer proliferation Acetylcholinesterase inhibitory Antioxidant Anticoagulant Anti-HIV
esculetin (35)	<i>I. batatas</i>	Antioxidant Anticoagulant Anti-HIV
umbelliferon (36)	<i>I. batatas</i> <i>I. cairica</i> <i>I. digitata</i>	Anticoagulant Anti-HIV

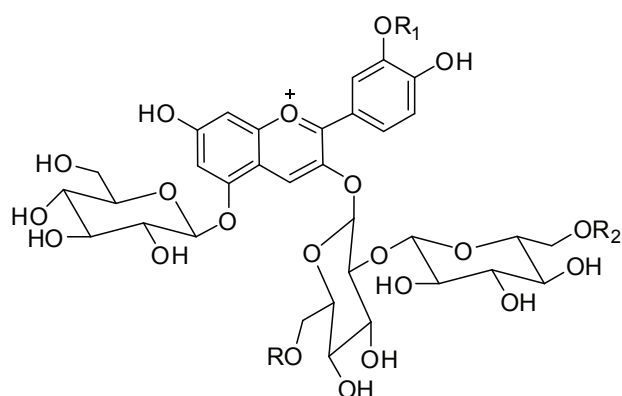


- 33** R₁=R₂=H
34 R₁=OH; R₂=OMe
35 R₁=R₂=OH
36 R₁=OH; R₂=H

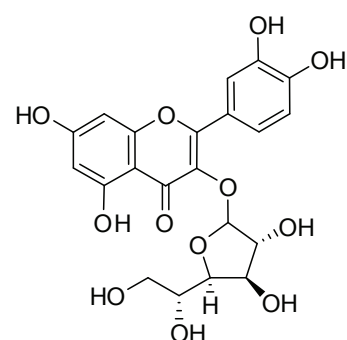
Norisoprenoids, diterpene, isocoumarin and benzenoids		
actinidol (37)	<i>I. pes-caprae</i>	Inhibition of ethyl phenylpropiolate-induced rat ear oedema
<i>trans</i> -β-damascenone (38) E-phytol (39)	<i>I. pes-caprae</i>	Antispasmodic activity
3,4-dihydro-8-hydroxi-3-methylisocoumarin (40) eugenol (41) 4,4,7-trimethyl-1,4-dihydro-2-hydroxy-1-naftalenone (42) 4-vinyl-guaiacol (43)	<i>I. pes-caprae</i>	Inhibition of prostaglandin synthesis
Flavonoids and antocianosides		
3α,7β-O-D-diglycopyranosyl-dihydroquercetin (44)	<i>I. aquatica</i>	Antioxidant; cytotoxic, <i>in vitro</i> .
peonidin (45)	<i>I. batatas</i>	Antioxidant
3-O-(2-O-(6-O-E-caffeoyl-β-D-glycopyranosyl)-(6-O-E-caffeoyl)-β-D-glycopyranosyl)-5-O-β-D-glycopyranoside-cianidin (46)	<i>I. asarifolia</i> <i>I. batatas</i> <i>I. purpurea</i>	Antioxidant
3-O-Sophoroside-5-O-glycosil-cianidin (47)	<i>I. batatas</i>	Antimutagenic
3-O-(6-O- <i>trans</i> -caffeoyl-2-O-β-glycopyranosyl-β-glycopyranoside)-5-O-β-glycoside-cianidin (48) 3-O-(6-O- <i>trans</i> -caffeoyl-2-O-β-glycopyranosyl-β-glycopyranoside)-5-O-β-glucoside-peonidin (49)	<i>I. batatas</i>	Antioxidant

3- <i>O</i> -(2- <i>O</i> -(6- <i>O</i> - <i>p</i> -hydroxybenzoil- β -D-glucopyranosyl))-(6- <i>O</i> - <i>E</i> -caffeoyl)- β -D-glucopyranosyl)-5- <i>O</i> - β -D-glycopyranoside-cianidin (50)	<i>I. batatas</i>	Antioxidant
3- <i>O</i> -(2- <i>O</i> -(6- <i>O</i> - <i>E</i> -feruloyl- β -D-glycopyranosyl))-(6- <i>O</i> - <i>E</i> -caffeoyl)- β -D-glycopyranosyl)-5- <i>O</i> - β -D-glycopyranoside-cianidin (51)	<i>I. batatas</i>	Antioxidant Antimutagenic
3- <i>O</i> -(2- <i>O</i> -(6- <i>O</i> - <i>E</i> -caffeoyl- β -D-glycopyranosyl))-(6- <i>O</i> - <i>E</i> -caffeoyl)- β -D-glycopyranosyl)-5- <i>O</i> - β -D-glycopyranoside-peonidin (52) 3- <i>O</i> -(2- <i>O</i> -(6- <i>O</i> - <i>p</i> -hydroxybenzoil- β -D-glycopyranosyl))-(6- <i>O</i> - <i>E</i> -caffeoyl)- β -D-glycopyranosyl)-5- <i>O</i> - β -D-glycopyranoside-peonidin (53)	<i>I. batatas</i>	Antioxidant
3- <i>O</i> -(2- <i>O</i> -(6- <i>O</i> - <i>E</i> -feruloyl- β -D-glycopyranosyl))-(6- <i>O</i> - <i>E</i> -caffeoyl)- β -D-glycopyranosyl)-5- <i>O</i> - β -D-glycopyranoside-peonidin (54)	<i>I. batatas</i>	Antioxidant Antimutagenic Anti- hyperglycemic
3- <i>O</i> - β -D-glycofuranosyl quercetin (55)	<i>I. pes-caprae</i>	Antinociceptive
heavenly blue anthocyanin (56)	<i>I. tricolor</i> <i>I. nil</i>	Protection against UV-B radiation

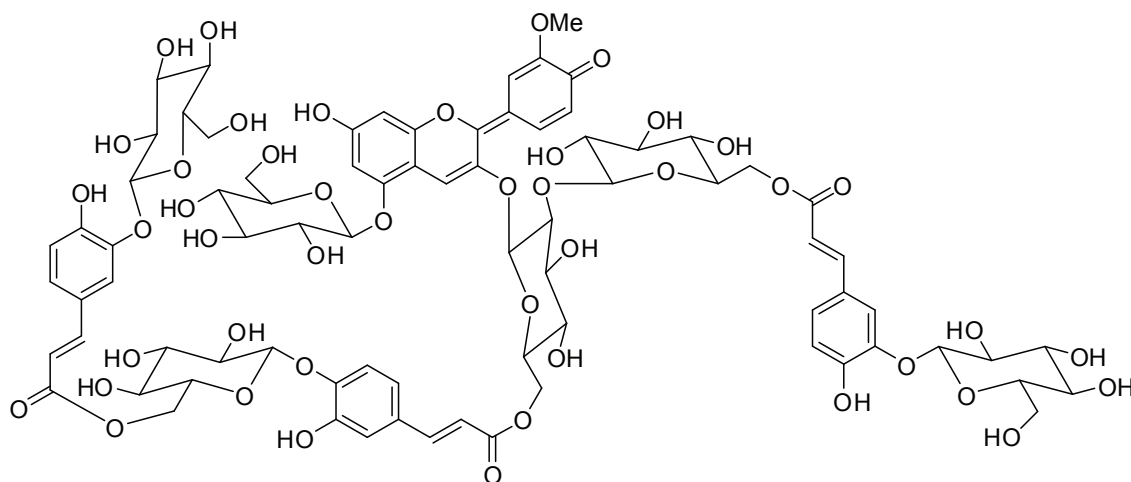
**37****38****39****40****41****42****43****44****45**



- 46** R=R₂=caffeoyl; R₁=H
47 R=R₁=R₂=H
48 R=caffeoyl; R₁=R₂=H
49 R=caffeoyl; R₁=Me; R₂=H
50 R=caffeoyl; R₁=H; R₂=*p*-hydroxy-benzoyl
51 R=R₂=caffeoyl; R₁=Me
52 R=caffeoyl; R₁=H; R₂=*p*-hydroxy-benzoyl
53 R=caffeoyl; R₁=Me; R₂=*p*-hydroxy-benzoyl
54 R=caffeoyl; R₁=Me; R₂=feruloyl



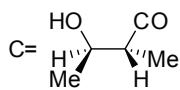
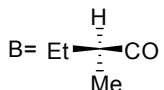
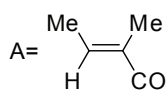
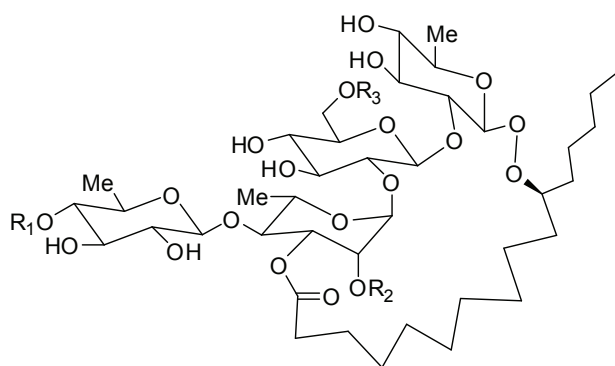
55



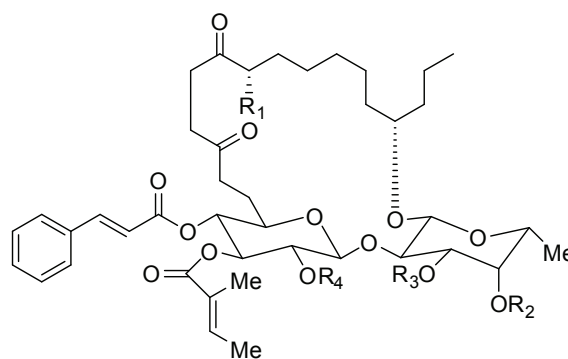
56

Glycolipids		
scammonine I (57)	<i>I. orizabensis</i>	Weak cytotoxicity against oral human epidermal carcinoma. Against methicillin-resistant staphylococcal
scammonine II (58)	<i>I. orizabensis</i>	Weak cytotoxicity against oral human epidermal carcinoma,
ipomoeassins A-E (59-63)	<i>I. squamosa</i>	Cytotoxic against ovarian carcinoma
murucin 1 (64)	<i>I. murucoides</i>	Cytotoxic against ovarian carcinoma
orizabins I-IV (65-68)	<i>I. orizabensis</i>	Laxative
orizabins V-VII (69-71)	<i>I. orizabensis</i>	Weak cytotoxicity against oral human epidermal carcinoma

orizabins IX-XXI (72-84)	<i>I. orizabensis</i>	Cytotoxicity against oral epidermoid carcinoma but weak cytotoxicity against colon carcinoma, squamous cell cervix carcinoma and ovarium cancer
orizabin VIII (85)	<i>I. orizabensis</i>	Weak cytotoxicity against colon carcinoma.
pescaproside A (86) pescapreins I-IV (87-90)	<i>I. pes-caprae</i>	Weak cytotoxicity against nasopharyngeal, colon, squamous cell cervical and ovarian carcinomas
simonin IV (91)	<i>I. batatas</i>	Fitotoxicity
stansin 5 (92)	<i>I. stans</i>	Cytotoxicity against cervical and ovarian carcinomas
tricolorin A (93)	<i>I. tricolor</i>	Fitotoxicity; Cytotoxic against breast carcinoma; Cytotoxicity against oral epidermoid carcinoma and weak cytotoxicity against colon, cervical and ovarian carcinomas Antibacteriana against <i>Staphylococcus aureus</i>
tricolorin B (94)	<i>I. tricolor</i>	Cytotoxicity against oral epidermoid carcinoma and weak cytotoxicity against colon, cervical and ovarian carcinomas. Antibacteriana against <i>Staphylococcus aureus</i> .
tricolorins C e E (95, 96) tricolorins D, F-J (97-102)	<i>I. tricolor</i>	Cytotoxicity against oral epidermoid carcinoma and weak cytotoxicity against colon, cervical and ovarian carcinomas.



57 R₁= A; R₂=B; R₃=H
58 R₁=H; R₂=B; R₃=H



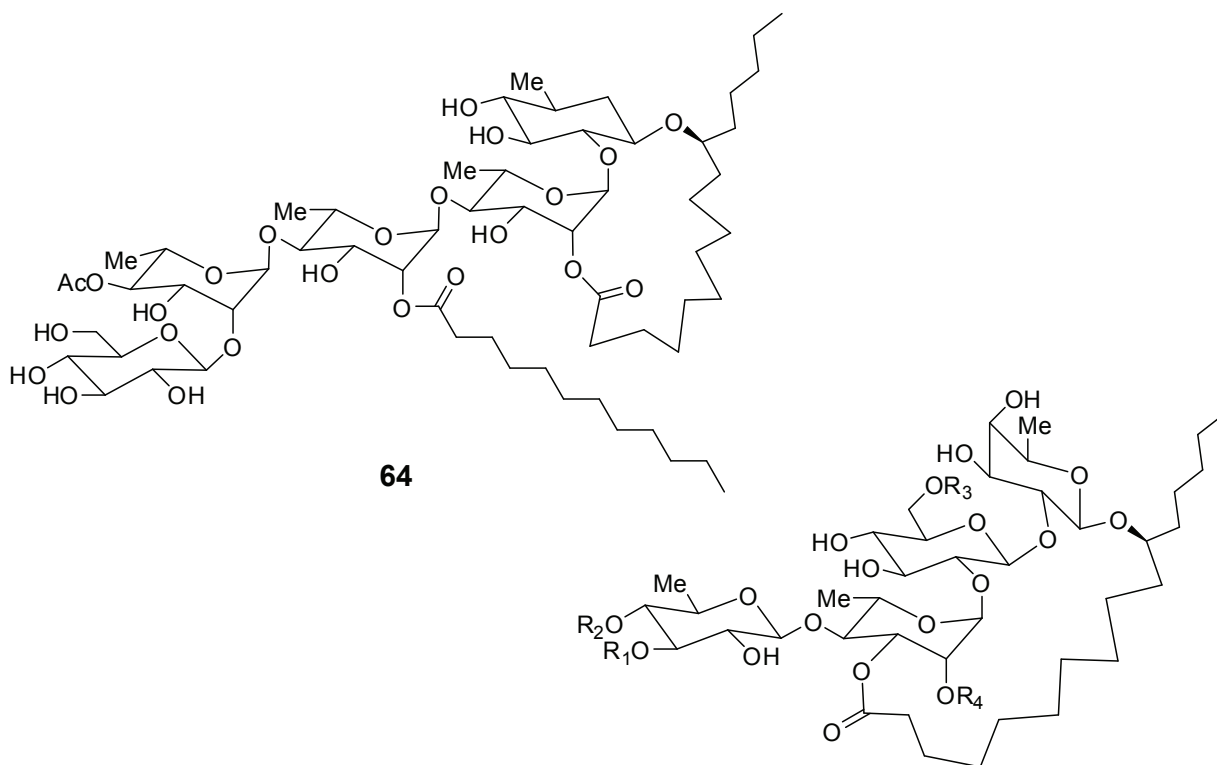
59 R₁=R₃=R₄=H; R₂=Ac

60 R₁=R₂=R₃=R₄=H

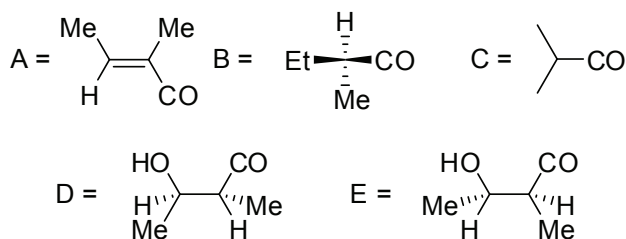
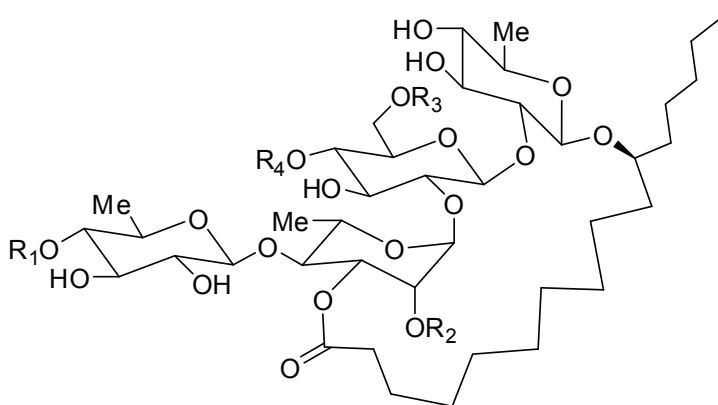
61 R₁=OH; R₂=Ac; R₃=R₄=H

62 R₁=OAc; R₂=Ac; R₃=R₄=H

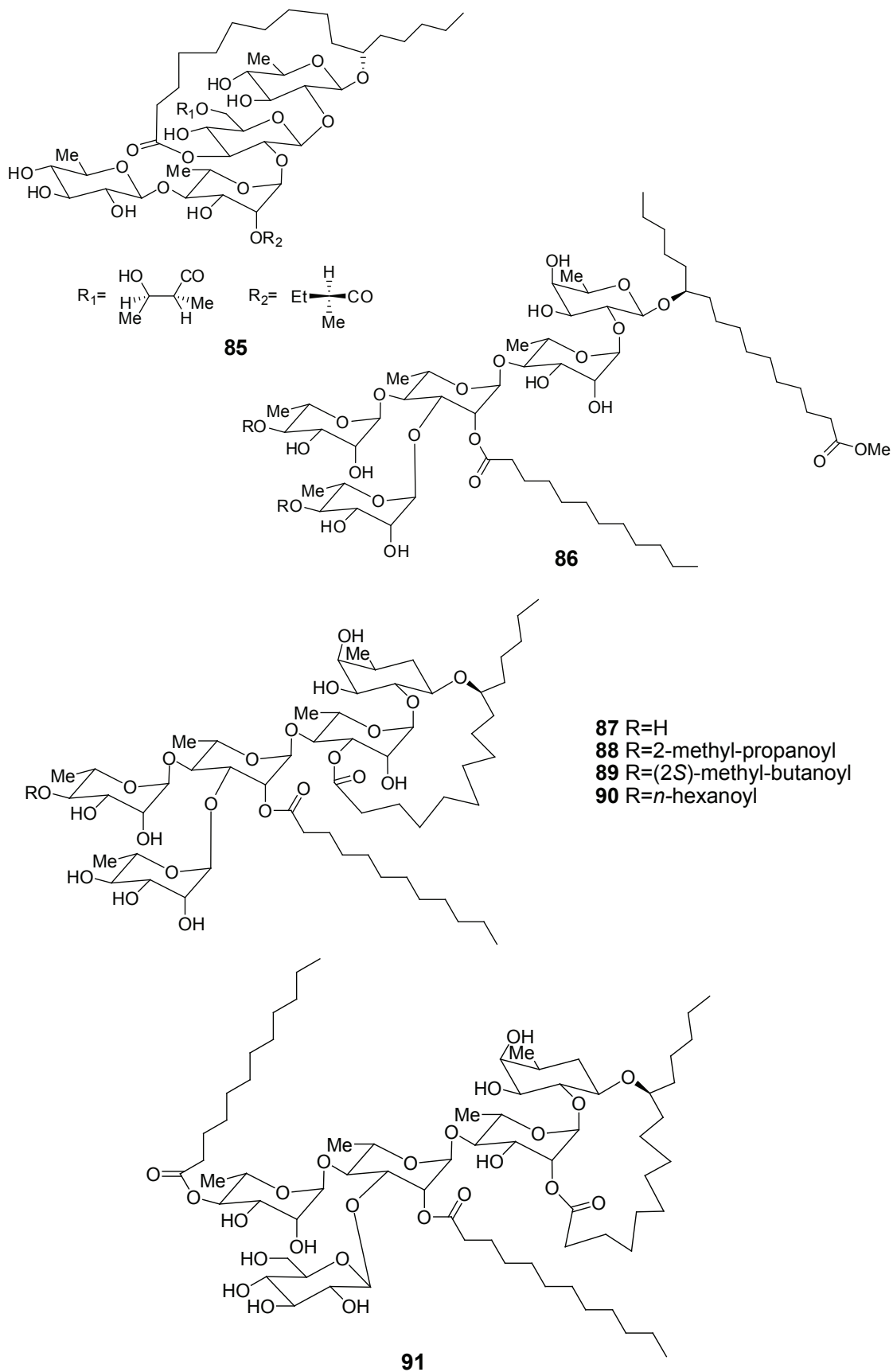
63 R₁=OAc; R₂=R₃=R₄=H

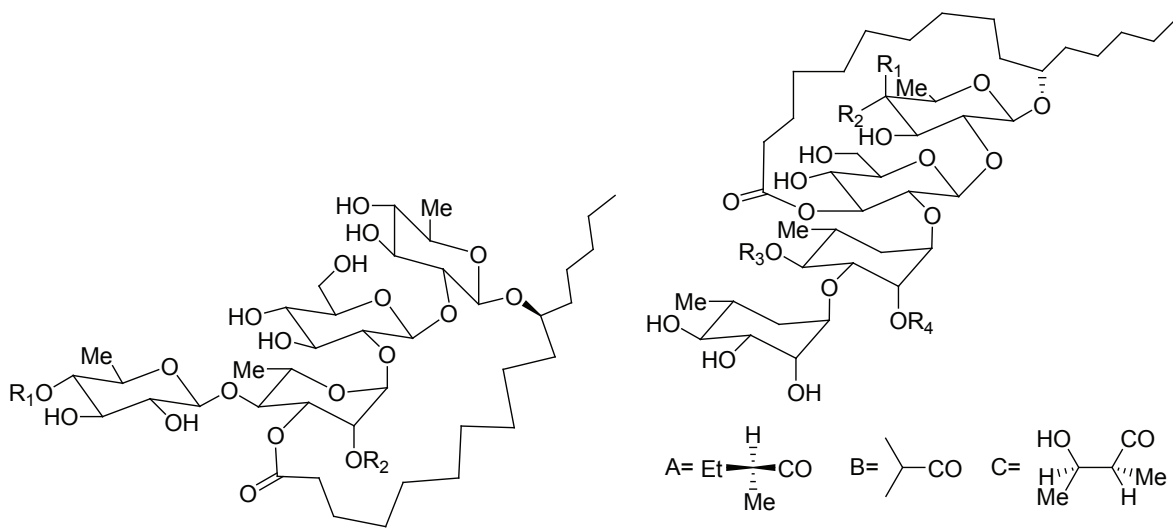


- 65** R₁=H; R₂= α -methyl-butanoyl; R₃=2-methyl-3-hydroxy-butanoyl; R₄=tigloyl
66 R₁=H; R₂=isobutanoyl; R₃=2-methyl-3-hydroxy-butanoyl; R₄=tigloyl
67 R₁=H; R₂=R₃=2-methyl-3-hydroxy-butanoyl; R₄=tigloyl
68 R₁=isobutanoyl; R₂=H; R₃=2-methyl-3-hydroxy-butanoyl; R₄=tigloyl



- 69** R₁=D; R₂=B; R₃=R₄=H
70 R₁=R₄=H; R₂=D; R₃=B
71 R₁=R₄=H; R₂=B; R₃=D
72 R₁=A; R₂=B; R₃=H; R₄=D
73 R₁=A; R₂=D; R₃=C; R₄=H
74 R₁=A; R₂=E; R₃=C; R₄=H
75 R₁=A; R₂=C; R₃=D; R₄=H
76 R₁=A; R₂=C; R₃=E; R₄=H
77 R₁=A; R₂=D; R₃=B; R₄=H
78 R₁=A; R₂=E; R₃=B; R₄=H
79 R₁=A; R₂=B; R₃=D; R₄=H
80 R₁=A; R₂=B; R₃=E; R₄=H
81 R₁=B; R₂=D; R₃=B; R₄=H
82 R₁=B; R₂=E; R₃=B; R₄=H
83 R₁=B; R₂=B; R₃=D; R₄=H
84 R₁=B; R₂=B; R₃=E; R₄=H





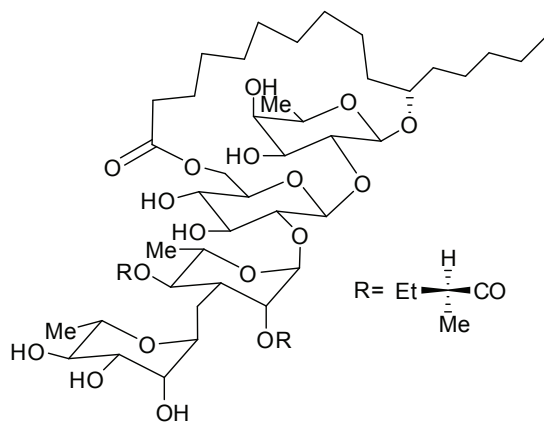
92 $R_1=R_2=2\text{-methyl-butanoyl}$

93 $R_1=\text{OH}; R_2=\text{H}; R_3=R_4=\text{A}$

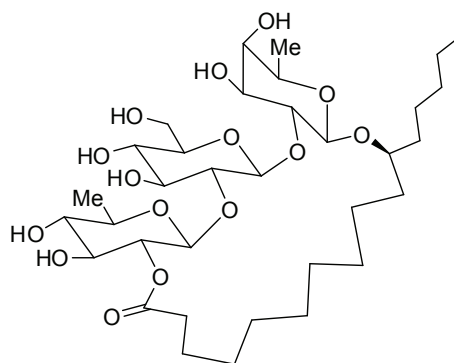
94 $R_1=\text{OH}; R_2=\text{H}; R_3=\text{B}; R_4=\text{A}$

95 $R_1=\text{OH}; R_2=\text{H}; R_3=\text{C}; R_4=\text{A}$

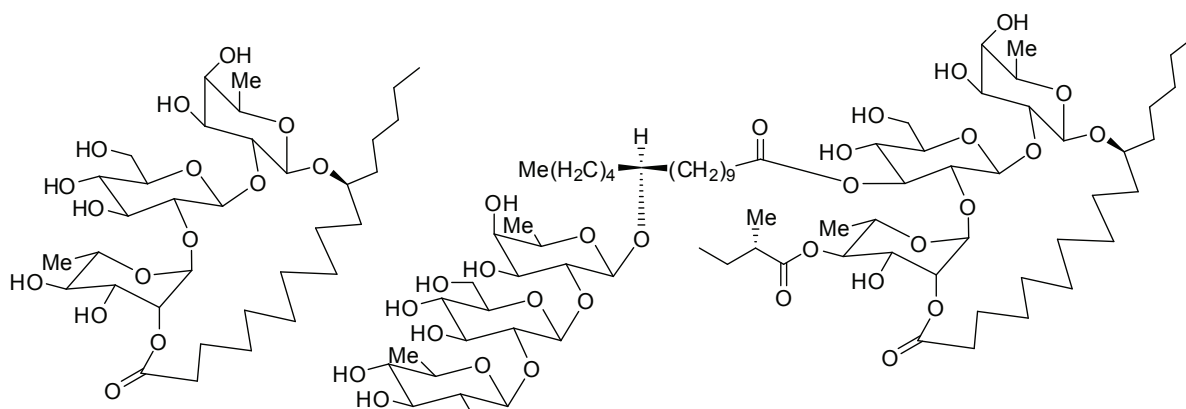
96 $R_1=\text{H}; R_2=\text{OH}; R_3=R_4=\text{A}$



97

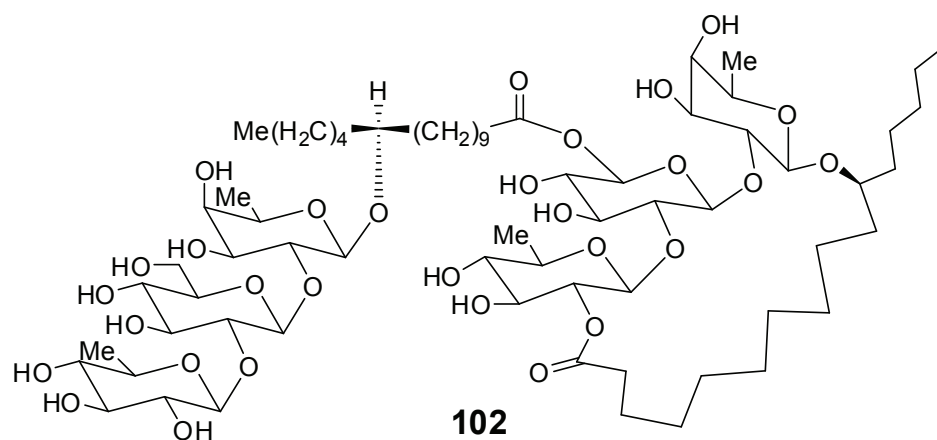
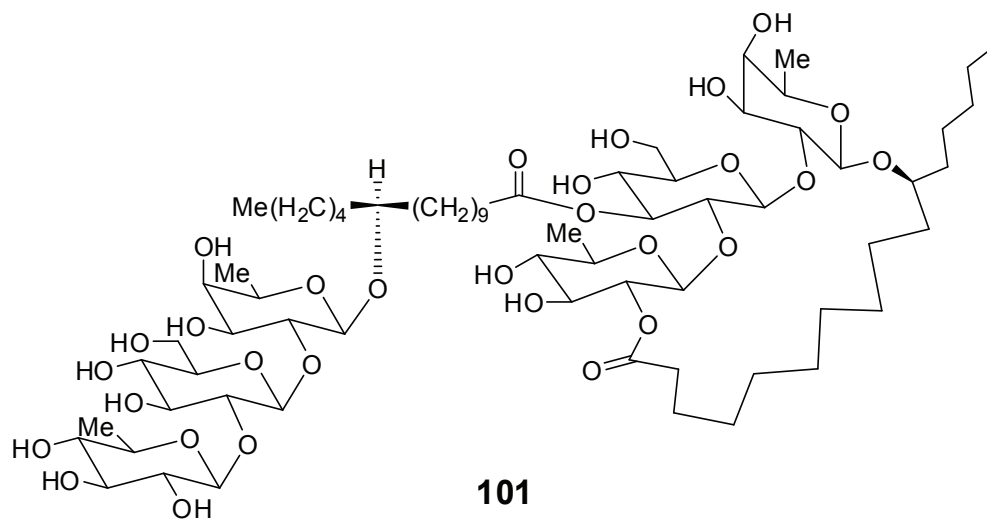


98

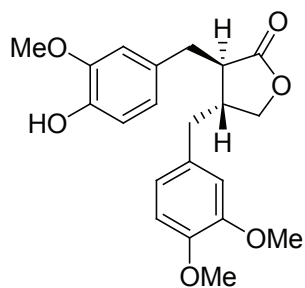


99

100

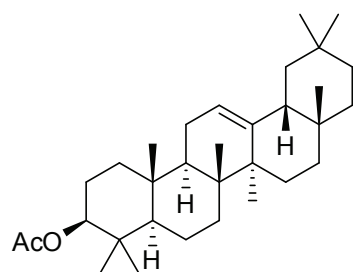


Lignan		
arctigenin (103)	<i>I. cairica</i>	Antioxidant, anti-inflammatory and inhibition of HIV replication

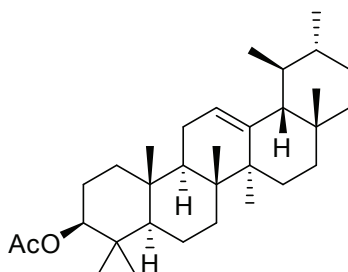


103

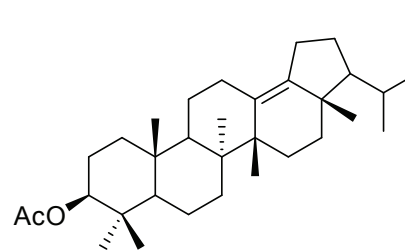
Triterpene		
β -amirin acetate (104)	<i>I. batatas</i> <i>I. pes-caprae</i>	Antinociceptive
α -amirin acetate (105)	<i>I. pes-caprae</i>	Antinociceptive
boehmeryl acetate (106)	<i>I. batatas</i>	Ovopositional stimulant for <i>Cylas formicarius elegantulus</i>
betulinic acid (107) glochidone (108)	<i>I. pes-caprae</i>	Antinociceptive
friedelin (109)	<i>I. batatas</i>	Antibacteriana against <i>Staphylococcus aureus</i> and antifungal against <i>Pseudallescheria boydii</i>
taraxerol (110)	<i>I. digitata</i>	Acetylcholinesterase inhibitory



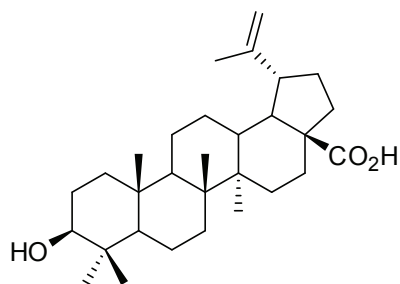
104



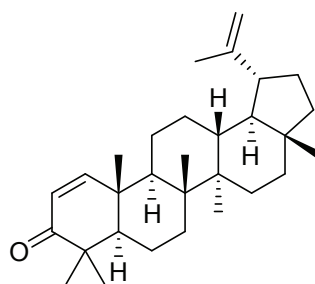
105



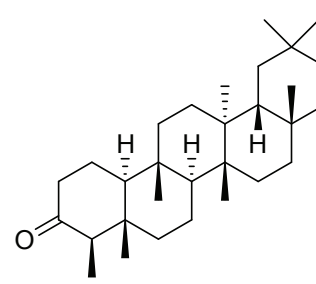
106



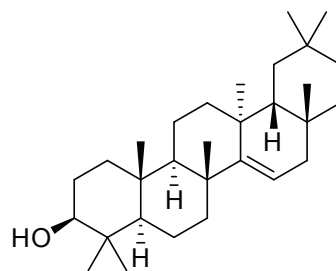
107



108



109



110

I. alba L.

Indolizidine alkaloids were isolated from the seeds of *I. alba*: ipalbine ipalbidine, isoipomine, ipalbidinium, *E*-ipomine, *Z*-ipomine, methoxyipomine, dimethoxyipomine and ipohardine (Ikhiri et al., 1987; Gourley et al., 1969). Ipalbidine (**13**) demonstrated non-addictive analgesic properties (Honda et al., 2003; Wang & Chu, 1996). Moreover it showed inhibitory effects on respiratory burst of leukocytes and scavenged oxygen-free radicals (Chen & Chu, 1998). Calystegines A5, B1 and B2 were isolated from the herbal material and roots of this plant (Schimming et al., 1998; 2005a). Calystegines B1 and B2 (**16** and **17**) are known to be potent inhibitors of rat lysosomal β -glucosidase (Haraguchi et al., 2003).

I. aquatica Forssk.

Calystegines B1 e B2 (**16** and **17**) beyond B4 were also found in *I. aquatica* (Schimming et al., 1998; 2005a). *N*-*cis*-Feruloyltyramine and *N*-*trans*-feruloyltyramine (**20** and **21**) isolated from roots of *I. aquatica* are inhibitors of prostaglandin synthesis (Tseng et al., 1986; 1992). An aqueous extract of *I. aquatica* showed as effective as the oral hypoglycaemic drug tolbutamide in reducing the blood sugar levels in rats (Malalavidhane et al., 2000; 2001). Isochlorogenic acids a, b and c (**24-26**) isolated of this species showed inhibitory activity of disaccharide-degrading enzyme. This research opens the possibility for the use of these substances as a food additive and a remedy for the prevention and treatment of diabetes and obesity (Okudaira et al., 2005). Isochlorogenic acids a, b and c (**24-26**) are also found in other species of *Ipomoea*, such as *I. batatas* and *I. pes-caprae* and exhibited collagenase inhibitory and were almost nocyctotoxic (Teramachi et al., 2005), beyond to showed radical scavenging activities (Islam et al., 2003) and inhibition of HIV infection (Mahmood et al., 1993; Islam et al., 2002a). Isochlorogenic acids a (**24**) presents still antifungal activity (Stange et al., 2001) and significant anti-spasmodic activity (Trute et al., 1997).

Some studies showed the medicinal effects of this plant on liver diseases, eye diseases, and constipation (Malalavidhane et al., 2000). *I. aquatica* was screened for its activity against fibroblast cell lysis after *Heterometrus laoticus* scorpion venom treatment. However, the result was clearly negative (Uawonggul et al., 2006). Diuretic activity has been observed in extract of *I. aquatica* when investigated in the Swiss albino mice. This study supports the popular use of this plant as diuretic (Mamun et al., 2003).

The crude methanolic extract of *I. aquatica*, as well as, its column fraction and the purified compound

7-*O*- β -D-glucopiranosil-dihydroquercetina-3-*O*- β -D-glucopiranosideo (**44**) isolated from it, were investigated for cytotoxic properties against normal and cancer cell lines, Vero (normal African green monkey kidney) and Hep-2 (human larynx epithelial carcinoma) cell and A-549 (human small cell lung carcinoma). The purified compound showed cytotoxicity towards cell cultures with CTC50 values of 387 mg/mL against normal Vero cell line, where as 156 and 394 mg/mL, against Hep-2 and A-549 cell lines respectively.

The crude methanolic extract of *I. aquatica* and its column fraction gave CTC50 values ranging from 41-332 mg/mL in Vero, 46 - 114 mg/mL in Hep-2 and 44 - 230 mg/mL in A-549 cell lines. The crude extract was more potent than that purified compound probably due to the combination of anthocyanins and other phenolic compounds (Prasad et al., 2005a,b).

I. asarifolia (Desr.) Roem. & Schult.

Four acylated anthocyanins were isolated of *I. asarifolia* (Pale et al., 1998; 2003). This species contain ergoline alkaloids such as chanoclavine I (**2**), ergine (**4**), ergobalansinine and lysergic acid α -hydroxyethylamide (Jenett-Siems et al., 2004). Chanoclavine I (**2**) is a psychotomimetic agent and ergine (**4**) presents hallucinogenic and psychotomimetic effects. *I. asarifolia* is a toxic plant in Northeastern Brazil affecting goats, sheep and cattle. The clinical signs of tremorgenic syndrome caused by this plans include depression, tremors of the head, incoordinated gait, and hypermetria (Medeiros et al., 2003).

Ipomoea batatas (L.) Lam.

Recent study showed that white-skinned sweet potato (WSSP) called Caiapo presents active ingredients that can prevent and improve symptoms of diabetes and hypoglycemia as well as, stimulate the imune response, such as phagocytosis and phagosome-lysosome and have antiinflammatory effects (Miyazaki et al., 2005). Study in normal rats as well as in streptozotocin induced insulin-deficient diabetic rats showed that WSSP have hipoglycemic activity and it increases blood insulin levels. WSSP suppressed the increase in blood glucose concentrations after glucose loading in normal rats and diabetic rats (Kusano et al., 1998; 2001; Kusano & Abe, 2000). The antidiabetic component was located almost exclusively in the cortex of WSSP and is a high-molecular weight compound (22000) presumed to be an acidic glycoprotein because it contained protein and sugar (Kusano & Abe, 2000). The study to investigate the tolerability, efficacy and mode of action of Caiapo extract on metabolic control in type 2 diabetic patients confirmed

the beneficial effects of Caiapo on plasma glucose as well as cholesterol levels (Ludvik et al., 2002; 2003; 2004). The polysaccharide PSPP (purified sweet potato polysaccharide) isolated from the roots of *I. batatas* improve the immune system when tested in rats and could be regarded as a biological response modifier (Zhao et al., 2005).

Other study confirmed that the extract from baked sweet potato showed potential cancer-preventing effects. Two fractions results of chromatography showed strong radical scavenging effects on DPPH radical coinciding with the high content of total phenolic compounds of them. These fractions suppressed strongly the proliferation of human promyelocytic leukemia cells (HL-60) with apoptosis inductions in a dependent manner. Besides, both of these fractions present antitumoral activity, when tested in mouse epidermal cell line (JB6) blocked the known tumor promoter called TPA (12-*O*-tetradecanoylphorbol-13-acetate) (Rabah et al., 2004). Extract of *I. batatas* caused marked dose-dependent growth inhibition in several human colon carcinoma cell lines with IC₅₀ values in the range of 20-50 µg/mL for HCT 116, SW480, HT29 and SW837 cell lines. However, the IC₅₀ value was more than 100 µg/mL when CaCo2 cells were tested (Kaneshiro, et al., 2005).

An indole-type alkaloid called Ipomine A was isolated of the hairy roots of *I. batatas* (Yuan et al., 2004). Calystegines B1 and B2 (16 and 17) that are potent inhibitors of rat lysosomal β-glucosidase (Haraguchi et al., 2003) besides A3, B3 and the alkaloid 2α, 7β-dihydroxynortropano were identified in the roots of *I. batatas* (Schimming et al., 1998, 2005a).

Study in rats has shown that *I. batatas* leaves are a good source of polyphenols, antioxidants and displayed vascular relaxing properties. These effects have been reported to reduce the risk of cardiovascular disease (Runnie et al., 2004). From *I. batatas* leaves were isolated the isochlorogenic acids a, b and c (24-26), also found in *I. aquatica* and *I. pes-caprae*, whose biological activities already were described. Chlorogenic acid (23) and 3,4,5-tri-*O*-caffeoylquinic acid (27) were also found in *I. batatas*. These compounds are also inhibitors of HIV replication (Mahmood et al., 1993) and present hypoglycaemic (Okudaira et al., 2005), radical scavenging (Islam et al., 2003) and antimutagenic (Yoshimoto et al., 2002) activities. Chlorogenic acids were not detected in the root. The stem also contained three feruloylquinic acids and small amounts of at least four caffeoyl-feruloylquinic acids (Zheng & Clifford, 2008).

The roots of *I. batatas* contain the coumarins aesculetin (35) (Minamikawa et al., 1962), scopoletin (34) and umbelliferone (36) which have anti-coagulation properties and inhibit HIV replication (Cambie & Ferguson, 2003). Scopoletin (34) presents also

hepatoprotective (Kang et al., 1998), antioxidant (Shaw et al., 2003), spasmolytic (Oliveira et al., 2001) and acetylcholinesterase (AChE) inhibitory (Lee et al., 2004) activities, as well as, inhibited proliferation by inducing apoptosis of human adrogen-independent prostate adenocarcinoma cells (PC3) (Liu et al., 2001). Scopoletin (34) is a member of the phytoalexins of *I. batatas* (Lima & Braz-Filho, 1997).

Vitamin C, caffeic acid and flavonoids, such as, rutin, quercetin (Guan et al., 2006), tilirosidine, astragaloside, rhamnocitrin, rhamnetin and kaempferol (Luo & Kong, 2005), cyanidins and peonidins (45-54) (Islam et al., 2002b; 2003; Terahara et al. 1999; Yang & Tsai, 1999; Lee et al., 1997; Goda et al., 1997; Otake et al., 1992; Tsukui et al., 1983) are also found in this species. The anthocyanins were stronger activity than ascorbic acid in the test *in vitro* DPPH radical-scavenging activity. Besides, these anthocyanins showed also antioxidative activity *in vivo* (Kano et al., 2005). Anthocyanidins occur, in general, in the periderm cell walls of the storage roots (Philpott et al., 2009).

The water extract from the roots of purple sweet potato Ayamurasaki variety inhibited strongly the mutagenicity of *Salmonella typhimurium*. However, an anthocyanin-deficient mutant of Ayamurasaki inhibited weakly the mutagenicity, suggesting that the anthocyanins pigments, which are abundant in the normal Ayamurasaki, decrease the mutagenic activity of the mutagens (Yoshimoto et al., 1999). The antimutagenicity of the anthocyanins isolated of sweet potatoes with purple-colored flesh was also investigated using *Salmonella typhimurium*. A comparison of the results showed that the cyanidin-type anthocyanin was superior to the peonidin-type in its antimutagenicity (Yoshimoto et al., 2001).

Other study showed that the diacylated anthocyanins such as the peonidin 3-*O*-(2-*O*-(6-*O*-*E*-feruloyl-β-D-glucopyranosyl)-6-*O*-*E*-caffeoyl-β-D-glucopyranoside)-5-*O*-β-D-glucopyranoside (54) isolated of the roots and leaves of *I. batatas* present postprandial anti-hyperglycemic effect when tested in rats through the retardation of maltase activity (Matsui et al., 2002).

Bioactive triterpenes were also found in *I. batatas*, such as, boehmeryl acetate (106) that acts as an ovipositional stimulant for the sweet potato weevil, *Cylas formicarius elegantulus* Summers (Son et al., 1990), friedelin (109), that demonstrated good activity against *S. Aureus* compared with ampicillin and amoxicillin, and good antifungal activity against *Pseudallescheria boydii* (Kilham, 2004; Tan et al., 1995) and β-amyryn acetate (104) that showed pronounced antinociceptive properties in the writhing test and formalin test in mice (Tan et al., 1995; Krogh et al., 1999).

The CHCl₃ extract from the roots of *I. batatas* presented significant phytotoxicity and the active constituents isolated were a series of resin glycosides

called simonins I-V (Baek et al., 1997; Noda et al., 1992). The major constituent simonin IV (**91**) presented phytotoxicity when tested pure (Pereda-Miranda & Bah, 2003). The extract of sweet potato exhibits still hepatoprotective (Suda et al., 1997), antiinflammatory, antimicrobial, antihypertensive activities and has ultraviolet protection effects (Yoshimoto, 2001).

The roots of *I. batatas* when molded (infected with *Fusarium solani*) are toxics. Animals consuming molded sweet potatoes produce a characteristic and often lethal respiratory disease. Tests *in vitro* with the major constituents, called 4-ipomeanol (1-(3-furyl)-4-hydroxypentanone) (Boyd & Wilson, 1972) showed that this compound presents citotoxic activity (Krauss & Unterreitmeier, 2005). From the tubers of *Ipomoea batatas* were isolated nine new lipo-oligosaccharides, batatosides H-P. Of these, only batatosides L and O showed a weak inhibitory effect on the growth of Hep-2 cells, while the others proved to be inactive (Yin et al., 2009). From the tuber of *Ipomoea batatas* were also isolated two saponines. Their antioxidants activities tested by DPPH and FRAP assay were moderate in relation to commercial standards (Dini et al., 2009). Tuberos roots of *Ipomoea batatas* contain a large amount of storage protein being sporamin the major. The principal function of the storage proteins is nutritional resource for seed germination or tuber regrowth. Recent study showed that exist a linear relationship between trypsin inhibitor activity (Ti activity) and amounts of sporamin B (Sun et al., 2009).

Ipomoea bahiensis Willd. ex Roem. & Schult.

Four antimicrobial glycosides have been isolated from *Ipomoea bahiensis*. One of these compounds revealed significant activity against Sarcoma 180 in mice (Bieber et al., 1986).

Ipomoea cairica (L.) Sweet (Syn. *I. palmata* Forssk.)

Aqueous extract from *I. cairica* showed anti-RSV (respiratory syncytial virus) activity *in vitro* (Ma et al., 2002). The ethanolic extract of this plant presents an antinociceptive effect (Ferreira et al., 2006). The major constituents of the extract were the coumarins scopoletin (**34**) and umbelliferone (**36**) and the lignans, arctigenin, matairesinol and trachelogenin (Lima & Braz-Filho, 1997). Arctigenin (**103**) was the most cytotoxic and presents also antioxidant and antiinflammatory activities (Cho et al., 2004), as well as, inhibited the replication of human immunodeficiency virus (Eich et al., 1996). The essential oil of *I. cairica* possesses remarkable larvicidal

properties. It could induce 100% mortality in the larvae of *Culex tritaeniorhynchus* (100 ppm), *Aedes aegypti* (120 ppm), *Anopheles stephensi* (120 ppm) and *Culex quinquefasciatus* (170 ppm) (Thomas et al., 2004). Indole alkaloids were isolated from the leaves of this specie (Sharda & Kokate 1979).

Ipomoea carnea Jacq. subsp. *fistulosa* (Mart. ex. Choisy) D.F. Austin (syn. *I. fistulosa* Mart. ex Choisy).

Pharmacological studies, conducted on rats, with the non-alkaloidal and non-saponifiable fraction isolated from the leaves of *I. carnea* showed the depressant activity of this species on the Central Nervous System (Ehattacharya & Ray, 1975).

In study for screening the HIV-1 RT inhibitory potential of medicinal plant, at a concentration of 200 µg/mL, crude water extracts of *I. carnea* subsp. *fistulosa* (aerial parts), proved to be strongly active with 98,95% of inhibition (Woradulayapinij et al., 2005). Other study for evaluation of immunomodulatory activity of this species on peritoneal cells of rats suggest that low dosages of *I. carnea* induced enhanced phagocytosis activity and hydrogen peroxide production by macrophages (Hueza et al., 2003a). The extract of *I. carnea* subsp. *fistulosa* presents antiinflammatory activity when tested in rats (Gorzalczany et al., 1996). The extract from the leaves of this species was tested *in vitro* against the adenocarcinoma de colon (L-HT29C) and human lymphocyte (L-THP) and presented no cytotoxicity (Lamidi et al., 2000).

Polyhydroxylated alkaloids were isolated from flowers, leaves and seeds of *I. carnea* subsp. *fistulosa* and characterized as 2-*epi*-lentiginosine (**14**), swainsonine (**15**), calystegines B1 (**16**), B2 (**17**), C1 (**18**) and B3 (**19**) and *N*-methyl-*trans*-4-hydroxy-L-proline (Haraguchi et al., 2003). When tested in rats, the calystegines B1 (**16**), B2 (**17**) and C1 (**18**) were potent inhibitors of lysosomal β-glucosidase and calystegine B3 (**19**) showed a moderate inhibitory activity toward α and β-lysosomal mannosidases. The compounds 2-*epi*-lentiginosine (**14**) and swainsonine (**15**) showed a potent inhibitory activity toward rat lysosomal α-mannosidase. The inhibitions of this enzymes result in lysosomal accumulation of undegraded oligosaccharides, vacuolation and cell death (Haraguchi et al., 2003; Ikeda et al., 2003). From leaves of this specie were isolated agroclavin (**1**) and dihydrolysergol (Umar et al., 1980).

I. carnea e *I. carnea* subsp. *fistulosa* cause serious intoxication of livestock. The animals, such as cattle, sheep, and goats (Górniak et al., 2010) presents intoxication clinically characterized by inappetence, soft feces, and weight loss, disorders of behaviors and consciousness, incoordinated gait, head shaking and death (Haraguchi et al., 2003; Daló & Moussatché, 1978; De Balogh et al., 1999). The toxic principles of this plant

have been identified as the alkaloids swainsonine (**15**) and calystegines B1 (**16**), B2 (**17**), C1 (**18**) and B3 (**19**) (Hueza et al., 2005, Haraguchi et al., 2003). The studies suggest that calystegines may act as coadjuvants of swainsonine in *I. carnea* toxicosis (Ikeda et al., 2003; Hueza et al., 2005). Other study showed that when administrated to pregnant rat toxic principle of *I. carnea* to pass through the placenta promoted decreased body weight, thymus atrophy and spleen enlargement in pups (Hueza et al., 2003b). *Ipomoea carnea* also promotes changes in lymphocyte distribution of young rats (Pipole et al., 2010). From latex of *I. carnea* was found a new chitinase, a digestive enzyme that break down glycosidic bonds in chitin (Patel et al., 2009; 2010). Caffeoyle derivatives were isolated from the seeds of *Ipomoea fistulosa* (Sattar et al., 1995). The aqueous extract of *I. carnea* Brazilian presented 0.09% swainsonine, 0.11% calystegine B2, 0.14% of calystegine B1, 0.06% calystegine C1 and the no proteic imino acid *N*-methyl-*trans*-4-hydroxy-L-proline (Schwarz et al., 2004).

Ipomoea corymbosa (L.) Roth ex Roem. & Schult.

I. corymbosa (*Rivea corymbosa*) is known by psychomimetic active principles of its seeds, the ancient Aztec drug "ololiuqui". In the seeds of this species were found alkaloids of the ergot type, such as, d-lysergic acid amide or LSA, also called ergine (**4**), as the major component in ololiuqui seeds as well as, the following minor alkaloids: chanoclavine I (**2**), elymoclavine (**3**), D-isolysergic acid amide also called erginine or isoergine (**5**) and lysergol (**11**) (Hoffmann, 1971). LSA or ergine (**4**) is a close analogue of best-know syntetic LSD (lysergic acid diethylamide). Hallucinogenic activity of LSA occurs with 2-5 mg, while LSD occurs at the microgram level (Halpern, 2004; Hoffmann, 1971). Elymoclavine (**3**), erginine (**5**) and lysergol (**11**) are also known to be psychoactive in humans (Hoffmann, 1963; Hoffmann & Tschertter, 1960; Hoffmann & Cerletti, 1961; Der Marderosian & Youngken Jr, 1966; Steinegger & Heimann, 1966; Ferrari, 1979).

Ipomoea digitata L.

The ether-sol. fraction of *I. digitata* presented hypotensive and muscle relaxant activity when tested in frogs, dogs, rats and rabbit (Tewati & Mishra, 1965). A glycoside called paniculatin isolated from the tubers of *I. digitata*, showed a stimulant effect on myocardium and respiration, a vasoconstrictor and bronchoconstrictor effect, a spasmogenic effect on smooth muscles of gut, as well as, it elevated the blood pressure, and also presented oxytocic activity (Matin et al., 1969a; 1969b). Other constituents isolated from the roots of

this plant are taraxerol, taraxerol acetate, *N*-butyl- β -D-fructopyranoside, octadecyl (*E*)-*p*-coumarate and the coumarins umbelliferone, scopoletin, scopolin (Dai et al., 2000) and scoparone (Rao et al., 1984). Scopoletin (**34**) and taraxerol (**110**) inhibited AChE (acetylcholinesterase) activity. This enzyme is responsible for the metabolic hydrolysis of the neurotransmitter acetylcholine. AChE inhibitors are important for the treatment of Alzheimer's disease. Memory impairments in this patients result from a deficit of cholinergic functions in the brain (Lee et al., 2004).

Ipomoea hederacea Jacq.

Methanolic extract of *I. hederacea* showed a strong cytotoxic potential when tested in cultured human lung (A549) and colon (Col 2) cancer cells (Nam & Lee, 2000). *I. hederacea* seeds contained chanoclavine I (**2**), elymoclavine (**3**), lysergol (**11**) and penniclavine (**12**) known to be psychoactive and isopenniclavine (Abou-Chaar, 1967).

Ipomoea hederifolia L.

From *I. hederifolia* were identified the active calystegines B1 (**16**) and B2 (**17**) (Haraguchi et al., 2003) besides A5 (Schimming et al., 1998). Moreover, several pyrrolizidine alkaloids of the ipanguline-type were isolated from *I. hederifolia* (Jenett-Siems et al., 1993; 1998).

I. horrida Huber

From the aerial parts of *I. horrida* were identified 7,4'-di-*O*-methylkaempferol and 7,3',4'-tri-*O*-methylquercetin (Barbosa-Filho et al., 1996).

Ipomoea imperati (Vahl) Griseb.

Methanol-water extract from the leaves of *I. imperati* showed local and systemic anti-inflammatory actions in mice and rats, respectively. This extract also presented antispasmodic activity on the isolated ileum, inhibiting histamine and acetylcholine. In the acute toxicity assay, 1 mg/kg of *I. imperati* methanol-water extract caused no mortality in mice after 24 h (Paula et al., 2003). *Ipomoea imperati* prevented the formation of gastric lesions in 78% ($p < 0.05$) when compared with the negative control tween 80 (Miyahara et al., 2011). Ethanol extract, lipid and aqueous fraction of *I. imperati* significantly inhibited the abdominal constriction in mice induced by acetic acid; increased the sleeping time evoked by pentobarbital sodium and showed a significant activity by inhibiting formalin-induced paw edema in mice (Paula-

Zurron et al., 2010).

Ipomoea indica (Burm.) Merr. (*I. congesta* R. Br.)

Methanolic extract from the seeds of *I. indica* (*I. congesta*) presented biological activity against Herpes Simplex-1 (Locher et al., 1995). Methanolic and aqueous extracts from the seeds of this species were also investigated for anti-bacterial activity against *Streptococcus pyogenes*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*. However, they did not present activity (Locher et al., 1995). Acetonitrile extract from the seeds of *I. indica* (*I. congesta*) was evaluated for its ability to inhibit the growth of three species of fungi, *Microsporum canis*, *Epidermophyton floccosum* and *Trichophyton rubrum*. *I. indica* (*I. congesta*) showed activity against *Microsporum canis* and *Epidermophyton floccosum* at a concentration of 1000 µg/mL but no growth inhibition was observed against *Trichophyton rubrum* (Locher et al., 1995). The glycoside called ipolearoside, with significant activity against Walker carcinosarcoma 256 in rats, has been isolated from ethanol extracts of the whole plants of *I. leari* Paxt. (*I. indica*) (Sarin et al., 1973).

Ipomoea involucrata P. Beauv.

Petroleum ether and ethanol extracts of *I. involucrata* were subjected to biological screening using *Klebsiella* spp., *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. The extracts inhibited the growth of both Gram-positive and Gram-negative organisms (Ejimadu & Ogbeide, 2001). Aqueous ethanolic extract of *I. involucrata* showed a true antiviral activity against herpes simplex virus type 1 (HSV 1) and a virucidal activity against VSV T2 (Vesicular stomatitis virus T2) SF A7 (Semliki forest virus A7) and MV-EA (Measles virus strain Edmonston A) (Sindambiwe et al., 1999).

Ipomoea leptophylla Torr.

The crude organic extract (MeOH-CH₂Cl₂) of *I. leptophylla* presented 92% inhibition at 150 µg/mL against *M. tuberculosis in vitro*. Bioassay-guided fractionation of this extract resulted in the isolation of two resin glycosides called leptophyllins A and B. However, these compounds presented weak or no activity when tested in the anti-tuberculosis assay. Upon the basis of the activity of the extract it appears that there may be other minor metabolites that contribute to the extract's anti-tuberculosis activity (Barnes et al., 2003).

Ipomoea lonchophylla J.M. Black

In Austrália occurs the "dumb lamb syndrome" that causes mortality among newly born lambs. It is believed that this disease occurs during gestation when the female feed toxic species. *I. lonchophylla* J. Black has been implicated in this disorder. One fraction from *I. lonchophylla* was toxic to mice but no tests have so far been carried out to determine whether this toxic fraction contribute to intoxication and death among newly born lambs. The toxic fraction contained an inseparable mixture of resin glycosides (Macleod et al., 1997).

Ipomoea muelleri Benth.

Several ergoline alkaloids, known to be psychoactive in humans, were isolated from the seeds of *I. muelleri*, such as agroclavine (1), chanoclavine I (2), elymoclavine (3), ergine or LSA (4), erginine or isolysergic acid amide (5), ergometrine (8), festuclavine (10), lysergol (11), penniclavine (12), as well, isopenniclavine, α-dihydrolysergol, Isolysergol, isosetoclavine, setoclavine, molliclavine, isolysergamide, N-(1-hydroxyethyl) chanoclavine II and ergometrinine (Der Marderosian et al., 1974; Hoffmann, 1963). Agroclavine (1) and festuclavine (10) were shown to be effective antimicrobial compounds and had significant cytostatic activity to a mouse lymphoma cell line. Agroclavine (1) was also effective at inhibiting *E. coli* multiplication (Panaccione, 2005). Ergometrine or ergonovine (8) has potent uterine antispasmodic activity and is used as an oxytocic and in treating postpartum hemorrhages. Bleeding is reduced because of its vasoconstrictor effects (Dewick, 2002).

Ipomoea muricata (L.) Jacq.

The seeds of *I. muricata* presented analgesic and antiseptic properties (Ysrael, 2003). The indolizidine alkaloidal ipalbicine, ipalbidine, ipalbinium and ipomine were isolated from the seeds (Exconde et al., 2004). Analgesic properties have been attributed for ipalbidine (13) (Honda et al., 2003; Dawidar et al., 1977). Antimicrobial and antifungal compounds were also identified (Ysrael, 2003). The indolizidine alkaloid called E-ipomine were also isolated in the seeds of *I. muricata* (Dawidar et al., 1977) besides caffeic acid, (Misra & Tewari, 1952), muricatins A and B (Misra & Tewari, 1953), muricatins I-VIII (Noda et al., 1985; 1988a; 1988b) and muricatic acids A, B and C (Noda et al., 1988c). Of these, caffeic acid (22) presents antioxidant and antimutagenic activities (Yoshimoto et al., 1999) and muricatin A in doses of 20-40 mg/kg to anesthetized dogs produced a fall in blood pressure with subsequent

rise to the original level. Muricatin B presented no pharmacological activity (Chaudhary et al., 1957).

Ipomoea murucoides Roem. & Schult.

From the roots of *I. murucoides* (cazahuate) were isolated the glycoresins called murucins 1-5. Murucin 1 (**64**) presents marginal activity (ED50 5.0 µg/mL) against ovarian carcinoma (OVCAR-5) cells, but was inactive (ED50 >20.0 µg/mL) against colon carcinoma (HCT-15) and cervical carcinoma (UISO-SQC-1) cells. Murucins 2-5 were inactive against all three of these cell lines (León et al., 2005). From flowers of *Ipomoea murucoides* were isolated five lipophilic tetrasaccharide called murucoidins XII-XVI. These compounds were tested for in vitro antibacterial and resistance modifying activity against strains of *Staphylococcus aureus* possessing multidrug resistance efflux mechanisms. Only murucoidin XIV showed antimicrobial activity against SA-1199B a norfloxacin-resistant strain that over-expresses the NorA MDR efflux pump (Chérigo et al., 2009).

Ipomoea nil (L.) Roth

Ethanol extract from the roots of *I. nil* (*Pharbitis nil*) induce growth inhibition and apoptosis of human gastric cancer cells (AGS) (Ko et al., 2004). From this species were also isolated peonidins (Saito et al., 2005) and the anthocyanins HBA (**56**) that presents protective effects against UV-B (Mori et al., 2005). A spermidine alkaloid, N1, N10-ditigloylspermidine were isolated from the seeds of *I. nil* (Schimming et al., 2005b).

Ipomoea obscura (L.) Ker Gawl.

Methanolic seed extract of *I. obscura* afforded indole alkaloids, such as ipobscurines B-D (Jenett-Siems et al., 2003). Active calystegins B1 (**16**), B2 (**17**), C1 (**18**) and B3 (**19**), besides calistegin B4, and were also isolated of this species (Asano et al., 2001; Schimming et al., 1998).

Ipomoea orizabensis (G. Pelletan) Ledeb. ex Steud.

I. orizabensis produced strong activity against sarcoma 37 (Belkin et al., 1952). From the roots of this species were isolated several glycoresins: scammonine I (**57**) a complex glycolipid active against methacillin-resistant staphylococci (Mitscher & Telikeyalli, 1992), scammonin II (**58**) and orizabins V a VII (**69-71**) which are weakly cytotoxic (ED50 4-20 µg/mL) against human oral epidermoid carcinoma (KB) (Hernandez-Carlos et al., 1999), orizabins I-IV (**65-68**) useful as laxatives (Noda

et al., 1985; 1987), orizabin VIII (**85**) that presents weak cytotoxicity against colon carcinoma and orizabins IX-XXI (**72-84**) which exhibited cytotoxic activity (ED50 1-5 µg/mL) against oral epidermoid carcinoma (KB) but exhibited a weak cytotoxicity against colon carcinoma (HCT-15), squamous cell cervix carcinoma (SQC-1) and ovarium cancer (OVCAR) cell lines (ED50 4-20 µg/mL) (Pereda-Miranda & Hernández-Carlos, 2002). These glycolipids contain an intramolecular macrocyclic lactone (Noda et al., 1990).

Ipomoea operculata Mart. et Spix. (*syn. Operculina macrocarpa* (L.) Urb.)

Several glycoresins called operculins I-XVIII were isolated from the roots of *I. operculata*. However its biological activities were not evaluated (Ono et al., 1989; 1990; 1991; 1992a).

Ipomoea parasitica (Kunth) G. Don

The petroleum ether extract from the seeds of *I. parasitica* (HBK) Don. were isolated a unique members of a class of glycoresin (Smith et al., 1964). From seeds of this species were identified lysergol and elymoclavine besides other ergoline alkaloids (Amor-Prats & Harborne, 1993a).

Ipomoea pes-caprae (L.) R. Br.

This specie is known as salsa-da-praia or batateira-da-praia in Brazil (Souza et al., 2000) and Railroad vine, bay hops or beach morning-glory in North America (Pereda-Miranda et al., 2005). To identify potential migraine therapeutics, *I. pes-caprae* was screened to detect inhibitors of platelet (¹⁴C) 5-hydroxytryptamine (5-HT) release. Studies showed that the methanolic extracts of *I. pes-caprae* was potent inhibitors of platelet (¹⁴C)5-HT release, even after the addition of PVP (polyvinyl pyrrolidone) to remove polyphenolic tannins that precipitate proteins (Rogers et al., 2000).

Study in mice indicated that both methanolic extract and two fractions (ethyl acetate and aqueous) exhibited antinociceptive activity against two classical models of pain, neurogenic and inflammatory. This study justifies at least in part, the traditional use of this plant to treat dolorous process (Souza et al., 2000). Some constituents isolated from *I. pes-caprae*, such as, quercetin 3-O-β-D-glucoside (**55**), β-amyrin acetate (**104**) α-amyrin acetate (**105**), betulinic acid (**107**) and glochidone (**108**) showed pronounced antinociceptive properties in mice. These data confirm the previous work concerning the antinociceptive action of the

hydroalcoholic extract of *I. pes-caprae* and support, at least in part the traditional use of this plant for the treatment of dolorous processes (Krogh et al., 1999).

I. pes-caprae exhibited insulinogenic, hypoglycemic (Khan et al., 1994), anti-haemolytic (Pongprayoon et al., 1991a) antispasmodic (Pongprayoon et al., 1989; 1992a), antiinflammatory (Pongprayoon et al., 1992b) and anti-histamine (Wasuwat, 1970) activities.

The crude extract of *I. pes-caprae* reversibly inhibited the contractions induced by several spasmogens in a concentration-dependent manner (Pongprayoon et al., 1989). Bioassay guided fractionation of this extract resulted in isolation of the isoprenoids *E*-phytol and β -damascenone. The antispasmodic potencies of these compounds were found to be in the same range as that of papaverine, a known spasmolytic agent (Pongprayoon et al., 1992a). However, similar study with the plant collected in Brazil showed difference in terms of the chemical composition and did not showed antispasmodic activity when tested on isolated guinea-pig ileum and rat duodenum (Emendorfer et al., 2005).

From the leaves of *I. pes-caprae* were isolated the isochlorogenic acids a, b and c (**24-26**) which were also found in other species of *Ipomoea*, such as *I. batatas* and *I. aquatica* whose biological activities already were described. Beyond that, others quinic acid esters (**28-32**) were also isolated from the leaves of this species (Teramachi et al., 2005). Isochlorogenic acids a, b and c (**24-26**) as well the quinic acid esters (**28-32**) presented collagenase inhibitory activity and showed almost no cytotoxicity (Teramachi et al., 2005). The development of compounds with collagenase inhibitory activity is an effective method for preventing aging of the skin. During ageing occurs reduction of the collagen of the skin due to its decomposition by action of the enzyme called collagenase. Compounds that inhibit this enzyme will avoid then the reduction of the collagen and consequently will maintain elasticity of the skin (Teramachi et al., 2005).

I. pes-caprae showed to be clinically effective toward dermatitis caused by venomous jellyfishes (Wasuwat, 1970). The crude extract of this plant showed an inhibitory effect on prostaglandin synthesis *in vitro*. Bioassay-guided separation of the extract led to the isolation of four active compounds: 3,4-dihydro-8-hydroxy-3-methyl-isocoumarin (**40**), eugenol (**41**), 4,4,7-trimethyl-1,4-dihydro-2-hydroxy-1-naftalenone (**42**) and 4-vinyl-guaiacol (**43**). The influence of these compounds on the formation of prostaglandins may partly explain a previously observed anti-inflammatory effect of the crude extract of *I. pes-caprae* (Pongprayoon et al., 1991b.) and supports the popular use of this plant to cure inflammations (Souza et al., 2000).

The cytotoxic potential of six lipophilic glycosides isolated from the aerial parts of *I. pes-caprae*, namely, pescaproside A (**86**), pescapreins

I-IV (**87-90**) and the known stoloniferin III was evaluated against four human cancer cell lines. All compounds exhibited weak cytotoxicity (ED₅₀ 5-20 μ g/mL) against nasopharyngeal (KB), colon (HCT-15), squamous cell cervical (SQC-1 UISO) and ovarian (OVCAR) carcinomas (Pereda-Miranda et al., 2005). From flowers of *I. pes-caprae* were isolated three linear hetero-pentasaccharides of jalapinic acid, pescapraeins XVIII-XX, which displayed resistance-modifying activity against strains of *Staphylococcus aureus* possess multidrug efflux pumps (Escobedo-Martínez et al., 2010). The thin layer chromatography for the hydroethanolic solutions indicated the presence of isoquercitrin, being more evident from the leaves (Barni et al., 2009).

Ipomoea purga

The CHCl₃ and MeOH extracts of *I. purga* showed a significant inhibitory effect (ED₅₀ <4 μ g/mL) against the human nasopharyngeal carcinoma and breast cancer cell cultures (Pereda-Miranda & Bah, 2003). The resin of *I. purga* of strong purgative effect is known as jalapa and consists of two fraction, one insoluble in ether called convolvulin and other soluble called jalapin (Costa, 2002). Treatment of convolvulin with sodium methoxide has yielded a β -D-quinovoside. It consist of one molecule of D-quinovose glycosidically linked to molecule of methyl 11-hydroxytetradecanoate (Singh & Stacey, 1973). Alkaline hydrolysis of jalapin yields volatile acids, tyglic, acetic, propionic, isobutyric, isovaleric, valeric and methyl-ethyl-acetic, beside jalaponic acid. It by acid hydrolysis yields the oses glucose, fucose and rhamnose, as well as, jalapinic acid or 11-hydroxypalmitic acid (Costa, 2002).

Ipomoea purpurea (L.) Roth.

A glycoresin called ipopurpuroside was isolated from *I. purpurea*. It consists of glucose, rhamnose and 6-deoxy-D-glucose glycosidically linked to ricinoleic acid. The acyl group removed by alkaline hydrolysis was identified as methylbutyric acid (Navarro-Ruiz et al., 1978). Others glycoresins called marubajalapins I-XV were isolated from the jalapin fraction of the serial part (leaves and stems) of *Pharbitis purpurea* (*I. purpurea*) (Ono et al., 1992b). From the flowers of this species were isolated cyanidins and pelargonidins (Saito et al., 1995; 1996; 1998). The compound 3-*O*-(2-*O*-(6-*O*-*E*-caffeoyl- β -D-glycopyranosyl))- (6-*O*-*E*-caffeoyl)- β -D-glycopyranosyl)-5-*O*- β -D-glycopyranoside-cianidin (**46**), also isolated from *I. batatas* and *I. asarifolia*, showed antioxidant activity (Kano et al., 2005). In study for investigation of new sources of ergoline alkaloids within the genus *Ipomoea*, *I. purpurea* was alkaloid-negative

species, although previous reports indicated presence of ergoline alkaloids. Maybe because *I. purpurea* is often confused with *I. tricolor* an alkaloid-positive species (Amor-Prats & Harborne, 1993b).

Ipomoea squamosa Choisy

From the leaves of *I. squamosa* were isolated the glycoresins called ipomoeassins A-E (**59- 63**). All the isolates showed cytotoxic activity against human ovarian (A2780) cancer cell line. Ipomoeassins A-C and E were moderately active (IC₅₀ from 0.5 to 3.3 μ M). While Ipomoeassin D (**62**) (IC₅₀ 0,035 μ M) which differs from C (**61**) (IC₅₀ 2,9 μ M) only by an acetyl group, is almost two orders of magnitude more active than C. However, the derivative fully acetylated was less active. These observations suggest that relatively minor structural variations may make significant differences to cytotoxicity (Cao et al., 2005).

Ipomoea stans Cav.

This specie is known as tumbavaquero in Mexico. Study realized in rats with aqueous extract from the roots of *I. stans* indicated the presence of active substances which can exert a vasorelaxant effect, making them possibly effective for the treatment of clinical disturbances where high smooth muscle tension is the main symptom. This study supports the popular use of *I. stans* as an antispasmodic agent (Perusquia et al., 1995). Other study demonstrated anticonvulsant effect of aqueous, hydroalcohol and chloroform extracts from *I. stans* root in rats (Gonzalez Ramirez et al., 1985). MeOH extract of *I. stans* showed high antioxidative activity in the tests of inhibition of autoxidation, DPPH scavenging activity, and superoxide anion-scavenging activity (Choi et al., 1998). Ethyl acetate extract from *Ipomoea stans* roots showed central nervous system depressant activity (Herrera-Ruiz et al., 2007).

From a fraction of *I. stans*, with pronounced cytotoxicity towards three human tumor cell lines and with specific antibiotic activity against two bacterial strains, were isolated and identified three glycoresins fraction (Reynolds et al., 1995). In other study, were isolated from the roots of *I. stans* the glycoresins called stansins 1-5. These compounds were subjected to a cytotoxic assay using cultured cells representative of colon (HCT-15) cervical (UISO-SQC-1) and ovarian (OVCAR-5) carcinomas. Among these compounds, to be detached, stansin 5 (**92**) that presents cytotoxic activity against ovarian (ED₅₀ 1,5 μ g/mL) and cervical (ED₅₀ 4,0 μ g/mL) carcinomas (León et al., 2004). Others glycoresins also isolated of *I. stans* were scammonic acid A and orizabin XX (Enriquez et al., 1992). But its

biological activities were not reported. The coumarin scopoletin (**34**) was also isolated from roots of *I. stans* (Noda et al., 1994).

Ipomoea stolonifera (Cirillo) J.F. Gmel. (*I. imperati* (Vahl) Griseb.)

Methanol-water extract from the leaves of *I. stolonifera* (*I. imperati* Vahl Griseb.) showed local and systemic anti-inflammatory actions in mice and rats, respectively. This extract also presented antispasmodic activity on the isolated ileum, inhibiting histamine and acetylcholine. In the acute toxicity assay, 1 mg/kg of *I. imperati* methanol-water extract caused no mortality in mice after 24 h (Paula et al., 2003). From the ether-soluble resin glycoside fraction was isolated twelve glycoresins called stoloniferins I-XII were isolated in the pure state from the whole plants of *I. stolonifera*, but its biological activities were not reported (Noda et al., 1994; 1998).

Ipomoea stolonifera (Cirillo) J.F. Gmel.

From the ether-soluble resin glycoside fraction was isolated twelve glycoresins called stoloniferins I-XII were isolated in the pure state from the whole plants of *I. stolonifera*, but its biological activities were not reported (Noda et al., 1994; 1998).

Ipomoea subincana Meisn.

The results obtained showed that *I. subincana* is a potential source of bioactive compounds with immunosuppressive activity since the fractions 1 and 9 isolated from chloroform extract exhibited respectively 93,18 and 91,21% of nitric oxide Inhibition and respectively 98,69 e 53,90% of lymphoproliferation inhibition. The fractions 8 and 9 from chloroform extract were strongly lethal towards brine shrimp nauplii since exhibited LC₅₀ respectively of 9,3 and 43,0 mg/L. The fraction 6 from the ethyl acetate extract showed 49,6% of antioxidant activity surpassing the activity of the standard commercial antioxidant, galato de propila (39,6%). From the chloroform extract of aerial parts of *I. subincana* were isolated scopoletin (**34**) and methyl 3,5-di-*O-E*-caffeoyl-quinatate (**32**) whose biological activities already were described. Besides others compound as lupeol, β -sitosterol, vanillin, vanillic acid, aromadendrane-4 β ,10 α -diol, 3- β -*O*- β -D-glycopiranosyl-sitosterol, cinamic acid, methyl caffeate, ethyl caffeate, methyl-3,4-dimethoxycinnamate, stigmasterol, α -amyrin, β -amyrin, *trans n*-icosyl-*p*-coumarates, *cis n*-docosyl-*p*-coumarates, *trans n*-nonadecyl *p*-coumarates, *trans n*-hencicosyl *p*-coumarates,

trans-n-docosyl-*p*-coumarates, *trans-n*-tricosyl-*p*-coumarates, tyrosol and the novel glycolipid subincine and the new ceramides (2S*,2'R*,3S*,4R*,11E)-*N*-(2'-hydroxyhenicosanoyl)-2-amino-nonadec-11-ene-1,3,4-triol (2S*,2'R*,3S*,4R*,8E)-*N*-(2'-hydroxytricosanoyl)-2-amino-nonadec-8-ene-1,3,4-triol, whose biological activities not were determined. From the ethyl acetate extract were isolated quercetin, 3-*O*- β -D-glycopyranosyl-quercetin, methyl 4-*O*-*E*-feruloyl-5-*O*-*E*-caffeoyl-quinate and methyl 3,5-di-*O*-*E*-caffeoyl-quinate (**32**) (Meira et al., 2008; Meira, 2008).

Ipomoea tyrianthina Lindl.

From this specie were isolated tyrianthins A and B two new partially acylated glycolipid ester-type heterodimers which showed significant in vitro relaxant effect on aortic rat rings. Scammonic acid A was determined as the glycosidic acid in both monomeric units. Also, these compounds were able to increase the release of GABA and glutamic acid in brain cortex, and displayed weak antimycobacterial activity (León-Rivera et al., 2009).

Ipomoea tricolor Cav.

The chloroform extract of *I. tricolor* showed effective chemical property for suppressing the growth of other plants. Bioactivity-directed fractionation of the crude extracts of *I. tricolor* led to the identification of the glycoresins mixture as the active fraction. Further chromatographic analysis of this fraction yielded tricolorin A (**93**) as the main constituent responsible for the phytotoxicity (Pereda-Miranda & Bah, 2003; Bah & Pereda-Miranda, 1996; Pereda-Miranda et al., 1993). Tricolorin A (**93**) showed antimicrobial activity against *Staphylococcus aureus* and strong citotoxic activity against human breast cancer (ED₅₀ 2,2 μ g/mL). All member of the tricolorin series (tricolorin A-J) (**93-102**) exhibited a weak cytotoxicity against colon carcinoma, squamous cell cervix carcinoma and ovarium cancer cell lines (ED₅₀ 4-20 μ g/mL). But a stronger effect was observed against oral epidermoid carcinoma (KB, ED₅₀ 1-5 μ g/mL) (Pereda-Miranda & Bah, 2003).

From *I. tricolor* were isolated several ergoline alkaloids such as, agroclavine (**1**), chanoclavine I (**2**), elymoclavine (**3**), ergine (**4**), ergocristine (**6**), ergotamine (**7**), ergometrine (**8**), penniclavine (**12**), besides, dihydrolysegol, isolysergol, ergometrinine, ergostine, and noragroclavine (Botz et al., 1991; Hahn, 1990). Although all of the natural ergoline alkaloids increase the motor activity of the uterus; ergometrine (**8**) is most active and also less toxic than ergotamine (**7**). Ergotamine (**7**) presents also vasoconstrictor activity and is useful in

the treatment of migraine headaches (Madlom, 2002).

Coumarin (**33**) and scopoletin (**34**) were also isolated of this species (Shah et al., 1972). The biological activity of scopoletin, also found in *I. batatas*, *I. cairica* and *I. digitata*, already were described. The coumarin (**33**) presents antiedema properties and is also immunostimulant and exhibit citotoxic activity (Bruneton, 2001).

Ipomoea violacea L.

From *I. violacea* were isolated several ergoline alkaloids, such as, chanoclavine I (**2**), elymoclavine (**3**), ergine (**4**), erginine (**5**), ergometrine (**8**), lysergol (**11**), penniclavine (**12**), besides, chanoclavine II and ergometrinine (Stanescu et al., 1973; Weber & Ma, 1976). The main ergoline alkaloid in the seeds of *I. violacea* is ergine (**4**). The total alkaloid content of *I. violacea* seed is approximately five times as great as that of the seeds of *I. corymbosa* (*Rivea corymbosa*) (Hoffmann, 1971). Calystegins B1 (**16**) and C1 (**18**) were also isolated of this species (Schimming et al., 1998).

Conclusion

The plants of the genus *Ipomoea* have long been used in folk medicine for the treatment of a wide variety of pathological conditions, including their use to treat inflammatory and algesic processes, kidney ailments, constipation, colic and digestive disorders. In recent years, the scientific interest in plants of *Ipomoea* genus has increased greatly. Substantial progresses on chemistry and pharmacological properties of this genus have showed it. Some species showed antimicrobial, analgesic, spasmolytic, spasmogenic, hypotensive, psychotomimetic and anticancer activities. Pharmacological studies have confirmed some uses in folk medicine. For example, antinociceptive action of *I. pes-caprae* that supported, at least in part, the traditional use of this plant for the treatment of dolorous processes. Other study realized in rats with aqueous extract from the roots of *I. stans* indicated the presence of active substances which can exert a vasorelaxant effect confirming the popular use of *I. stans* as an antispasmodic agent. Although, an extensive amount of research work has been done on some plants of genus *Ipomoea* to date, a large number of species are still partially studied such as, *I. parasitica*, *I. operculata* (syn. *Operculina macrocarpa*), *I. lonchophylla*, *I. involucreta*, *I. hederacea*, *I. bahiensis*. Consequently, a broad field of future research remains possible in which the isolation of new active principles from these species would be of great scientific merit.

Glycolipids, phenolics compounds and alkaloids are of particular interest as many are highly potent bioactives and perhaps responsible for most of activities

shown by the plants of this genus. A detailed study is required to understand the structure–activity relationship of these constituents. Many plant extracts of *Ipomoea* showed biological activity. However, the particular constituent responsible for the activity has not always been isolated in further process. Furthermore, some plant extracts were only preliminarily studied for their *in vitro* activities, so, the advance clinical trial of them deserves to be further investigated.

References

- Abbott I A, Shimazu C 1985. The geographical origin of plants most commonly used for medicine by Hawaiians. *J Ethnopharmacol* 14: 213-222.
- Abou-Chaar CI 1967. Alkaloids of an *Ipomoea* seed. *Lebanese Pharm J* 9: 93-109.
- Amor-Prats D, Harborne JB 1993a. Allelochemical effects of ergoline alkaloids from *Ipomoea parasitica* on *Heliothis virescens*. *Birkhäuser Verlag AG* 4: 55-61.
- Amor-Prats D, Harborne JB 1993b. New sources of ergoline alkaloids within the genus *Ipomoea*. *Biochem Syst Ecol* 21: 455-461.
- Asano N, Yokoyama K, Sakurai M, Ikeda K, Kizu H, Kato A, Arisawa M, Höke D, Dräger B, Watson AA, Nash RJ 2001. Dihydroxynortropane alkaloids from calystegine-producing plants. *Phytochemistry* 57: 721-726.
- Austin DF 1997. Convolvulaceae (morning glory family). <http://ag.arizona.edu/herbarium/assoc/people/daustin/convolv.html>, accessed May 2011.
- Austin DF, Huáman Z 1996. A synopsis of *Ipomoea* (Convolvulaceae) in the Americas. *Taxon* 45: 3-38.
- Baek NI, Ahn EM, Bang MH, Kim HY 1997. Development of biologically active compounds from edible plant sources - I. Isolation of major components from the tuber of *Ipomoea batatas* Lam. *Han'guk Nonghwa Hakhoechi* 40: 583-587.
- Bah M, Pereda-Miranda R 1996. Detailed FAB-mass spectrometry and high resolution NMR investigations of tricolorin A-E, individual oligosaccharides from the resins of *Ipomoea tricolor* (Convolvulaceae). *Tetrahedron* 52: 13063-13080.
- Bah M, Pereda-Miranda R 1997. Isolation and structural characterization of new ester type dimers from the resin of *Ipomoea tricolor* (Convolvulaceae). *Tetrahedron* 53: 9007-9022.
- Barbosa-Filho JM, Athayde-Filho PF, Silva PMS, Agra MF, Bhattacharyya J 1996. Constituents of *Ipomoea horrida* Humber ex Ducke: spectroscopic identification of the flavonoids. *Rev Bras Farmacogn* 5: 161-166.
- Barnes CC, Smalley MK, Manfredi KP, Kindscher K, Loring H, Sheeley DM 2003. Characterization of an anti-tuberculosis resin glycoside from the Prairie medicinal plant *Ipomoea leptophylla*. *J Nat Prod* 66: 1457-1462.
- Barni ST, Cechinel-Filho V, Couto AG 2009. Caracterização química e tecnológica das folhas, caules e planta inteira da *Ipomoea pes-caprae* (L.) R. Br., Convolvulaceae, como matéria-prima farmacêutica. *Rev Bras Farmacogn* 19: 865-870.
- Belkin M, Fitzgerald DB, Cogan GW 1952. Tumor-damaging capacity of plant materials. I. Plants used as cathartics. *J Natl Cancer I* 13: 139-55.
- Bieber LW, Silva Filho AA, Lima RMOC, Chiappeta AA, Nascimento SC, Souza IA, Mélo JF, Veith HJ 1986. Anticancer and antimicrobial glycosides from *Ipomoea bahiensis*. *Phytochemistry* 25: 1077-1081.
- Botz L, Hahn E, Szabo LG 1991. Botanical identification of *Ipomoea tricolor* Cav. seed samples from Hungary and thin-layer chromatographic examination of their hallucinogen ergot alkaloids. *Acta Bot. Hung* 36: 229-243.
- Bovell-Benjamin AC 2007. Sweet Potato: A review of its past, present, and future role in human nutrition. *Adv Food Nutr Res* 52: 1-59.
- Boyd MR, Wilson BJ 1972. Isolation and characterization of 4-ipomeanol, a lung-toxic furanoterpenoid by sweet potatoes (*Ipomoea batatas*). *J Agric Food Chem* 20: 428-430.
- Bruneton J 2001. Farmacognosia, fitoquímica, plantas medicinais. 5 ed. Zaragoza: Editorial Acribia S.A.
- Camargo MTLA 1998. Contribuição ao estudo da *Ipomoea purpurea* Roth., *I. alba* L. e *I. pes-caprae* Sw. empregadas na medicina popular e em rituais de religiões de origem e influência africana no Brasil. VI Simpósio Argentino de Farmacobotânica. I Reunion de Farmacobotânica de Países integrantes del Mercosur Posadas, Misiones, Argentina. [http://www.qui.una.py/botanicafeq/Vol%205\(1\)%201999/Contribuicao%20ao%20estudo.pdf](http://www.qui.una.py/botanicafeq/Vol%205(1)%201999/Contribuicao%20ao%20estudo.pdf), accessed 20 May 2011.
- Cambie RC, Ferguson LR 2003. Potential functional foods in the traditional Maori diet. *Mutat Res*: 109-117, 523-524.
- Cao S, Guzza RC, Wisse JH, Miller JS, Evans R, Kingston DGI 2005. Ipomoeassins A-E, cytotoxic macrocyclic glycosides from the leaves of *Ipomoea squamosa* from the Suriname rainforest. *J Nat Prod* 68: 487-492.
- Chaudhary SS, Singh H, Handa KL 1957. Chemical composition of *Ipomea palmata* and pharmacology of its extracts. *Curr Sci* 26: 148-149.
- Chen X, Chu Y 1998. Inhibitory effects of ipalbidine on respiratory burst and oxygen free radicals of leukocytes. *Zhongguo Yaolixue Tongbao* 14: 243-244.
- Chérigo L, Pereda-Miranda R, Gibbons S 2009. Bacterial resistance modifying tetrasaccharide agents from *Ipomoea murucoides*. *Phytochemistry* 70: 222-227.
- Cho MK, Jang YP, Kim YC, Kim SG 2004. Arctigenin, a phenylpropanoid dibenzylbutyrolactone lignan, inhibits MAP kinases and AP-1 activation via potent MKK inhibition: the role in TNF-alpha inhibition. *Int Immunopharmacol* 10-11: 1419-1429.
- Choi WS, Lee SE, Lee HS, Lee YH, Park BS 1998. Antioxidative activities of methanol extracts of tropical and oriental medicinal plants. *Han'guk Nonghwa Hakhoechi* 41: 556-559.
- Costa AF 2002. *Farmacognosia*. v. II, 5. ed. Lisboa: Fundação Calouste Gulbenkian.
- Dai H, Xiong J, Zhou J, Ding Z 2000. Chemical constituents from root of *Ipomoea digitata*. *Yunnan Zhiwu Yanjiu*

- 22: 166-168.
- Daló N, Moussatché H 1978. Acción tóxica de las plantas del género *Ipomoeas*. Tarea Común. *Rev Universidad Centro Occidental* 6: 25-39.
- Dawidar AM, Winternitz F, Johns SR 1977. Structure of ipomine, a new alkaloid from *Ipomoea muricata* Jacq. *Tetrahedron* 33: 1733-1734.
- De Balogh KIM, Dimande AP, Van Der Lugt JJ, Molyneux RJ, Naudé TW, Welman WG 1999. A lysosomal storage disease induced by *Ipomoea carnea* in goats in Mozambique. *J Vet Diagn Invest* 11: 266-273.
- Der Marderosian A, Cho E, Chao JM 1974. Isolation and identification of ergoline alkaloids from *Ipomoea muelleri*. *Planta Med* 25: 6-16.
- Der Marderosian AH, Youngken Jr HW 1966. The distribution of indole alkaloids among certain species and varieties of *Ipomoea*, *Rivea*, and *Convolvulus*. *Lloydia* 29: 35-42.
- Dewick PM 2002. *Medicinal Natural Products. A Biosynthetic Approach*. 2. ed. New York: John Wiley & Sons Ltda.
- Diaz JL 1976. *Uso de las Plantas Medicinales de Mexico*. Monografías Científicas II. IMEPLAN, Mexico D.F., Mexico, pp. 31, 56-57, 67, 69, 118.
- Dini I, Tenore GG, Dini A 2009. Saponins in *Ipomoea batatas* tubers: Isolation, characterization, quantification and antioxidant properties. *Food Chem* 113: 411-419.
- Duke JA, Wain KK 1981. *Medicinal Plants of the World, 3 vol. Computer index with more than 85,000 entries*. *Plants genetics and germplasm Institute*. Agriculture Research Service, Beltsville, Maryland.
- Ehattacharya SK, Ray A 1975. Dasgupta, B. Central Nervous System depressant activity of *Ipomoea carnea* Jacq. *Indian J Pharmac* 7: 31-34.
- Eich E, Pertz H, Kaloga M, Schulz J, Fesen MR, Mazumder A, Pommier Y 1996. (-)-Arctigenin as a lead structure for inhibitors of human immunodeficiency virus type-1 integrase. *J Med Chem* 39: 86-95.
- Ejimadu IM, Ogbiede ON 2001. Antimicrobial activities of petroleum ether and ethanol extracts of leaf, stem and root barks of *Ipomoea involucreata* P. Beauv. *J Chem Soc Nigeria* 26: 56-59.
- Emendorfer F, Emendorfer F, Bellato F, Noldin V F, Niero R, Cechinel-Filho V, Cardozo AM 2005. Evaluation of the relaxant action of some Brazilian medicinal plants in isolated guinea-pig ileum and rat duodenum. *J Pharm Pharmaceut Sci* 8: 63-68.
- Enriquez RG, Leon I, Perez F, Walls F, Carpenter KA, Puzzuoli FV, Reynolds WF 1992. Characterization, by two-dimensional NMR spectroscopy, of a complex tetrasaccharide glycoside isolated from *Ipomoea stans*. *Can J Chem* 70: 1000-1008.
- Escobedo-Martínez C, Cruz-Morales S, Fragoso-Serrano M, Rahman MM, Gibbons S, Pereda-Miranda R 2010. Characterization of a xylose containing oligosaccharide, an inhibitor of multidrug resistance in *Staphylococcus aureus*, from *Ipomoea pes-caprae*. *Phytochemistry* 71: 1796-1801.
- Exconde NC, Guevara BQ, Lerma JV, Nonato MG, Sibulo M, Solevilla RC, Songco LV 2004. An antibacterial and analgesic drug material from Tonkin. Project from HERDIN Central Hub.
- Ferrari G 1979. Steroid polyhydroxylates, lysergol, and ergolinic alkaloids. *Ger. Offen. DE 78-2834703* 19780808.
- Ferreira AA, Amaral FA, Duarte IDG, Oliveira PM, Alves RB, Silveira D, Azevedo AO, Raslan DS, Castro MSA 2006. Antinociceptive effect from *Ipomoea cairica* extract. *J Ethnopharmacol* 105: 148-153.
- Ghani A 1989. *Medicinal Plants of Bangladesh*. Published by Asiatic Society of Bangladesh, 201 pp.
- Gilmore M 1977. *Uses of Plants by Indians of the Missouri River Region*. University of Nebraska Press: Lincoln. NB.
- Goda Y, Shimizu T, Kato Y, Nakamura M, Maitani T, Yamada T, Terahara N, Yamaguchi M 1997. Two acylated anthocyanins from purple sweet potato. *Phytochemistry* 44: 183-186.
- Gonzalez Ramirez D, Hernandez RM, Bolado C, Garcia Delgado J 1985. Possible anticonvulsant activity of the root of *Ipomoea stans*. *Salud pública de México* 27: 485-491.
- Górniak S, Gotardo A, Pfister J 2010. The effects of *Ipomoea carnea* on neonate behavior: A study in goats. *Toxicol Lett* 196: S186.
- Gorzalczyński S, Acevedo C, Muschietti L, Martino V, Ferraro G 1996. Search for antiinflammatory activity in Argentine medicinal plants. *Phytomedicine* 3: 181-184.
- Gourley JM, Heacock RA, Mcinnes AG, Nikolin B, Smith DG 1969. Structure of ipalbine, a new hexahydroindolizine alkaloid isolated from *Ipomoea alba*. *J Chem Soc* 13: 709-710.
- Guan Y, Wu T, Lin M, Lin M, Ye J 2006. Determination of pharmacologically active ingredients in sweet potato (*Ipomoea batatas*) by capillary electrophoresis with electrochemical detection. *J Agric Food Chem* 54: 24-28.
- Hahn E 1990. Qualitative and quantitative examination of lysergic acid derivatives in *Ipomoea* species. *Gyogyszereszet* 34: 349-358.
- Halpern JH 2004. Hallucinogens and dissociative agents naturally growing in the United States. *Pharmacol Ther* 102: 131-138.
- Haraguchi M, Gorniak SL, Ikeda K, Minami Y, Kato A, Watson AA, Nash RJ, Molyneux RJ, Asano N 2003. Alkaloidal components in the poisonous plant, *Ipomoea carnea* (Convolvulaceae). *J Agric Food Chem* 51: 4995-5000.
- Hernandez-Carlos B, Bye R, Pereda-Miranda R 1999. Orizabins V-VIII, tetrasaccharide glycolipids from the Mexican scammony root (*Ipomoea orizabensis*). *J Nat Prod* 62: 1096-1100.
- Herrera-Ruiz M, Gutiérrez C, Jiménez-Ferrer JE, Tortoriello J, Mirón G, León I 2007. Central nervous system depressant activity of an ethyl acetate extract from *Ipomoea stans* roots. *J Ethnopharmacol* 112: 243-247.
- Hoffmann A 1963. The active principles of the seeds of *Rivea corymbosa* and *Ipomoea violacea*. *Harvard Univ Bot Mus Leaflet* 20: 194-212.
- Hoffmann A 1971. Teonanácatl and Ololiuqui, two ancient magic drugs of Mexico. *B Narcotics* 1: 3-14.
- Hoffmann A, Cerletti A 1961. Active substances in the third aztec magic drug. The solution to the ololiuqui puzzle. *Deut Med Wochenschr* 86: 885-888.

- Hoffmann A, Tschertter H 1960. Isolation of lysergic acid alkaloid from the Mexican magic drug Ololuiqui (*Rivea corymbosa*). Sandoz Lab., Basel, Switz. *Experientia* 16: 414-416.
- Honda T, Namiki H, Nagase H, Mizutani H 2003. Total synthesis of an indolizidine alkaloid, (+)-ipalbidine, by means of an intramolecular McMurry coupling reaction. *Arkivoc VIII*: 188-198.
- Hueza IM, Fonseca ES, Paulino CA, Haraguchi M, Gorniak SL 2003a. Evaluation of immunomodulatory activity of *Ipomoea carnea* on peritoneal cells of rats. *J Ethnopharmacol* 87: 181-186.
- Hueza IM, Dagli ML, Gorniak SL, Paulino CA 2003b. Toxic effects of prenatal *Ipomoea carnea* administration to rats. *Vet Hum Toxicol* 45: 298-302.
- Hueza IM, Guerra JL, Haraguchi M, Asano N, Gorniak SL 2005. The role of alkaloids in *Ipomoea carnea* toxicosis: A study in rats. *Exp Toxicol Pathol* 57: 53-58.
- Ikeda K, Kato A, Adachi I, Haraguchi M, Asano N 2003. Alkaloids from the poisonous plant *Ipomoea carnea*: effects on intracellular lysosomal glycosidase activities in human lymphoblast cultures. *J Agric Food Chem* 51: 7642-7646.
- Ikhiri K, Kouloido DDD, Garba M, Mamane S, Ahond A, Poupat C, Potier P 1987. New indolizine alkaloids from *Ipomoea alba*. *J Nat Prod* 50: 152-156.
- Islam MS, Yoshimoto M, Yahara S, Okuno S, Ishiguro K, Yamakawa O 2002a. Identification and characterization of foliar polyphenolic composition in sweetpotato (*Ipomoea batatas* L.) genotypes. *J Agric Food Chem* 50: 3718-3722.
- Islam MS, Yoshimoto M, Terahara N, Yamakawa O 2002b. Anthocyanin composition in sweetpotato (*Ipomoea batatas* L.) leaves. *Biosci Biotechnol Biochem* 66: 2483-2486.
- Islam S, Yoshimoto M, Ishiguro K, Yamakawa O 2003. Bioactive compounds in *Ipomoea batatas* leaves. *Acta Hort* 2: 693-699.
- Jayaweera DMA 1982. In: Medicinal plants (indigenous and exotic) used in Ceylon. Part 11, National Science Council, Colombo, Sri Lanka, 99 pp.
- Jenett-Siems K, Kaloga M, Eich E 1993. Ipangulines, the first pyrrolizidine alkaloids from the Convolvulaceae. *Phytochemistry* 34: 437-440.
- Jenett-Siems K, Schimming T, Kaloga M, Eich E, Siems K, Gupta MP, Witte L, Hartmann T 1998. Pyrrolizidine alkaloids of *Ipomoea hederifolia* and related species. *Phytochemistry* 47: 1551-1560.
- Jenett-Siems K, Weigh R, Kaloga M, Schulz J, Eich E 2003. Ipobscurines C and D: macrolactam-type indole alkaloids from the seeds of *Ipomoea obscura*. *Phytochemistry* 62: 1257-1263.
- Jenett-Siems K, Kaloga M, Eich E 2004. Ergobalansine/ergobalansinine, a proline-free peptide-type alkaloid of the fungal genus *Balansia*, is a constituent of *Ipomoea piurensis*. (Erratum to document cited in CA121:297184). *J Nat Prod* 67: 2160.
- Kaneshiro T, Suzui M, Takamatsu R, Murakami A, Ohigashi H, Fujino T, Yoshimi N 2005. Growth inhibitory activities of crude extracts obtained from herbal plants in the Ryukyu Islands on several human colon carcinoma cell lines. *Asian Pacific J Cancer Prev* 6: 353-358.
- Kang SY, Sung SH, Park JH, Kim YC 1998. Hepatoprotective activity of scopoletin, a constituent of *Solanum lyratum*. *Arch Pharmacol Res* 21: 718-722.
- Kano M, Takayanagi T, Harada K 2005. Antioxidative activity of anthocyanins from purple sweet potato, *Ipomoea batatas* cultivar ayamurasaki. *Biosci Biotechnol Biochem* 69: 979-988.
- Khan MM, Ahmad F, Rastogi AK, Kidwai JR 1994. Insulinogenic and hypoglycemic activities of *Ipomoea pes-caprae*. *Fitoterapia* 65: 231-234.
- Kilham C 2004. Tamanu oil: a tropical topical remedy. *Herbalgram* 63: 26-31.
- Ko SG, Koh SH, Jun CY, Nam CG, Bae HS, Shin MK 2004. Induction of apoptosis by *Saussurea lappa* and *Pharbitis nil* on AGS gastric cancer cells. *Biol Pharm Bull* 27: 1604-1610.
- Krauss J, Unterreitmeier D 2005. Synthesis of new lipophilic ipomeanol analogues and their cytotoxic activities. *Arch Pharm (Weinheim Ger)* 338: 44-48.
- Krogh R, Kroth R, Berti C, Madeira AO, Souza MM, Cechinel-Filho V, Delle-Monache F, Yunes RA 1999. Isolation and identification of compounds with antinociceptive action from *Ipomoea pes-caprae* (L.) R. Br. *Die Pharmazie* 54: 464-466.
- Kusano S, Abe H 2000. Antidiabetic activity of white skinned sweet potato (*Ipomoea batatas* L.) in obese Zucker fatty rat. *Biol Pharm Bull* 23: 23-26.
- Kusano S, Abe H, Okada A 1998. Study of antidiabetic activity of white skinned sweet potato (*Ipomoea batatas* L.): comparison of normal and streptozotocin induced diabetic rats and hereditary diabetic mice. *Nippon Nougai Kagaku Kaishi (in Japanese)* 72: 1045-1052.
- Kusano S, Abe H, Tamura H 2001. Isolation of antidiabetic components from White-skinned Sweet Potato (*Ipomoea batatas* L.). *Biosci Biotechnol Biochem* 65: 109-114.
- Lamidi M, Rondi ML, Ollivier E, Faure R, Ekekang LN, Balansard G 2000. Constituents of *Ipomoea fistulosa* leaves. *Fitoterapia* 71: 203-204.
- Lee JH, Lee KT, Yang JH, Baek NI, Kim DK 2004. Acetylcholinesterase inhibitors from the twigs of *Vaccinium oldhami* Miquel. *Arch Pharmacol Res* 27: 53-56.
- Lee L, Cheng E, Rhim J, Ko B, Choi S 1997. Isolation and identification of anthocyanins from purple sweet potatoes. *J Food Sci Nutr* 2: 83-88.
- León I, Enríquez RG, Nieto DA, Alonso S, Reynolds WF, Aranda E, Villa J 2005. Pentasaccharide glycosides from the roots of *Ipomoea murucoides*. *J Nat Prod* 68: 1141-1146.
- León I, Enríquez RE, Gnecco D, Villarreal ML, Cortés DA, Reynolds WF, Yu M 2004. Isolation and characterization of five new tetrasaccharide glycosides from the roots of *Ipomoea stans* and their cytotoxic activity. *J Nat Prod* 67: 1552-1556.
- León-Rivera I, Mirón-López G, Estrada-Soto S, Aguirre-Crespo F, Gutiérrez MC, Molina-Salinas GM, Hurtado G, Navarrete-Vázquez G, Montiel E 2009. Glycolipid ester-type heterodimers from *Ipomoea tyrianthina* and their pharmacological activity. *Bioorg Med Chem Lett* 19: 4652-4656.

- Lima OOA, Braz-Filho R 1997. Dibenzylbutyrolactone lignans and coumarins from *Ipomoea cairica*. *J Braz Chem Soc* 8: 235-238.
- Liu XL, Zhang L, Fu XL, Chen K, Qian BC 2001. Effect of scopoletin on PC3 cell proliferation and apoptosis. *Acta Pharmacol Sin* 22: 929-933.
- Locher CP, Burch MT, Mower HF, Berestecky J, Davis H, Van Poel B, Lasure A, Vanden Berghe DA, Vlietinck AJ 1995. Anti-microbial activity and anti-complement activity of extracts obtained from selected Hawaiian medicinal plants. *J Ethnopharmacol* 49: 23-32.
- Lorenzi H, Abreu Matos FJ 2002. Plantas Medicinales no Brasil. Nativas e exóticas. Instituto Plantarum de Estudos da Flora Ltda. São Paulo.
- Ludvik BH, Mahdjoobian K, Waldhaeusl W, Hofer A, Prager R, Kautzky-Willer A, Pacini G 2002. The effect of *Ipomoea batatas* (Caiapo) on glucose metabolism and serum cholesterol in patients with type 2 diabetes. *Diabetes Care* 25: 239-240.
- Ludvik B, Neuffer B, Pacini G 2004. Efficacy of *Ipomoea batatas* (Caiapo) on diabetes control in type 2 diabetic subjects treated with diet. *Diabetes Care* 27: 436-440.
- Ludvik B, Waldhaeusl W, Prager R, Kautzky-Willer A, Pacini G 2003. Mode of action of *Ipomoea batatas* (Caiapo) in type 2 diabetic patients. *Metabolism* 52: 875-880.
- Luo JG, Kong LY 2005. Study on flavonoids from leaf of *Ipomoea batatas*. *Zhongguo Zhong Yao Za Zhi* 30: 516-518.
- Ma SC, Du J, But PPH, Deng XL, Zhang YW, Ooi VEC, Xu HX, Lee SHS, Lee SF 2002. Antiviral Chinese medicinal herbs against respiratory syncytial virus. *J Ethnopharmacol* 79: 205-211.
- Macleod JK, Ward A, Oelrichs PB 1997. Structural investigation of resin glycosides from *Ipomoea lonchophylla*. *J Nat Prod* 60: 467-471.
- Madlom Z 2002. The Origin of Drugs in Current Use: The Ergot Alkaloids Story. http://www.world-of-fungi.org/Mostly_Medical/Ziad_Madlom/Ergot_alkaloids.htm, accessed 25 May 2011.
- Mahmood N, Moore PS, Tommasi ND, Simone FD, Colman S, Hay AJ, Pizza C 1993. Inhibition of HIV infection by caffeoylquinic acid derivatives. *Antiviral Chem Chemother* 4: 235-240.
- Malalavidhane S, Wickramasinghe SM, Jansz ER 2001. An aqueous extract of the green leafy vegetable *Ipomoea aquatica* is as effective as the oral hypoglycaemic drug tolbutamide in reducing the blood sugar levels of Wistar rats. *Phytother Res* 15: 635-637.
- Malalavidhane TS, Wickramasinghe SM, Jansz ER 2000. Oral hypoglycaemic activity of *Ipomoea aquatica*. *J Ethnopharmacol* 72: 293-298.
- Mamun MM, Billah MM, Ashek MA, Ahasan MM, Hossain MJ, Sultana T 2003. Evaluation of diuretic activity of *Ipomoea aquatica* (Kalmisak) in mice model study. *J Med Sci* 3: 395-400.
- Martinez M 1989. *Las Plantas Mediciniais de Mexico*. Mexico: Ediciones Botas.
- Martinez M 1990. *Las Plantas Mediciniais de Mexico*. Mexico: Ediciones Botas, p. 276-279.
- Matin MA, Tewari JP, Kalani DK 1969a. Pharmacological effects of paniculatin-a glycoside isolated from *Ipomoea digitata* Linn. *J Pharm Sci* 58: 757-759.
- Matin MA, Tewari JP, Kalani DK 1969b. Pharmacological investigations of *Ipomea digitata*. *Indian J Med Sci* 23: 479-482.
- Matsui T, Ebuchi S, Kobayashi M, Fukui K, Sugita K, Terahara N, Matsumoto K 2002. Anti-hyperglycemic effect of diacylated anthocyanin derived from *Ipomoea batatas* cultivar ayamurasaki can be achieved through the α -glucosidase inhibitory action. *J Agric Food Chem* 50: 7244-7248.
- Medeiros RMT, Barbosa RC, Riet-Correa F, Lima EF, Tabosa IM, Barros SS, De Gardner DR, Molyneux RJ 2003. Tremorgenic syndrome in goats caused by *Ipomoea asarifolia* in Northeastern Brazil. *Toxicol* 41: 933-935.
- Meira M 2008. Estudo fitoquímico das partes aéreas de *Ipomoea subincana* (Convolvulaceae). Salvador-BA, 212 p. Tese de Doutorado, Instituto de Química, Universidade Federal da Bahia.
- Meira M, David JM, David JP, Araujo SV, Regis TL, Giulietti AM, Queiróz LP 2008. Chemical constituents of *Ipomoea subincana* Meisn. (Convolvulaceae). *Quim. Nova* 31: 751-754.
- Minamikawa T, Akazawa T, Uritani I 1962. Isolation of esculetin from sweet potato roots with black rot. *Nature (London UK)* 195: 726-727.
- Miyahara MRM, Imamura PM, Freitas JC, Leonor SJ, Baffa O, Kinoshita A, Paula-Zurron ACB 2011. Anti-oxidative and anti-ulcerogenic activity of *Ipomoea imperati*. *Rev Bras Farmacogn* 21: 978-985.
- Misra AL, Tewari JD 1953. Chemical examination of *Ipomoea muricata* seeds. IV. *J Indian Chem Soc* 30: 391-397.
- Misra AL, Tewari JD 1952. Chemical examination of *Ipomoea muricata* seeds. II. *J Indian Chem Soc* 29: 63-67.
- Mitscher LA, Telikepalli H 1992. Bioassay-directed discovery of natural product leads. Antibacterials and antifungals from unusual sources. *Workshop* 5: 281-310.
- Miyazaki Y, Kusano S, Doi H, Aki O 2005. Effects on immune response of antidiabetic ingredients from white-skinned sweet potato (*Ipomoea batatas* L.). *Nutrition* 21: 358-362.
- Mori M, Yoshida K, Ishigaki Y, Matsunaga Y, Nikaido O, Kameda K, Kondo T 2005. UV-B protective effect of a polyacylated anthocyanin, HBA, in flower petals of the blue morning glory, *Ipomoea tricolor* cv. Heavenly Blue. *Bioorg Med Chem* 13: 2015-2020.
- Nam KA, Lee SK 2000. Evaluation of cytotoxic potential of natural products in cultured human cancer cells. *Nat Prod Sci* 6: 183-188.
- Navarro-Ruiz A, Mora GP de La, Villanueva-Michel MT, Dominguez-Rodriguez JR, Bastidas-Ramirez BE, Quezade-Arellano JD, Ruiz-Nikolin A, Nikolin B, Jankovi M 1978. Ipopurpurosido, a new glycoside from *Ipomoea purpurea*. *Phytochemistry* 17: 451-452.
- Noda N, Nishi M, Ono M, Miyahara K, Kawasaki T 1985. Isolation and structures of the resin glycosides of *Ipomoea orizabensis* (roots) and *I. muricata* (seeds). Fac. Pharm. Sci., Setsunan Univ., Japan. *Tennen Yuki Kagobutsu Toronkai Koen Yoshishu* 27: 427-434.
- Noda N, Ono M, Miyahara K, Kawasaki T 1987. Resin glycosides. I. Isolation and structure elucidation of

- orizabin I, II, III and IV. Genuine resin glycosides from the root of *Ipomoea orizabensis*. *Tetrahedron* 43: 3889-3902.
- Noda N, Kobayashi H, Miyahara K, Kawasaki T 1988a. Resin glycosides. III. Isolation and structural study of the genuine resin glycosides, muricatins I-VI, from the seeds of *Ipomoea muricata*. *Chem Pharm Bull* 36: 920-929.
- Noda N, Nishi M, Miyahara K, Kawasaki T 1988b. Resin glycosides. IV. Two new resin glycosides, muricatins VII and VIII, from the seeds of *Ipomoea muricata*. *Chem Pharm Bull* 36: 1707-1713.
- Noda N, Kobayashi H, Miyahara K, Kawasaki T 1988c. Resin glycosides. II. Identification and characterization of the component organic and glycosidic acids of the crude resin glycoside from the seeds of *Ipomoea muricata*. *Chem Pharm Bull* 36: 627-633.
- Noda N, Kogetsu H, Kawasaki T, Miyahara K 1990. Scammonins I and II, the resin glycosides of radix scammoniae from *Convolvulus scammonia*. *Phytochemistry* 29: 3565-3569
- Noda N, Yoda S, Kawasaki T, Miyahara K 1992. Resin Glycosides. XV. Simonins I-V, ether-soluble resin glycosides (jalapins) from the roots of *Ipomoea batatas* (cv. Simon). *Chem Pharm Bull* 40: 3163-3168.
- Noda N, Takahashi N, Kawasaki T, Miyahara K, Yang CR 1994. Stoloniferins I-VII, resin glycosides, from *Ipomoea stolonifera*. *Phytochemistry* 36: 365-371.
- Noda N, Takahashi N, Miyahara K, Yang CR 1998. Stoloniferins VIII-XII, resin glycosides, from *Ipomoea stolonifera*. *Phytochemistry* 48: 837-841.
- Odake K, Terahara N, Saito N, Toki K, Honda T 1992. Chemical structures of two anthocyanins from purple sweet potato, *Ipomoea batatas*. *Phytochemistry* 31: 2127-2130.
- Okudaira R, Kyanbu H, Ichiba T, Toyokawa T 2005. *Ipomoea* extracts with disaccharidase-inhibiting activities. *Jpn. Kokai Tokkyo Koho JP* 2005213221.
- Oliveira EJ, Romero MA, Silva MS, Silva BA, Medeiros IA. 2001. Intracellular calcium mobilization as a target for the spasmolytic action of scopoletin. *Planta Med* 67: 605-608.
- Ono M, Kubo K, Miyahara K, Kawasaki T 1989. Operculin I and II, new ether-soluble resin glycosides ("jalapin") with fatty acid ester groups from Rhizoma Jalapae Braziliensis (roots of *Ipomoea operculata*). *Chem Pharm Bull* 37: 241-244.
- Ono M, Nishi M, Kawasaki T, Miyahara K 1990. Resin glycosides. IX. Operculins I, II, V, VII and VIII, new ether-soluble resin glycosides of Rhizoma Jalapae Braziliensis (the roots of *Ipomoea operculata*). *Chem Pharm Bull* 38: 2986-2991.
- Ono M, Kawasaki T, Miyahara K 1991. Resin glycosides. XI. Operculins III, IV, IX, X, XVI, XVII and XVIII, new ether-soluble resin glycosides of rhizoma jalapae braziliensis (root of *Ipomoea operculata*). *Chem Pharm Bull* 39: 2534-2539.
- Ono M, Fujimoto K, Kawata M, Fukunaga T, Kawasaki T, Miyahara K 1992a. Resin glycosides. XIII. Operculins VI, XI, XII, XIII, XIV and XV, the ether-soluble resin glycosides (jalapin) from Rhizoma Jalapae Braziliensis (roots of *Ipomoea operculata*). *Chem Pharm Bull* 40: 1400-1403.
- Ono M, Ueguchi T, Murata H, Kawasaki T, Miyahara K 1992b. Resin glycosides. XVI. Marubajalapins I-VII, new ether-soluble resin glycosides from *Pharbitis purpurea*. *Chem Pharm Bull* 40: 3169-3173.
- Pale E, Kouda-Bonafos M, Nacro M, Vanhaelen M, Vanhaelen-Fastré R 2003. Two triacylated and tetraglucosylated anthocyanins from *Ipomoea asarifolia* flowers. *Phytochemistry* 64: 1395-1399.
- Pale E, Nacro M, Vanhaelen M, Vanhaelen-Fastret R, Ottinger R 1998. Acylated anthocyanins from the flowers of *Ipomoea asarifolia*. *Phytochemistry* 48: 1433-1437.
- Panaccione DG 2005. Origins and significance of ergot alkaloid diversity in fungi. *FEMS. Microbiol Lett* 251: 9-17.
- Patel AK, Singh VK, Yadav RP, Moir AJG, Jagannadham MV 2009. ICChI, a glycosylated chitinase from the latex of *Ipomoea carnea*. *Phytochem* 70: 1210-1216.
- Patel AK, Singh VK, Yadav RP, Moir AJG, Jagannadham MV 2010. Purification and characterization of a new chitinase from latex of *Ipomoea carnea*. *Process Biochem.* 45: 675-681.
- Paula ACB, Hayashi LSS, Freitas JC 2003. Anti-inflammatory and antispasmodic activity of *Ipomoea imperati* (Vahl) Griseb (Convolvulaceae). *Braz J Med Biol Res* 36: 105-112.
- Paula-Zurron ACB, Petraglia NMMA, Aur CR, Moura SHP, Imamura PM., Freitas JC, Catanzaro-Guimarães AS 2010. Antinociceptive activity of *Ipomoea imperati* (Vahl) Griseb Convolvulaceae. *Rev Bras Farmacogn* 20: 180-185.
- Pereda-Miranda R, Bah M 2003. Biodynamic constituents in the mexican morning glories: purgative remedies transcending boundaries. *Curr Top Med Chem* 3: 111-131.
- Pereda-Miranda R, Hernández-Carlos B 2002. HPLC Isolation and structural elucidation of diastereomeric niloyl ester tetrasaccharides from Mexican scammony root. *Tetrahedron* 58: 3145-3154.
- Pereda-Miranda R 1995. Bioactive natural products from traditionally used Mexican plants. In: Arnason JT, Mata R, Romeo JT. *Phytochemistry of medicinal plants*. New York: Plenum Press, p. 83-112.
- Pereda-Miranda R, Escalante-Sánchez E, Escobedo-Martínez C 2005. Characterization of lipophilic pentasaccharides from beach morning glory (*Ipomoea pes-caprae*). *J Nat Prod* 68: 226-230.
- Pereda-Miranda R, Mata R, Anaya AL, Wickramaratne DBM, Pezzuto JM, Kinghorn AD 1993. Tricolorin A, major phytochemical inhibitor from *Ipomoea tricolor*. *J Nat Prod* 56: 571-582.
- Perusquia M, Mendoza S, Bye R, Linares E, Mata R 1995. Vasoactive effects of aqueous extracts from five Mexican medicinal plants on isolated rat aorta. *J Ethnopharmacol* 46: 63-69.
- Philpott M, Ferguson LR, Gould KS, Harris PJ 2009. Anthocyanidin-containing compounds occur in the periderm cell walls of the storage roots of sweet potato (*Ipomoea batatas*). *J Plant Physiol* 66: 1112-1117.
- Pípole F, Latorre AO, Hueza IM 2010. *Ipomoea carnea*, a poisonous plant, promotes changes in lymphocyte distribution of young rats. *Toxicol Lett* 196: S200.

- Pongprayoon U, Bohlin L, Sandberg F, Wasuwat S 1989. Inhibitory effect of extract of *Ipomoea pes-caprae* on guinea-pig ileal smooth muscle. *Acta pharm (Nordica) 1*: 41-44.
- Pongprayoon U, Bohlin L, Wasuwa S 1991a. Neutralization of toxic effects of different crude jellyfish venoms by an extract of *Ipomoea pes-caprae* (L.) R. Br. *J Ethnopharmacol 35*: 65-69.
- Pongprayoon U, Baeckstrom P, Jacobsson U, Lindstrom M, Bohlin L 1991b. Compounds inhibiting prostaglandin synthesis isolated from *Ipomoea pes-caprae*. *Planta Med 57*: 515-518.
- Pongprayoon U, Baeckstrom P, Jacobsson U, Lindstrom M, Bohlin L 1992a. Antispasmodic activity of β -damascenone and E-phytol isolated from *Ipomoea pes-caprae*. *Planta Med 58*: 19-21.
- Pongprayoon U, Baeckström P, Jacobsson U, Lindström M, Bohlin L 1992b. Inhibition of ethyl phenylpropionate-induced rat ear oedema by compounds isolated from *Ipomoea pes-caprae*. *Phytother Res 6*: 104-107.
- Prasad KN, Divakar S, Shivamurthy GR, Aradhya SM 2005a. Isolation of a free radical-scavenging antioxidant from water spinach (*Ipomoea aquatica* Forsk.). *J Sci Food Agric 85*: 1461-1468.
- Prasad KN, Ashok G, Raghu C, Shivamurthy GR, Vijayan P, Aradhya SM 2005b. *In vitro* cytotoxic properties of *Ipomoea aquatica* leaf. *Indian J Pharmacol 37*: 397-398.
- Rabah IO, Hou DX, Komine S, Fujii M 2004. Potential chemopreventive properties of extract from baked sweet potato (*Ipomoea batatas* Lam. Cv. Koganesengan). *J Agric Food Chem 52*: 7152-7157.
- Rao CB, Suseela K, Rao PVS, Krishna PG, Raju GVS 1984. Chemical examination of some Indian medicinal plants. *Indian J Chem 8*: 787-788.
- Rao KS, Rangan D, Singh K, Kaluwin C, Donalds E, Rivett G, Jones P 1990. Lipid, fatty acid, amino acid and mineral composition of five edible plant leaves. *J Agric Food Chem 38*: 2137-2139.
- Reynolds WF, Yu M, Enriquez RG, Gonzalez H, Leon I, Magos G, Villareal ML 1995. Isolation and characterization of cytotoxic and antibacterial tetrasaccharide glycosides from *Ipomoea stans*. *J Nat Prod 58*: 1730-1734.
- Rogers KL, Grice ID, Griffiths LR 2000. Inhibition of platelet aggregation and 5-HT release by extracts of Australian plants used traditionally as headache treatments. *Eur J Pharm Sci 9*: 355-363.
- Runnie I, Salleh MN, Mohamed S, Head RJ, Abeywardena MY 2004. Vasorelaxation induced by common edible tropical plant extracts in isolated rat aorta and mesenteric vascular bed. *J Ethnopharmacol 92*: 311-316.
- Saito N, Tatsuzawa F, Yoda K, Yokoi M, Kasahara K, Iida S, Shigihara A, Honda T 1995. Acylated cyanidin glycosides in the violet-blue flowers of *Ipomoea purpurea*. *Phytochemistry 40*: 1283-1289.
- Saito N, Tatsuzawa F, Yokoi M, Kasahara K, Iida S, Shigihara A, Honda T 1996. Acylated pelargonidin glycosides in red-purple flowers of *Ipomoea purpurea*. *Phytochemistry 43*: 1365-1370.
- Saito N, Tatsuzawa F, Kasahara K, Iida S, Honda T 1998. Acylated cyanidin 3-sophorosides in the brownish-red flowers of *Ipomoea purpurea*. *Phytochemistry 49*: 875-880.
- Saito N, Toki K, Morita Y, Hoshino A, Lida S, Shigihara A, Honda T 2005. Acylated peonidin glycosides from duskish mutant flowers of *Ipomoea nil*. *Phytochemistry 66*: 1852-1860.
- Sarin JPS, Garg HS, Khanna NM, Dhar MM 1973. Ipolearoside: A new glycoside from *Ipomoea leari* with anti-cancer activity. *Phytochemistry 12*: 2461-2468.
- Sattar EA, Gala A, Rashwan O 1995. Caffeoyl derivatives from the seeds of *Ipomoea fistulosa*. *Int J Pharm 33*: 155-158.
- Schimming T, Tofern B, Mann P, Richter A, Jenett-Siems K, Dräger B, Asano N, Gupta MP, Correa MD, Eich E 1998. Distribution and taxonomic significance of calystegines in the Convolvulaceae. *Phytochemistry 49*: 1989-1995.
- Schimming T, Jenett-Siems K, Mann P, Tofern-Reblin B, Milson J, Johnson RW, Derooin T, Austin DF, Eich E 2005a. Calystegines as chemotaxonomic markers in the Convolvulaceae. *Phytochemistry 66*: 469-480.
- Schimming T, Jenett-Siems K, Siems K, Witte L, Eich E 2005b. N1, N10-ditigloylspermidine, a novel alkaloid from the seeds of *Ipomoea nil*. *Pharmazie 60*: 958-959.
- Schwarz A, Hosomi RZ, Henrique BS, Hueva I, Gardner D, Haraguchi M, Górniak SL Bernardi MM, Spinosa HS 2004. Identificação de princípios ativos presentes na *Ipomoea carnea* brasileira. *Rev Bras Cienc Farm 40*: 181-187.
- Shah CS, Qadry JS, Krishnamurthy TN 1972. Sugars and coumarins in Black-turpeth (*Ipomea turpethum*). *Indian J Pharm 34*: 126-127.
- Sharda S, Kokate CK 1979. Indole alkaloids from the leaves of *Ipomoea palmata* Forsk. *Indian Drugs 17*: 70-71.
- Shaw CY, Chen CH, Hsu CC, Chen CC, Tsai YC 2003. Antioxidant properties of scopoletin isolated from *Sinomonium acutum*. *Phytother Res 17*: 823-825.
- Silva MSH 2002. Plantas com potencial terapêutico: elo integrador na promoção da saúde. I Congresso Brasileiro de Extensão Universitária. João Pessoa, Paraíba. http://www.prac.ufpb.br/anais/Icbeu_anais/anais/saude/plantas.pdf, accessed May 2011.
- Sindambiwe JB, Calomme M, Cos P, Totté J, Pieters L, Vlietinck A, Berghe DV 1999. Screening of seven selected Rwandan medicinal plants for antimicrobial and antiviral activities. *J Ethnopharmacol 65*: 71-77.
- Singh S, Stacey BE 1973. A new β -D-Quinovoside from commercial *Ipomoea purga*. *Phytochemistry 12*: 1701-1705.
- Singh V, Pandey M, Srivastava A, Sethi R 2003. A non-ionic water-soluble seed gum from *Ipomoea campanulata*. *Fitoterapia 74*: 40-44.
- Singh V, Srivastava V, Sethi R 2004. *Ipomoea digitata* seed gum and the gum-g-polyacrylamide: potential pharmaceutical gums. *Pharm Biol 42*: 230-233.
- Smith Jr. CR, Niece LH, Zobel HF, Wolff IA 1964. Glycosidic constituents of *Ipomoea parasitica* seed. *Phytochemistry 3*: 289-299.
- Son K, Severson RF, Arrendale RF, Kays SJ 1990. Isolation and characterization of pentacyclic triterpene ovipositional stimulant for the sweet potato weevil from *Ipomoea batatas* (L.) Lam. *J Agric Food Chem 38*: 134-137.
- Souza MM, Madeira A, Berti C, Krogh R, Yunes RA, Cechinel-Filho V 2000. Antinociceptive properties of the methanolic extract obtained from *Ipomoea pes-caprae*

- (L.) R. Br. *J Ethnopharmacol* 69: 85-90.
- Stanescu U, Riscalcic E, Grigorescu E 1973. Phytochemical study of *Ipomoea violacea* seeds. *Farmacía (Bucharest, Romania)* 21: 719-728.
- Stange Jr RR, Midland SL, Holmes GJ, Sims JJ, Mayer RT 2001. Constituents from the periderm and outer cortex of *Ipomoea batatas* with antifungal activity against *Rhizopus stolonifer*. *Postharvest Biol. Technol* 23: 85-92.
- Steinegger E, Heimann H 1966. Pharmacochimistry and psychic effect of three Mexican wonder drugs. *Gesellschaft in Bern* 23: 83-99.
- Suda I, Furuta S, Nishiba Y, Matsugano K, Sugita K 1997. Reduction of liver injury induced by carbon tetrachloride in rats administered purple-colored sweetpotato juice. *Nippon Shokuhin Kagaku kogaku Kaishi (in Japanese)* 44: 315-318.
- Sun YL, Sun JM, Li QP 2009. Purification and trypsin inhibitor activity of a sporamin B from sweet potato (*Ipomoea batatas* Lam.). *Agric Sci (China)* 8: 808-820.
- Taber WA, Vinig LC, Heacock RA 1963. Clavine and lysergic acid alkaloids in varieties of morning glory. *Phytochemistry* 2: 65-70.
- Tan G, Xu P, Dai Z, Tang G 1995. Studies on the chemical components of *Ipomoea batatas* Lam. *Tianran Chanwu Yanjiu Yu Haifa* 7: 44-46.
- Terahara N, Shimizu T, Kato Y, Nakamura M, Maitani T, Yamaguchi M, Goda Y 1999. Six diacylated anthocyanins from the storage roots of purple sweet potato, *Ipomoea batatas*. *Biosci Biotechnol Biochem* 63:1420-1424.
- Teramachi F, Koyano T, Kowithayakor T, Hayashi M, Komiyama K, Ishibashi M 2005. Collagenase inhibitory quinic acid ester from *Ipomoea pes-caprae*. *J Nat Prod* 68: 794-796.
- Tewati JP, Mishra SS 1965. Pharmacological investigations of *Ipomoea digitata*. *Vijnana Parishad Anusandhan Patrika* 7: 85-88.
- Thomas TG, Rao S, Lal S 2004. Mosquito larvicidal properties of essential oil of an indigenous plant, *Ipomoea cairica* Linn. *Jpn J Infect* 57: 176-177.
- Trute A, Gross J, Mutschler E, Nahrstedt A 1997. *In vitro* antispasmodic compounds of the dry extract obtained from *Hedera helix*. *Planta Med* 63: 125-129.
- Tseng CF, Iwakami S, Mikajiri A, Shibuya M, Hanaoka F, Ebizuka Y, Padmawinata K, Sankawa U 1992. Inhibition of *in vitro* prostaglandin and leukotriene biosyntheses by cinnamoyl-beta-phenethylamine and *N*-acyldopamine derivatives. *Chem Pharm Bull* 40: 396-400.
- Tseng CF, Mikajiri A, Shibuya M, Goda Y, Ebizuka Y, Padmawinata K, Sankawa U 1986. Effects of some phenolics on the prostaglandin synthesizing enzyme system. *Chem Pharm Bull* 34: 1380-1383.
- Tsukui A, Kuwano K, Mitamura T 1983. Anthocyanin pigment isolated from purple root of sweet potato. *Kaseigaku Zasshi* 34: 153-159.
- Uawonggul N, Chaveerach A, Thammasirirak S, Arkaravichien T, Chuachan C, Daduang S 2006. Screening of plants acting against *Heterometrus laoticus* scorpion venom activity on fibroblast cell lysis. *J Ethnopharmacol* 103: 201-207.
- Umar S, Junior P, Wichtl M 1980. Isolation and identification of agroclavin and -dihydrolysergol from leaves of *Ipomoea fistulosa*. *Planta Med* 40: 328-332.
- Wagner H 1973. The chemistry of the resin glycosides of the Convolvulaceae family, in: Bendz G, Santesson J (eds.), *Medicine and Natural Sciences, Chemistry in Botanical Classification*, Academic Press., New York, p. 235-240.
- Wang LM, Chu YH 1996. Effect of norepinephrinergic system on ipalbidine analgesia. *Acta Pharm Sinica* 31: 806-811.
- Wasuwat S 1970. Extract of *Ipomoea pes-caprae* (Convolvulaceae) antagonistic to histamine and jelly-fish poison. *Nature* 225: 758-59.
- Weber JM, Ma TS 1976. Microchemical investigations of medicinal plants. XIV. Identification of the alkaloids in the leaves of *Ipomoea violacea* using preparative thin layer chromatography and solid probe mass spectrometry. *Mikrochimica Acta* 1: 227-242.
- Wills RBH, Azhari R 1996. Determination of carotenoids in Chinese vegetables. *Food Chem* 56: 451-455.
- Woradulayapinij W, Soonthornchareonnon N, Wiwat C 2005. *In vitro* HIV type 1 reverse transcriptase inhibitory activities of Thai medicinal plants and *Canna indica* L. rhizomes. *J Ethnopharmacol* 101: 84-89.
- Yang C, Tsai T 1999. Four acylated anthocyanins from red skin sweet potatoes (*Ipomoea batatas*). *Shipin Kexue (Tapei)* 26: 182-192.
- Yin YQ, Wang JS, Luo JG, Kong LY 2009. Novel acylated lipopoligosaccharides from the tubers of *Ipomoea batatas*. *Carbohydr Res* 344: 466-473.
- Yoshimoto M 2001. New trends of processing and use of sweetpotato in Japan. *Farming Japan* 35: 22-28.
- Yoshimoto M, Okuno S, Yamaguchi M, Yamakawa O 2001. Antimutagenicity of deacylated anthocyanins in purple-fleshed sweetpotato. *Biosci Biotechnol Biochem* 65: 1652-1655.
- Yoshimoto M, Okuno S, Yoshinaga M, Yamakawa O, Yamaguchi M, Yamada J 1999. Antimutagenicity sweetpotato (*Ipomoea batatas*) roots. *Biosci Biotechnol Biochem* 63: 537-541.
- Yoshimoto M, Yahara S, Okuno S, Islam MS, Ishiguro K, Yamakawa O 2002. Antimutagenicity of mono-, di-, and tricaffeoylquinic acid derivatives isolated from sweetpotato (*Ipomoea batatas*) leaf. *Biosci Biotechnol Biochem* 66: 2336-2341.
- Ysrael MC 2003. Tonkin herbal drug: a multidisciplinary approach to development. *Clin Hemorheol Micro* 29: 247-251.
- Yuan SQ, Zhao YM, You Y 2004. Alkaloids of the hairy roots of *Ipomoea batatas* Lam. *Acta Pharm Sin* 39: 818-20.
- Zhao G, Kan J, Li Z, Chen Z 2005. Characterization and immunostimulatory activity of an (1→6)-a-D-glucan from the root of *Ipomoea batatas*. *Int Immunopharmacol* 5: 1436-1445.
- Zheng W, Clifford MN 2008. Profiling the chlorogenic acids of sweet potato (*Ipomoea batatas*) from China. *Food Chem* 106: 147-152.
- Zhou J, Zhao G, Jin W, Zheng W, Chi Z 1988. Title. *Chin Acad Sci Shanghai* 9: 107-111.

***Correspondence**

Marilena Meira
Instituto de Química, Sala 218, Universidade Federal da Bahia,
Campus Universitário de Ondina
Rua Barão de Jeremoabo s/n, 40170-115 Salvador-BA, Brazil
marimeir@ufba.br
Tel: +55 71 3283 6842