Pharmacogn. Commn. 2018; 8(4): 138-145
A multifaceted peer reviewed journal in the field of Pharmacognosy and Natural Products
www.phcogcommn.org

Review Article

Pharmacological and Phytochemical Updates on *Pothos scandens* L

Saurabh Gupta[1], Shareen Singh[1], Renu Gupta[2], Thakur Gurjeet Singh[1,*]
[1]Chitkara College of Pharmacy, Chitkara University, Chandigarh-Patiala National Highway (NH-64), Rajpura 140 401, Punjab, INDIA.
[2]Dr. Batra's Homeopathic Clinic, M.G. Road, Indore 452001, Madhya Pradesh, INDIA.

ABSTRACT

Pothos scandens L. (*Pothos scandens*) belonging to the family araceae used as folk healing worldwide possessing several ethnomedicinal properties for treatment of various devasting disorders. Phytochemical analysis of various parts of plant *Pothos scandens* indicated the presence of several metabolites. These metabolites include the various excretory product of the plant such as alkaloids, tannins, saponins, glycosides and flavonoids etc. tends to show curative and therapeutic values in various diseases. The several extract-based studies isolated bioactive compounds of *Pothos scandens* possessing various activities like anticancer, antioxidant, histamine release inhibitory activities using *in-vivo* and *in-vitro* models. Knowing the significance of this plant in traditional medicine and the diverse usage of herbal plants gaining the more popularity now days in exploring many new possibilities in different diseases. The present review has been focused on traditional uses, phyto-chemistry and biological studies of *Pothos scandens*, which are being used in folklore medicines.

Key words: *Pothos scandens,* Alkaloids, Flavonoids, Terpenoids, Antimicrobial activity, Antioxidant activity, Burn wound healing.

Correspondence:
Dr. Thakur Gurjeet Singh
Chitkara College of Pharmacy, Chitkara University, Chandigarh-Patiala National Highway (NH-64), Rajpura 140 401, Punjab, INDIA.
Phone no: +91 9815951171
E-mail: gurjeet.singh@chitkara.edu.in
DOI: 10.5530/pc.2018.4.30.

INTRODUCTION

Traditional medicine is widely used for treatment of various diseases in most countries due to its safe, cost-efficient and effective nature.[1-2] *P. scandens* Linnaeus is a traditional medicinal plant belongs to the family *Araceae.* This medicinal plant is utilized widely throughout the world to cure various diseases. The *P. scandens* have shown its potency in diseases like asthma, snake bite, diarrhea, cancer, small pox, sprains, epilepsy, skin diseases, boils, swellings, wounds, ulcers, dropsy, vomiting, flatulence, strangury, burning sensation, intermittent fever, skin disorder, reduce swelling, malaria, convulsions and wounds etc.[3-12] The climbing aroid is known by several local and common names (i.e. English*: Climbing aroid,* Assamese*: Kokalsepalata,* Bengali*: Batilata,* Kannada*: Adhikabeeluballi,* Malayalam*: Anaparua,* Marathi*: bendarli,* Tamil: *Anaparuga* etc.).[3,10] *P. scandens*is an epiphyte with climbing and rooting branches. Its leaves are (5-10)×(1-5) cm, distichous, ovate or ovate-lanceolate, acute or acuminate, obliquely linear with broad flat truncate petiole, sheathing at the base, having a bright green color. Flowers are small in globose or ovoid, peduncled yellow spadix. The fruits or berries are 1.3-1.7 cm long, oblong and on ripe they become scarlet. Seeds are 3-6 mm in diameter, ellipsoid to compressed-spherical with smooth testa and lacking albumen.[2,3] The plant is mainly a native to the Himalaya as well Indo-Burma region and Madagascar. However, it is commonly found on rocks, walls, tree trunks in moist and wet forests in northeastern India. In other parts of India, it is found in Bihar, Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu, Andaman and Nicobar Islands.[13-24] The earlier phytochemical studies on the current plant reported to contain both primary and secondary metabolites. The preliminary phytochemical screening reported some of the several secondary metabolites from the different parts of plant. Amongst isolated compounds of the current plant, the syringoyl derivatives from the methanolic extract of *P. scandens* tends to show strong anti-estrogenic activity against human breast cancer cell lines. The flavonoids, luteolin, apigenin and kaempferol were found to have strong hyaluronidase and histamine release inhibitory activity.[10] Various studies of *P. scandens* extracts or its constituents showed that the plant possess some of the diverse biological activities like antioxidant, antipyretic, anti-diabetic, free radical scavenging, burn wound healing, anticarcinogenic, anti-estrogenic, hyaluronidase inhibition, histamine release inhibitory, antiseptic, anti-inflammatory, antimicrobial, anticancer, bronchodilator like biological activities of the plant.[10-12,25-36] Despite of the several use of this plant for ethnomedicinal agent, only a few of compounds were isolated from the plant extracts.

Traditional uses

The plant is used traditionally by implementing their own various methods to use this plant like the stem partof the plantis cut up with camphor and smoked like tobacco for treatment of asthma throughoutIndia.[4] The root of the plant is also cut and fried in oil to promote the curing process of abscesses. The people of Northeast India uses the whole plant for bone fracture.[21] Fruits of *P. scandens* are cooked and seeds are roasted and consumed by people in Kerala and also the whole plant is used to cure skin diseases, boils, wounds, ulcers, dropsy, vomiting, flatulence, strangury and burning sensation by the people of Thrissur district, Kerala.[9] The whole plant is used for treating skin disorders, asthma, diarrhea, cancer, small pox, sprains, epilepsy, convulsions and wounds by the tribal peoples of the hill regions of Bangladesh.[10] The leaves of *P. scandens* is used by the tribal people of Sri Lanka to reduce swelling speedily in trauma area.[11] The ethnic people (Kanikaran) of Southern Western Ghats of India use *P. scandens* leaves mixed with the fruits of *Capsicum annuum* and rhizome of *Allium sativum* and the mixture is ground into a paste with coconut oil and applied topically on affected places to healwounds created during delivery.[5,11,28] Chinese people use the plant as blood coagulant for wounds, tumors and drinking for anti-cough.[28] The leaves are used as tea by the Dai ethnic minority.[37] The powdered leaves are applied to the body to cure small pox, increases milk in cows, stem and leaves are used in snake bites.[48] For a summary of the ethnomedicinal uses reported for *P. scandens* (Table 1).

Identifications of phytochemicals constituents

Phytochemical analysis of this plant confirms the presence of various phytochemicals like alkaloids, flavonoids, tannins, terpenoids, saponin, catechin, coumarin, phenol, sugar, glycoside and xanthoprotein steroids,

Table 1: Ethanomedical uses of *Pothos scandens.*

Plant part	Method of preparation	Use	References
Leaf	Mixed with the fruits of *Capsicum annuum* and rhizome of *Allium sativum*and paste with coconut oil.	Wound healing	11
	Infusion	Convulsions,epilepsy	30
	Unspecified	Reduce swelling	11
	Boiled water decoctions	Tea	37
	Unspecified	Reduce body heat and induce conception, skin disorders	27,28
	Powder	Small pox	36
		Increases milk in Cows	36
Stem part	Cut up with camphor and smoked like tobacco	Asthma	4
Aerial parts		Cancer	34,6
Whole plant	Decoction	Diarrhea	8
	Unspecified	Skin disorders, asthma, snake bite, cancer, smallpox, sprains, epilepsy, wounds, convulsions, bone fracture, blood coagulant, tumors, anti-cough, hysteia, ulcers, dropsy, vomiting, burning sensation.	5-12,30,21, 31
Root part	Cut and fried in oil	Curing process of Abscesses	10,36

Table 2: Type of Phytochemicals present in *Pothos scandens.*

Plant part	Extracts	Type of Phytochemicals reported	References
Leaf	Petroleum ether	Coumarin, Phenol, Tannin	25
	Benzene	Flavonoid, Steroid, Xanthoprotein.	25
	Chloroform	Alkaloid, Flavonoid, Coumarin, Phenol, Saponin, Tannin, Terpenoid, Sugar, Xanthoprotein	25
	Methanol	Reducing sugar, Alkaloids, Reducing Sugar, Glycoside, Tannins, Steroids, saponins.	30
	Ethanol	Alkaloid, Catachin, Flavonoid, Coumarin, Phenol, Saponin, Tannin, Sugar, Xanthoprotein.	25
Stem	Methanol and Ethanol	Alkaloid, saponins, tannin, glycosides, Hydroquinone, Flavones, Flavonols.	31
Whole plant	Methanol	Tannins, Terpenoid, Alkaloid, Steroid, Saponins, Flavonoids.	36,48
Aerial	Ethanolicand Aqueous	Alkaloids, Carbohydrates, fixed oil, proteins, glycosides, flavonoids and Phenolic compounds	28

proteins, reducing sugars, carbohydrates and cardiac glycosides, phytosterols, fixed oils and fats, gums and mucilage according to standard methods in its different extracts[28,30,31,36] as shown in Table 2.

Among leaf, stem and root of *P. scandens*, the ethanol extract of stem showed better phenolic content as compared to that of leaf and root. Although, acetone and methanol extracts of all parts used were found to have appreciable amount of total phenolic ranging from 111.1 to 238.5 mg GAE/g extract, but the absolute ethanol was found to be more efficient solvent for extracting the phenolics from different parts of *P. scandens*. The amount of tannins was found to be higher in ethanol and methanol extracts of leaf, stem and root parts of *P. scandens* ranging from 109.9 to 156.0 mg GAE/g extract respectively. Also, acetone extract of root has found higher flavonoid content as compared to other solvent extracts of root.[31,55]

Muhit *et al.* reported the isolation of eighteen compounds from the methanol extract of stem and root, namely pothobanoside A **(1)**, pothobanoside B **(2)**, pothobanoside C **(3)**, pothobanol **(4)**, eleutherazine B **(5)**, isoschaftoside **(6)**, vicenin-2 **(7)**, neoschaftoside **(8)**, vitexin 2˝˝-O-xyloside **(9)**, kaempferol 3-O-gentiobioside **(10)**, quercetin 3 O-gentioside **(11)**, isorhamnetin3-Ogentiobioside **(12)**, canthoside B **(13)**, zizybeoside I **(14)**, markhamioside F **(15)**, canthoside A **(16)**, 1, 2, 3, 4- tetrahydro-3-carboxy-2-carboline **(17)**, scoparin 2˝˝-O-xyloside**(18).**[10,53-64] According to Liu *et al.* from the AcOEt extract of the whole plant of *P. scandens* yields a novel diterpenoid methyl pothoscandensate**(19)** as well as known compounds N-trans-cinnamoyltyramine **(20)**, N-trans-feruloyltyramine **(21)**, N-trans-p-cumaroyltyramine **(22)**, (–)-serotobenine **(23)**, (3β)-ent-kaurane-3,16,17-triol **(24)**, (+)-syringaresinol **(25).**[37,38-47]

According to Gupta *et al.* 5-Oxoundecyl- 3-hydroxypentanoate **(26)** was isolated from theethanolic extract of aerial part of *P. scandens* including known compounds.[28]

Lalitharani *et al.* identified and characterized nineteen compounds by GC-MS analysis from the ethanolic extract of leaf of *P. scandens*as dodecanoic acid **(27)**, tetra decanoic acid **(28)**, hexadecenoic acid **(29)**, octadecanoic acid **(30)**, 2-methyl-1-Hexadecanol **(31)**, 2-hexa- decanol **(32)**,1,1-diethoxy- Butane **(33)**, d-Mannose **(34)**, 2,3-dihydro-3,5-dihy-

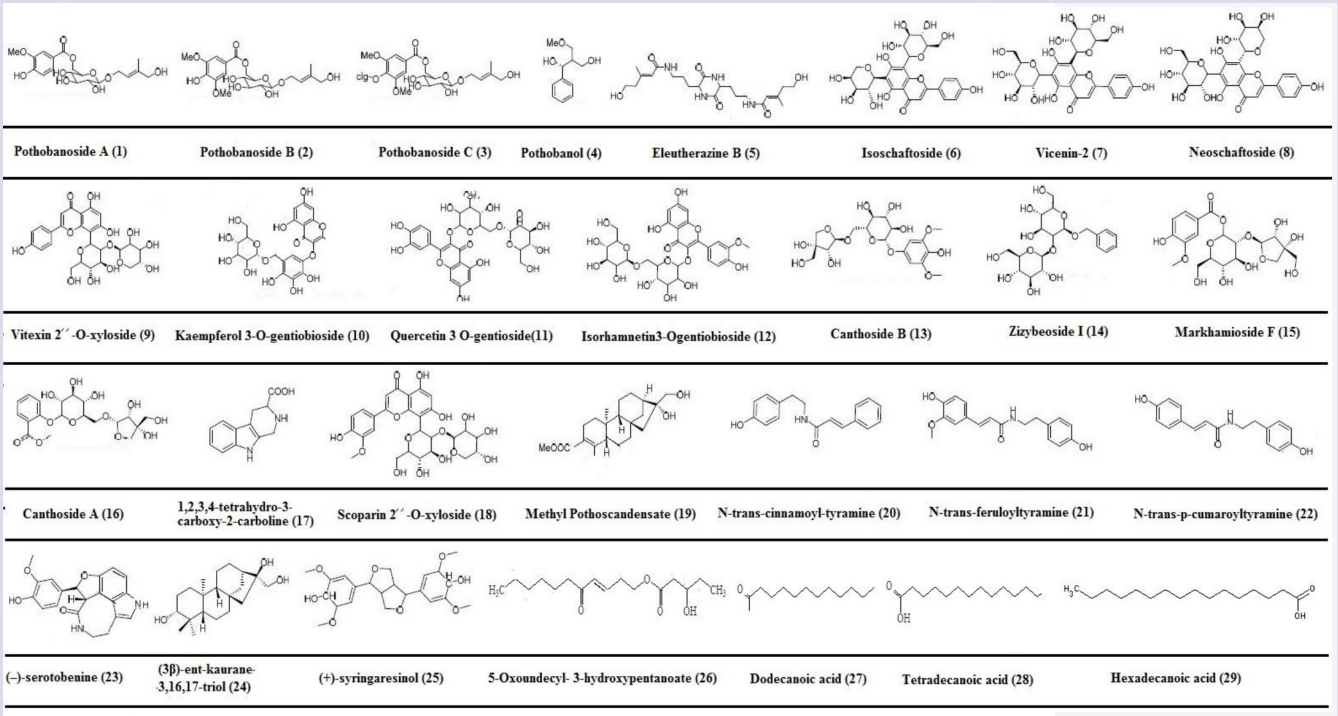

Figure 1a: Structure of Isolated compounds of *Pothos scandens* 1-29.

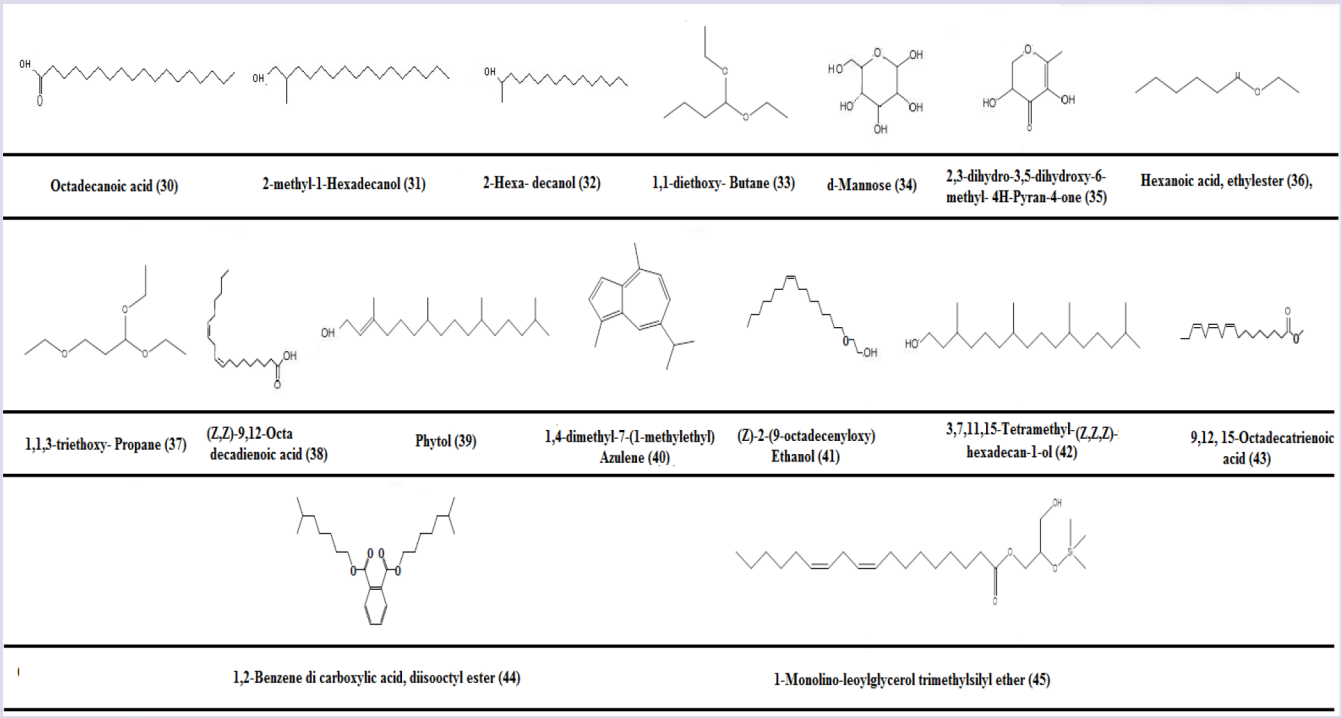

Figure 1b: Structure of Isolated compounds of *Pothos scandens*. [32-33, 62,64,56,57,60,54,59,63,61,58,53,55]

Table 3: Compounds isolated from *Pothos scandens*.

Plant Part	Compound Name	References
Stem part	**Hemiterpene glucoside**	
	1. Pothobanoside A (**1**)	10
	2. Pothobanoside B (**2**)	10
	3. Pothobanoside C (**3**)	10
	4. Canthoside B (**13**)	53
	Phenyl isobutanol	
	5. Pothobanol (**4**)	10
	Flavones	
	6. Isoschaftoside (**6**)	54
	7. Vicenin-2 (**7**)	55
	8. Neoschaftoside (**8**)	56
	9. Vitexin 2-O-xyloside (**9**)	57
	10. Scoparin 2-O-xyloside (**18**)	57
	Flavonols	
	11. Kaempferol 3-O-gentiobioside (**10**)	58
	12. Quercetin 3-O-gentiobioside (**11**)	59
	13. Isorhamnetin 3-Ogentiobioside (**12**)	60
	Glycosides	
	14. Zizybeoside I (**14**)	61
	15. Canthoside A (**16**)	62
	Hydroquinone Glycoside	
	16. Markhamioside F (**15**)	53
	Diketopiperazines Glycoside	
	17. Eleutherazine B **(5)**	63
	Alkaloid	
	18. 1,2,3,4-tetrahydro-3-carboxy-2 carboline (**17**)	64
Whole plant	**Diterpenoids**	
	19. Methyl Pothoscandensate(**19**)	37
	20. (3β)-ent-kaurane-3,16,17-triol (**24**)	41
	21. (3β)-ent-kaurane-3,16,17-triol-3-β-D glucopyranoside (**46**)	42
	Alkaloids	
	22. N-trans-cinnamoyltyramine (**20**)	45
	23. N-trans-feruloyltyramine (**21**)	43
	24. N-trans-p-cumaroyltyramine (**22**)	46
	Indole Alkaloids	
	25. (–)-serotobenine (**23**)	44
	Lignan	
	26. (+)-syringaresinol (**25**)	47
Whole Aerial part	**Fatty acid ester**	28
	27. 5-oxoundecyl-3-hydroxy pentanoate (**26**)	

droxy-6-methyl- 4H-Pyran-4-one **(35)**, hexanoic acid, ethyl ester **(36)**, 1,1,3-triethoxy- propane **(37)**, (Z,Z)-9,12-octa decadienoic acid **(38)**, phytol **(39)**, 1,4-dimethyl-7-(1-methylethyl)azulene **(40)**, (Z)-2-(9-octadecenyloxy)ethanol **(41)**, 3,7,11,15-tetramethyl-hexadecan-1-ol **(42)**, (Z,Z,Z)-9,12, 15-octadecatrienoic acid **(43)**, 1,2-benzene di carboxylic acid, diisooctyl ester **(44)**, 1-monolino-leoylglycerol trimethylsilyl ether **(45)**.[27] Total 26 different types of compounds have been isolated from *P. scandens* and are depicted in (Figure 1a and Figure 1b) and listed in (Table 3).

Bioactivity and pharmacological properties

Literature review has revealed that extracts and its isolated molecules of *P. scandens* showed antioxidant, antipyretic, anti-diabetic, free radical scavenging, burn wound healing, anticarcinogenic, antiestrogenic, hyaluronidase inhibition, histamine release inhibitory, antiseptic, anti-inflammatory, antimicrobial, anti-cancer and bronchodilator activities. A summary of biological activities of isolated compounds is carried in (Table 4).

Table 4: Biological activities of compounds present in *P. scandens*.

Isolated	Biological activities	Reference
1	Hyaluronidase inhibitory activity.	10
2	Anti-estrogenic, Histamine release inhibition, Hyaluronidase inhibitory activity.	10
3	Anti-estrogenic, Histamine release inhibition, Hyaluronidase inhibitory activity.	
4	Histamine release inhibition, Hyaluronidase inhibitory activity.	10
5	Hyaluronidase inhibitory activity.	10
6	Hyaluronidase inhibitory activity.	10
7	Hyaluronidase inhibitory activity	10
8	Anti-estrogenic, Hyaluronidase inhibitory activity.	10
9	Anti-estrogenic, Hyaluronidase inhibitory activity.	10
10	EGF receptor tyrosine kinase activity.	10
11	EGF receptor tyrosine kinase, Anti-estrogenic activity.	10
12	Anti-estrogenic activity	10
13	Anti-estrogenic activity.	10
14	Anti-inflammatory and anti-hepatitis activity.	65
15	Anti-eczematic activity.	66
16	Anti-eczematic activity.	66
17	Benzodiazepine receptor antagonist, neurotransmitters.	67
19	PRRSV inhibitory activity.	37
26	Anti-asthmatic activity.	28
27	Antioxidant activity.	27,28
28	Antioxidant activity.	27, 28
29	Antioxidant, Hypocholesterolemic Nematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic, 5-Alpha reductase inhibitory activity.	27,28,68
31	Antimicrobial activity.	69
34	Anti-Infective agent, Antimicrobial activity.	70, 71
35	Antimicrobial, anti-inflammatory activity.	69
38	Anti-inflammatory, Hypocholesterolemic, Cancerpreventive, Hepatoprotective, Antiandrogenic, Antiarthritic, Insectifuge activity.	27, 28, 68
39	Antimicrobial, anticancer, anti-inflammatory, antidiuretic, Immunostimulatory, anti-diabetic activity.	72
40	Antimicrobial activity.	73
41	Anticancer, antigonorrheal, Antireverse transcriptase.	71
42	Antimicrobial, Anti-inflammatory activity.	68
43	Anti-inflammatory and anti-atherogenic activity.	49
44	Antimicrobial, Antifouling activity.	68

Antimicrobial activity

In a study by Karunathilaka *et al*.[35] the hexane, ethyl acetate and methanol extracts of *P. scandens* were tested *in-vitro* analysis for antimicrobial activity against four microbial strains *E. coli, Staphylococcus aureus*, methicillin resistant. *Staphylococcus aureus* (MRSA) and *Candida albicans* were studied against the extract. The hexane and the ethyl acetate extracts of *P. scandens* were active against MRSA bacteria and *Candida albicans*. In a study by Vinayaka *et al*.[36] the methanol extract of *P. scandens* tested for antibacterial activity against six species of bacteria belonging to Gram positive (*Staphylococcus aureus* MTCC-902 and *Clostridium perfringens* MTCC-450) and Gram negative (*Escherichia coli* MTCC-405, *Klebsiella pneumoniae* MTCC-432, *Salmonella typhimurium* MTCC-1252 and *Pseudomonas aeruginosa* MTCC-1934) using minimum inhibitory concentration for each of the test bacteria and found that gram positive bacteria were inhibited at low concentrations (250µg/ml and 200µg/ml) than Gram negative bacteria (400 µg/ml to 500 g/ml). The antibacterial activity may be attributed to the presence of various secondary metabolites present in them. In another study by Vinayaka *et al*.[48] the petroleum ether, chloroform and methanol extracts of *P. scandens* were tested for antifungal activity against Fungi namely *Aspergillus niger* (MTCC-478), *Candida albicans* (MTCC-1637), *Microsporium gypsium* (MTCC-2819), *Chrysosporium keratinophilum* (MTCC-1367), *Trichophytum rubrum* (MTCC-3272) and *Chrysosporium indicum* (MTCC-4965). Methanol extract was found to possess more antimitotic activity than chloroform and petroleum ether extracts. Among fungi tested, more inhibition of

Chrysosporium Keratinophilum was observed in case of all the plant extracts followed by *Chrysosporium tropica*, *T. rubrum* and others.[49]

Antioxidant activity

In a study by Jethinlal khosh *et al.*[34] 50% ethanolic extract of *P. scandens* was tested for antioxidant activity by different assays and the extract showed much lesser IC_{50} value (240.44±4.62 µg/mL) for inhibiting hydroxyl radical which showed the capability of the plant as a potent antioxidant. In another study by Thankarajan *et al.*[31] extracts from leaf, stem and root of the plant were tested for *in vitro* antioxidant activity by different assays. The methanol extract of root showed free radical scavenging activity in assays namely ABTS radical scavenging (8221.5 µM TE/g extract), FRAP assay (514.4 mM Fe (II)/g extract), hydrogen peroxide (60.3%) and nitric oxide scavenging assay (58.7%). The ethanol extract of root showed significant free radical scavenging activity in assays such as DPPH and superoxide anion radical scavenging activity (IC50 0.284 mg/mL and 70.84%). Dodecanoic acid (**1**), tetra decanoic acid (**2**) and n- hexadecanoic acid (**3**) present in *P. scandens* acts as antioxidant.[10]

Antipyretic activity

For the treatment of pyrexia or fever, people use medicinal plants as a source of antipyretic agents from very earliest times.[50] In a study by Thankarajan *et al.*[31] the methanolic extract of *Pothos scandens* L. root by pyrexia induced by brewer's yeast on Wistar albino rats at concentration of 200 and 400 mg/Kg doses using paracetamol as standard drug and showed significant reduction of temperature at these concentrations.

Anti-diabetes activity

The *in-vitro* study of Hossain *et al.*[30] was run by using α-amylase enzyme inhibition techniqueon anti-diabetic methanolic extract of whole plant which tends topossess anti-diabetic potential activity with IC_{50} value of 1.49±0.190 mg/ml. The another OGTT method for *in- vivo* study also showed a dose dependent anti-diabetic activity of methanolic extract at different standard concentrations of 100mg, 200mg, 400mg of samples. Amongst these different standard concentrations, the 100 mg dose concentrationtends to have slight hypoglycemic activity whereas, the 200mg and 400 mg dose concentration resulted in moderate hypoglycemic activity comparing with positive control (Gliclazide).

Bronchodilator Activity

The results from Hossain *et al.*[30] study has justified the traditional uses of the plant in asthma by suggesting that the *P. scandens* leaves extract have significant bronchodilator activity. The bronchodilator activity was proved at 100 mg/kg dose of extract studied by applied on Wistar rats and the counting in preconvulsive time showed 41.56% protection as compared to the standard drug Salbutamol. Thus, the *P. scandens* tends to have bronchodilator activity.

Burn wound healing

Traditionally, *P. scandens* have a great medicinal value for its burn wound healing property.[38] The studies of Mohammed *et al.*[11] used the ethanolic extract of *P. scandens* (4% w/v) for different gel formulations was prepared using polymers carbopol 934 and carbopol 940 by varying their concentration. The current study revealed that *P. scandens* tends to have wound healing effect as the *P. scandens* extract treated animals were epithelize in 22 days while the solvent control and the untreated rats were epithelized within 35 and 40 days which respectively showed significant wound healing effect. Likewise, another study of Sainuddin *et al.*[51] used four different gel formulations A1, A2, A3 and A4 of ethanolic extract which was prepared by using Carbopol 940 in varying proportions of 0.5, 1.0, 1.5 and 2.0%. The current study revealed that formulation third (A3) and fourth (A4) formulations were found to betranslucent but the second formulation (A2) was found to be transparent, non-greasy and 275 stables was tested for primary skin irritation which showed no signs of irritation.

Anticarcinogenic activity

In a study by Junaid *et al.*[32] the methanol extract of *P. scandens* leaf was found anticarcinogenic activity. Here, thirteen clinical isolates of *Streptococcus mutans* (SM-1 to SM-13) recovered from infected teeth samples of dental caries patients were tested for their sensitivity to the extract by Agar well diffusion method and showed the inhibition of the growth with zone of inhibition 1.1 to 1.9.

Cytotoxic activity

According to Yusuf *et al.*[12] the *in vitro* study of the methanolic extract of *P.scandens* leaf showed strong cytotoxic activity with LC_{50} value of 14.195 µg/ml compared to standard vincristine sulphate (0.305 µg/ml) by brine shrimp lethality bioassay. In another study by Jethinlal khosh *et al.*[34] the 50% ethanol extract of aerial parts of *P. scandens* has showed significant cytotoxic activity against MCF-7 cell lines with an IC_{50} of 90.18±5.20 µg/ml by MTT assay.

Thrombolytic activity

Blood clot formation is a severe problem of blood circulation which leads hypertension, stroke to the heart, anoxia etc.[47] In a study by Yusuf *et al.*[12] the methanolic extract of *P. scandens* Leaf showed thrombolytic activity of 19.451±1.711% lysis of clot compared to standard streptokinase (69.480±2.651%) and water (3.0695±0.497%), used as positive and negative controls respectively.

Anticancer activity

Today cancer is considered as a major threat to humankind next to diseases of the heart and vascular system.[52] In a study by Jethinlal khosh *et al.*[46] the 50% ethanol extract of aerial parts of *P. scandens* was evaluated for cytotoxicity against MCF-7 (breast cancer) and L929 (normal fibroblast) cell lines by MTT assay and revealed that the extract has significant cytotoxic activity against MCF-7 cell lines with an IC50 of 90.18±5.20 µg/ml and also cell death of MCF-7 treated with the extract was due to the induction of apoptosis, which was confirmed by comet assay.[12] In another study by Muhit *et al.*[10] the isolated molecule from the extracts of stem and roots of the Bangladeshi medicinal plant *P. scandens* L. were tested for their anti-estrogenic activity using the estrogen-responsive human breast cancer cell lines MCF-7 and T47D with increasing concentrations at 0.01, 0.1, 1,10 µM. The syringoyl derivatives showed strong anti-estrogenic activity and less oxygenated derivatives were almost inactive against both cell lines. Among them pothobanoside B (**2**), pothobanoside C (**3**) and canthoside B (**13**) isolated from the plant have shown wide spectrum of anti-estrogenic activities.

Peritoneal mast cell stabilization activity

According to Gupta *et al.*[29] the ethanolic, 50% aqueous ethanolic and aqueous extracts (1, 10 and 100 µg/mL) of *P. scandens* L. were studied for peritoneal mast cell stabilization activity in rat mesenteric preparation induced by C 48/80 and 50% aqueous ethanolic showed dose dependent significant increase in the number of intact cells at the concentrations 10 µg/mL (52.2±4.9) and 100 µg/mL (67.8±2.9).

Hyaluronidase inhibitory activity

According to report, flavonoids, luteolin, apigenin and kaempferol were found to have strong hyaluronidase inhibitory activity, whereas quercetin

exhibited moderate activity. In a study by Muhit *et al.*[10] the eighteen isolated molecules from the extracts of *P. scandens* L. were tested for this activity. The mammalian hyaluronidase and rosmarinic acid was used as a positive control. Nine compounds were found to have significant inhibition at 200 μM. Among the isolates, pothobanoside A showed a statistically significant activity with a 46.7% inhibition rate, whereas rosmarinic acid had a 64.7% inhibition rate at 200 μM. This could be potential as an anti-tumor compound. Therefore, the compounds of *P. scandens:* pothobanoside A (**1**), pothobanoside B (**2**), pothobanoside C (**3**), pothobanol (**4**), eleutherazine B (**5**), isoschaftoside (**6**), vicenin-2 (**7**), neoschaftoside (**8**) and vitexin 2´´-O-xyloside (**9**) have shown hyaluronidase inhibitory activity.

Anti-asthmatic and Histamine release inhibition activity

In a study by Muhit *et al.*[10] the isolated compounds pothobanoside C (**3**) and pothobanol (**4**) from *P. scandens* have significant inhibition of histamine releasewas likely to be positive control EGCgG3Me. The pothobanoside B(**2**) have shown significant inhibition of histamine release from basophilic cells. Whereas thecurrent study supported by ova induced asthmatic and anti-allergic rhinitis properties of *P. scandens* ethanolic extract and isolated compound does not show the respective result on the same model reported by Gupta *et al.*[28,29]

CONCLUSION

The plant *P. scandens* have been used as traditional medicine since past decades as plant has gained a popularity worldwide and have become very wild in many parts of the world.As the extracts of different parts of *P. scandens* and their isolated compounds have promising biological activities and hold potential for further research. This has provided an attractive bio resource for drug research using the natural products. Although the plant has great traditional value and several biological activities, but the detailed phytochemical study so far has not been explored properly. Thus, there is a need of phytochemical analysis of *P. scandens* plant.

ACKNOWLEDGEMENT

This work was financially supported by the JSS University, Mysore. I personally acknowledge to my supervisor Late Dr. M. N. Sathish Kumar for his valuable deep input on the selected pant and guidance for this research work. The author is thankful to R&D Head Dr. U.V. Babu from Himalaya drugs ltd. Bangalore for his constant evaluation of work.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

MRSA: Methicillin resistant Staphylococcus aureus; **ABTS:** 2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid); **FRAP:** Ferric reducing ability of plasma; **DPPH:** 2, 2-diphenyl-1-picrylhydrazyl; **OGTT:** Oral glucose tolerance test; **IC_{50}:** Inhibitory concentration 50%; **SM:** Streptococcus mutans; **LC_{50}:** Lethal concentration 50; **MCF-7:** Michigan Cancer Foundation-7; **MTT:** Dimethyl thiazolyldiphenyl tetrazolium salt.

SUMMARY

The medicinal plant *P. scandens* L have gained a planetary importance worldwide as folk medicine since decades. *P. scandens* L have been recognized as a rich resource of active ingredients widely useful for medicinal valuable purposes in several human health disorders. The preliminary phytochemical screening of crude extract *P. scandens* L declared that leaf, root and stem as rich resource of active constituents like alkaloids, tannins, saponins, glycosides and flavonoids of *P. scandens*. The various *in- vivo* and *in- vivo* studies of *P. scandens* L extract possess various biological activities such as antioxidant, antipyretic, anti-diabetic, free radical scavenging, burn wound healing, anticarcinogenic, anti-inflammatory, antimicrobial, anticancer, bronchodilator etc.

REFERENCES

1. The WHO Traditional Medicine Strategy. 2014-2023. WHO, Geneva.
2. Boyce PC. A review of *Pothos* L. (Araceae: Pothoideae: Pothoeae) for Thailand. Thai Forest Bull (Bot). 2009;37:15-26.
3. Kim J, Jeong HS, Lee W, Min H. *In vitro* anti-inflammatory activity of *Pothos scandens* extract in RAW 264.7 cells. Food Sceince and Biotechnology. 2017;26(3):791-9.
4. Dogra KS, Chauhan S, Jalal JS. Assessment of Indian medicinal plants for the treatment of Asthma. J Med Plants Res. 2015;9(32):851-62.
5. Ayyanar M, Ignacimuthu S. Traditional knowledge of Kanitribals in Kouthalai of Tirunelveli hills. Tamil Nadu, India. J Ethnopharmacol. 2005;102(2):246-55.
6. Inta A, Shengji P, Balslev H, Wangpakapattanawong P, Trisonthi C. A comparative study on medicinal plants used in Akha's traditional medicine in China and Thailand, cultural coherence or ecological divergence. J Ethnopharmacol. 2008;116(3):508-17.
7. Bhandary MJ, Chandrashekar KR, Kaveriappa KM. Medical ethnobotany of the Siddis of Uttara Kannada district, Karnataka, India. J Ethnopharmacol. 1995;47(3):149-58.
8. Lee S, Xiao C, Pei S. Ethnobotanical survey of medicinal plants at periodic markets of Honghe Prefecture in Yunnan Province, SW China. J Ethnopharmacol. 2008;117(2):362-77.
9. Deepa MR, Dharmapal S, Udayan PS. Medicinal plants in the selected sacred groves of Kodungallur, Thrissur district, Kerala. J Med Plants Studies. 2016;4(3):149-55.
10. Muhit MA, Izumikawa M, Umehara K, Noguchi H. Phenolic constituents of the Bangladeshi medicinal plant *Pothos scandens* and their anti-estrogenic, hyaluronidase inhibition and histamine release inhibitory activities. Phytochemistry. 2015;121:30-7.
11. Mohammed HKP, Shahima HK, Saraswathi R, Mohanta GP, Nayar C. Formulation and evaluation of herbal gel of *Pothos scandens* Linn. Asia Pac J Trop Med. 2010;3(12):988-92.
12. Yusuf ATM, Rashid MMU, Hassan MM, Sayeed MA, Jainul MA. *In-vitro* cytotoxic and thrombolytic potential of *Pothos scandens L.* J Pharmcog Phyto Chem. 2013;2(1):193-8.
13. Shu SG, Heng L, Boyce PC. *Pothos* Linnaeus. Flora of China. 2010;23:6-8.
14. Hook F. *Pothos scandens* Linn. Sp. Plant. Flora of British India. 1893;6:551-3.
15. Sajeesh T, Arunachalam K, Parimelazhagan T. Antioxidant and antipyretic studies on *Pothos scandens* L. Asian Pacific J Tropical Medi. 2011;4(11):889-99.
16. Houghton PJ, Osibogun IM. Flowering plants used against snakebite. J Ethnopharmcol.1993;39(1):1-29.
17. Nair, Nayar. *Pothos scandens* Linn. Fl Cour. 1987;2:394.
18. Boyce PC, Hay A. A taxonomic revision of Araceae tribe *Potheae* (Pothos, Pothoidium and Pedicellarum) for Malaysia, Australia and the tropical Western Pacific. Telopea. 2002;9(3):449-571.
19. Boyce PC. The genus *Pothos* (Araceae: Pothoideae: Potheae) of Thailand and Indochina. Blumea. 2002;45(1):147-204.
20. Boyce PC, Hay A. Current advances in the taxonomy of *Pothos*. Acta Bot Yunnan. 1998;20:43-7.
21. Das AK, Dutta BK, Sharma GD. Medicinal plants used by different tribes of Cachar district, Assam. Ind J Trad Knowledge. 2008;7(3):446-54.
22. Chowdhury A, Biswas R, Das AP. Macrophytic flora of Gossaihat Beel, Jalpaiguri Forest Division, West Bengal, India: II. Pteridophyta and Liliopsida. 2014;8(2):293-310.
23. Baharuddin S, Mansor M, Medicinal aroids conservation: a case study of a floral garden, School of Biological ScieCes, University Sains Malayasia, 4th IMT-GT UNINET Conference. 2002;216-9.
24. Hay A. The genus *Pothos* L. (Araceae-Potheae) in New Guinea, Solomon Islands and Australia. Blumea. 1995;40:397-419.
25. Lalitharani S, Mohan VR, Maruthupandian A. Pharmacognostical and phytochemical studies on *P. scandens L.* Int J Phytomed. 2010;2(3):277-83.
26. Lalitharani S, Mohan VR, Regini GS. Ethnomedicinal plants used by Kanikkars in Karaiyar of Agasthiamalai biosphere, Tamil Nadu. J Econ Taxon Bot. 2010; 34:472-7.
27. Lalitharani S, Mohan VR, Regini GS, Kalidass C. GC-MS analysis of ethanolic extract of *P. scandens* leaf. J Herb Med Toxicol. 2009;2:159-60.
28. Gupta S, Basavan D, Muthureddy NSK, Raju KR, Babu UV, Sharath KLM, *et al.* Assessment of inhibitory potential of *Pothos scandens* L. on ovalbumin-induced airway hyper responsiveness in balb/c mice. Int Immunopharmacol. 2014;18(1):151-62.

29. Gupta S, Duraiswamy B, Satishkumar MN. Peritoneal mast cell stabilization potential of *Pothos scandens* L. Indian J Pharmacol. 2013;44(1):99-102.
30. Kamal HM, Bidur S, Kaium SMA, Mazumder K. Anti-diabetic and bronchodilator activities of *Pothos scandens* linn leaves. Int J Pharma Phytochem Res. 2015;7(6):1202-7.
31. Sajeesh T, Arunachalam K, Parimelazhagan T. Antioxidant and antipyretic studies on *Pothos scandens* L. Asia Pac J Trop Med. 2011;4(11):889-99.
32. Syed J, Dileep N, Rakesh KN, Pavithra GM, Vinayaka KS, Kekuda TRP. Anticariogenic Activity of *Gnidia glauca (Fresen.) Gilg, Pothos scandens L.* and *Elaegnus kologa Schlecht*. J Appld Pharma Sci. 2013;3(3):20-3.
33. Jethinlal KJP, Antony A, Praveena P, Doss VA. Phytochemicals, antioxidant and free radical scavenging of hydroethanolic extract of aerial parts of *Pothos scandens* L. Asian J Pharma Clin Res. 2016;9(3):236-9.
34. Jethinlal KJP, Nair SS, Praveena P, Doss VA. Cytotoxicity and apoptotic inducibility of hydro-ethanolic extract of aerial parts of *Pothos scandens* L. against MCF-7 breast cancer cell line. Int J Pharm Pharm Sci. 2016;8(7):274-6.
35. Thamizhvanan K. Anthelmintic and antimicrobial activity of petroleum ether extract of *Yucca gloriosa* L. whole plant. Int J Preclinical Pharmaceut Res.2012;3(1):20-2.
36. Vinayaka KS, Kekuda TRP, Rajkumar N, Chandrashekar MB, Banakar S, Hegde SV. Studies on Antibacterial, Anthelmintic and Larvicidal Efficacy of *Pothos scandens* L. Res J Pharm Tech. 2009;2(3):850-3.
37. Liu H, Bi JL, Wang YH, Gu W, Su Y, Liu F, *et al*. Methyl Pothoscandensate, a new ent-18(43)-Abeokaurane from *Pothos scandens*. Helvetica Chimica Acta. 2012;95(7):1231-7.
38. Ediriweeraa ERHSS, Grerub DD. Traditional medicinal practices of Srilanka in orthopedic treatment. AYU. 2009;30(2):147-52.
39. Lawrence R, Lawrence K. Antioxidant activity of garlic essential oil *Allium sativum* grown in north Indian plains. Asian Pac J Trop Biomed. 2011;1(Suppl 1): S51-S54.
40. Khare CP. Indian medicinal plant, Published by Springer Science Berlin. 2007;515:727-8.
41. Xue-Xiang C, Jian-Xia H, Yang-Wen O, Xiao-Juan L, Li-Ping Z, Yong CAO. Isolation and Crystal Structure of Ent–kaurane Diterpenes from *Rubus corchorifolius* L. F Chinese J Struct Chem. 2015;34(3):349-58.
42. Ferreira FP, Oliveira DCRD. New constituents from *Mikania laevigata* Shultz Bip. ex Baker. Tetrahedron Lett. 2010;51(52):6856-9.
43. Kanada RM, Simionato JI, Arruda RF, Santin SMO, Souza DMC, Silva DCC. N-trans-feruloyltyramine and flavonol glycosides from the leaves of *Solanum sordidum*. Braz J Pharmacog. 2012;22(3):502-6.
44. Sato H, Kawagishi H, Nishimura T, Yoneyama S, Yoshimoto Y, Sakamura S, *et al*. Serotobenine, a Novel Phenolic Amide from Safflower Seeds (*Carthamu stinctorius L.)*. Agric Biol Chem. 1985;49(10):2969-74.
45. Torel J, Cillard J, Cillard P. Antioxidant activity of flavonoids and reactivity with peroxy-radicals. Phytochemistry. 1985;25(2):383-5.
46. Sembiring L, Ward AC, Goodfellow M. Selective isolation and characterization of members of the Streptomyces violaceus niger clade associated with the roots of *Paraserianthes falcataria*. Leeuwenhoek. 2000;78(3-4):353-66.
47. Hussain F, Islam A, Bulbul L, Moghal MR, Hossain MS. *In vitro* thrombolytic potential of root extracts of four medicinal plants available in Bangladesh. Anc Sci Life. 2014;33(3):162-4.
48. Vinayaka KS, Hegde SV, Banakar S, Kekuda TRP. Antifungal potency of *Gnidia glauca* (Fresen) Gilg. And *Pothos scandens* L. Nat Prod. 2009;5(3):146-8.
49. Idan SA, Al-Marzoqi AH, Hameed IH. Spectral analysis and anti-bacterial activity of methanolic fruit extract of *Citrullus colocynthis* using gas chromatography-mass spectrometry. Afri J Biotech. 2015;14(46):3131-58.
50. Sultana S, Asif HM, Akhtar N, Ahmad K. Medicinal plants with potential antipyretic activity: A Review. Asia Pac J Trop Disease. 2015;5(Suppl 1):S202-S208.
51. Sainuddin T. Formulation and Pharmacological Evaluation of Herbal Gel of *Pothos scandens* Linn. Webmed Central. 2010;1-12.
52. Tantengco OAG, Jacinto SD. Cytotoxic activity of crude extracts and fractions from *Premna odorata* (Blanco), *Artocarpus camansi* (Blanco) and *Gliricidia sepium* (Jacq.) against selected human cancer cell lines. Asi Pac J Trop Biomedicine. 2015;5(12):1037-41.
53. Kanchanpoom T, Kasai R, Yamasaki K. Phenolic glycosides from *Markhamia stipulate*. Phytochemistry. 2002;59(5):557-63.
54. Wada S, Puming H, Hashimoto I, Watanabe N, Sugiyama K. Glycosidic flavonoids as rat-liver injury preventing compounds from green tea. Bio Sci Biotechnol Biochem. 2000;64(10):2262-5.
55. Islam MN, Ishita IJ, Jung HA, Choi JS. Vicenin 2 isolated from *Artemisia capillarys* exhibited potent antiglycation properties. Food ChemToxicol. 2014;69:55-62.
56. Xie C, Veitch NC, Houghton PJ, Simmonds MSJ. Flavone C-Glycosides from Viola yedoensis MAKINO. Chem Pharm Bull. 2003;51(10):1204-7.
57. Fiasson KG, Jay M, Viricel MR. Flavone O- and C-glycosides from *Setaria italica*. Phytochemistry. 1989;28(9):2471-5.
58. Iwashina T, López-Sáez JA, Herrero A, Kitajima J, Matsumoto S. Flavonol glycosides from *Asplenium foreziense* and its five related taxa and *A. incisum*. Biochem Syst Ecol. 2000;28(7):665-71.
59. Liao H, Liu H, Yuan K. A new flavonol glycoside from the *Abelmoschus esculentus* Linn. Phcog Mag. 2012;8(29):12-5.
60. Huang X, W Gao, W Zhao, Zhang T, Xu J. Flavone and steroid chemical constituents from rhizome of *Paris axialis*. China J Chin Mater Med. 2010;35(22):2994-8.
61. Takashima J, Ikeda Y, Komiyama K, Hayashi M, Kishida A, Ohsaki A. New constituents from the leaves of *Morinda citrifolia*. Chem Pharm Bull (Tokyo). 2007;55(2):343-5.
62. Kanchanpoom T, Kasai R, Yamasaki K. Iridoid and phenolic diglycosides from *Canthium berberidifolium*. Phytochemistry. 2002;61(4):461-4.
63. Li, ZF, Xu N, Feng BM, Zhang QH, Pei YH. Two diketopiperazines from *Acanthopanax senticosus harms*. J Asian Nat Prod Res. 2010;12(1):51-5.
64. Zhang AL, Yu M, Xu HH, Si JP. Constituents of *Dendrobium devonianum* and their antioxidant activity. China J Chin Mater Med. 2013;38(6):844-7.
65. Inge NA, Bogaert V, Zhang J, Soetaert W. Microbial synthesis of sophorolipids. Proc Biochem. 2011;46(4):821-33.
66. Braham H, Mighri Z, JannetHichem B, Matthew S, Abreu PM. Antioxidant Phenolic Glycosides from *Moricandia arvensis*. J Nat Prod. 2005;68(4):517-22.
67. Tomas H, Zhixian H, Ough CS. 1,2,3,4-Tetrahydro-β-carboline-3-carboxylic acid and l-Methyl-l,2,3,4-Tetrahydro-β-carboline-3-carboxylic acid in Wines. J Agric Food Chem. 1993;41(3):455-9.
68. Rajeswari G, Murugan M, Mohan VR. GC-MS analysis of bioactive components of *Hugonia mystax* L. (*Linaceae).* Res J Pharma Bio ChemSci. 2012;3(4):301-8.
69. Jegadeeswari P, Nishanthini, Muthukumarasamy S, Mohan VR. GC-MS analysis of bioactive components of *Aristolochia Krysagathra* (Aristolochiaceae). J Curr Chem Pharm Sci. 2012;2(4):226-32.
70. Hu X, Shi Y, Zhang P, Miao M, Zhang T, Jiang B. D-Mannose: Properties, Production and Applications: An Overview. Comprehensive Rev Food Sci Food Safety. 2016;15(4):773-85.
71. Altameme H, Hameed IH, Abu-Serag NA. Analysis of bioactive phytochemical compounds of two medicinal plants, *Equisetum Arvense* and *Alchemila Valgaris* seeds using gas chromatography-mass spectrometry and fourier-transform infrared spectroscopy. Malays Appln Biol. 2015;44(4):47-58.
72. Venkata RB, Samuel LA, PardhaSaradhi M, Narashimha RB, Naga VKA, Sudhakar M, *et al*. Antibacterial, antioxidant activity and GC-MS analysis of *Eupatorium Odoratum*. Asi J Pharma Clin Res. 2012;5(Suppl-2):99-106.
73. Sleha R, Mosio P, Vydrzalova M, Jantovska A, Bostikova V, Mazurova J. *In vitro* antimicrobial activities of cinnamon bark oil, anethole, carvacrol, eugenol and guaiazulene against Mycoplasma hominis clinical isolates. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2014;158(2):208-11.