

Review Article

FAMILY ACANTHACEAE AND GENUS APHELANDRA: ETHNOPHARMACOLOGICAL AND PHYTOCHEMICAL REVIEW

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ABSTRACT

Aphelandra belong to family Acanthaceae. We have reviewed traditional uses, pharmacological potential and phytochemical study of family Acanthaceae and genus Aphelandra. Traditionally the most important part use in Acanthaceae is the leaves and they are used externally for wounds. We have found that Acanthaceae possess antifungal, cytotoxic, anti-inflammatory, anti-pyretic, anti-oxidant, insecticidal, hepatoprotective, immunomodulatory, Anti- platelet aggregation and anti-viral potential. Phytochemical reports on family Acanthaceae are glycosides, flavonoids, benzenoids, phenolic compounds, naphthoquinone and triterpenoids. We have also document genus Aphelandra, its phytochemical and pharmacological potential.

Keywords: Acanthaceae, Aphelandra, Ethnomedicinal, Phytochemistry, Wound healing potential,

INTRODUCTION

Majority of the population in developing world is struggling to raise living standards and improvement of health care delivery due to increasing poverty and population. According to an estimate, 70-80% of rising world is dependent on conventional plants obtained remedies as pharmaceuticals are high priced. From this reality, it can be retrieved that by data assembling and experimentation, valuable plus economical medicaments can be separated from different flora to satisfy requirements of evolving world. Hence requirements of officinal plants cannot be neglected[1]. Databases used to search for the literature were: Google scholar, PubMed, Tropicos (for plant taxonomy). Bold numeral in the text refers to chemical structures reported in Fig. 1. All the structures were reported from the literature and drawn by ChemDraw.

Ethnomedicinal importance of family acanthaceae

Ground leaves of *Adhatoda vesica* Nees. (Acanthaceae) are used in treatment of bronchial diseases. Ground fresh leaves of *Andrographispaniculata* are used to alleviate bites of poisonous insects and reptiles[2].

Infusions of leaves of *Aystasiaschimperii*, *Dyschoristeradicans*, *Acanthus eminens*, *Dyschoristethumbergiiflora*, *Lepidagathisscariosa* and *Thunbergiaaolata* (Family: Acanthaceae) are used for cough, skin diseases, wounds, eye infections, anti-diarrhea, edema, pneumonia and backache. Paste of leaves of *Barberigrandicalyx* (Acanthaceae) is used for snake bites. Ash of leaves of *Justiciabetonica*, *Acanthus pubescens* and *Justiciaflava* is used for dry cough, anti-diarrhea, flu and ulcers [3].

Leaves of *Blepharismaderaspatensis* belonging to family Acanthaceae are mixed with onion bulbs to form paste. This paste is applied externally for cuts and wounds. Leaves of *Hygrophilauriculata* (Acanthaceae) are used to relieve from cough. Leaves of *Justiciatranquebariensis* (Acanthaceae) are used for poisonous bites [4].

Leaves of *Andrographispaniculata* Nees. And *Justiciagendrarrussa* L. Which belongs to family Acanthaceae, are used for fever, headache, vertigo and wounds [5].

Powder of leaves of *Andrographispaniculata* (Acanthaceae) is used internally for diabetes. Juice of leaves of *Blepharismaderaspatensis* (Acanthaceae) is used externally for wounds. Paste of leaves of *Elytrariaaqualis* (Acanthaceae) is used externally for hip pain.

Decoction of whole plant of *Rungialinifolia* which belongs to family Acanthaceae is used internally for ulcers [6].

Leaves of *Justiciaadhatoda* which belongs to family Acanthaceae are used for rheumatism, fever, chest diseases, pneumonia, asthma, tuberculosis, antispasmodic, expectorant, diuretic, antiseptic and to reduce swelling [7].

Andrographispaniculata, *Hygrophilaspinoso*, *Barleriaprionitis* and *Adhatoda vasica* are members of the Acanthaceae family, which are used traditionally as antiviral, antipyretic, antiasthmatic and in respiratory diseases [8].

Pharmacological reports on family acanthaceae

Antibacterial activity

Aqueous extract of *Andrographispaniculata* belonging to family Acanthaceae showed significant antibacterial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* in comparison to some known antibiotics[9].

Methanolic extract of *Asteracanthalongifolia* L. belonging to family Acanthaceae showed the most promising results against *Burkholderiapseudomallei* strain1and strain 2 and *Staphylococcus aureus*[10].

Acetone crude extract of *Andrographisaffinis* Nees belongs to family Acanthaceae showed higher degree of inhibition against *Staphylococcus aureus*, *Proteus vulgaris*, *Escherichia coli*, *Klebsiellapneumoniae*, and *Pseudomonas aeruginosa*[11].

Chloroform crude extract of *Andrographispaniculata* (Acanthaceae) showed antibacterial activity against *S. aureus*, *E. coli*, *B. subtilis* and *P. vulgaris*. The effect produced by the extract was comparable with benzyl penicillin[12].

A large number of gram positive and gram negative bacteria exhibited vulnerability when exposed to extract of *Rhinacanthusnasutus* (Acanthaceae) [13].

Antifungal activity

The dichloromethane extract of the leaves of *Hypoesteserpens* (Acanthaceae) showed antifungal activity against *Cladosporiumcucumerinum* and *Candida albicans*. Fucoserpamol A

and dolabeserpenoid acid A were isolated responsible for this activity [14].

The chloroform extract of *Androgrphispaniculata* (Acanthaceae) exhibited activity against *Aspergillusniger* and *Penicillium chrysogenum*. The activity was found to be effective against all the organisms tested [15].

Antifungal activity was reported by aqueous extract of *Andrographispaniculata* belonging to family acanthaceae against *Candida albicans* in comparison to Nystatin[9]. Anti-fungal activity has been exhibited by the extract of *Rhinacanthusnasutus* (Acanthaceae) against *Aspergillusniger*, *Pyriculariaoryzae*,

Cryptococcus neoformans, *Saccharomyces spp.*, *Epidermophytesflocosum*, *Candida albicans*, *Trichophytonrubrum*, *Tricophytonmentagrophytes*, *Microsporumcanis* and *Microsporumgypeseum*[13].

Cytotoxic activity

Elenoside(**1**) was reported in *Justiciahyssopifolia* belonging to family Acanthaceae. Elenoside showed cytotoxic activity to human cancer cell lines in range concentrations from 10⁻⁵ to 10⁻⁴M. It has an LD₅₀ in mice, of 305mg/kg and central depression properties at doses of 25, 50, and 100mg/kg. Thus elenoside appears to be sedative with broad spectrum cytotoxicity [16].

Table 1: Traditional uses of family Acanthaceae

Species	Part use	Traditional uses
<i>Adhatoda vesica</i> Nees	Leaves	Treatment of bronchial diseases ²
<i>Andrographispaniculata</i>	Leaves	Alleviate bites of poisonous insects and reptiles ²
<i>Aystasiaschimperi</i> , <i>Dyschoristeradicans</i> , <i>Acanthus eminens</i> , <i>Dyschoristethumbergiiiflora</i> , <i>Lepidagathisscariosa</i> <i>Thunbergialalata</i>	Leaves	Used for cough, skin diseases, wounds, eye infections, anti-diarrhea, edema, pneumonia and backache ³ .
<i>Barberigrandicalyx</i>	Paste of leaves	Paste of leaves of (Acanthaceae) is used for snake bites. ³
<i>Justiciabetonica</i> , <i>Acanthus pubescens</i> and <i>Justiciaflava</i>	Ash of leaves	Ash of leaves of are used for dry cough, anti-diarrhea, flu and ulcers ³
<i>Blepharismaderaspatens</i>	Mixed with onion bulbs to form paste	This paste is applied externally for cuts and wounds. ⁴
<i>Hygrophilauriculata</i>	Leaves	Leaves of Hygrophilauriculata (Acanthaceae) are used to relieve from cough. ⁴
<i>Justiciatranquebariensis</i>	Leaves	Leaves of Justiciatranquebariensis(Acanthaceae) are used for poisonous bites ⁴
<i>Andrographispaniculata</i> Nees. and <i>Justiciagendraruissa</i> L	Leaves	Leaves of <i>Andrographispaniculata</i> Nees. and <i>Justiciagendraruissa</i> L. which belongs to family Acanthaceae, are used for fever, headache, vertigo and wounds ⁵
<i>Andrographispaniculata</i>	Powder of leaves	Powder of leaves of <i>Andrographispaniculata</i> (Acanthaceae) is used internally for diabetes.
<i>Blepharismaderaspatensis</i>	Juice of leaves	Juice of leaves of <i>Blepharismaderaspatensis</i> (Acanthaceae) is used externally for wounds. ⁶
<i>Elytrariaaqualis</i>	Paste of leaves	Paste of leaves of <i>Elytrariaaqualis</i> (Acanthaceae) is used externally for hip pain ⁶
<i>Rungialinifolia</i>	Decoction of whole plant	Decoction of whole plant of <i>Rungialinifolia</i> which belongs to family Acanthaceae is used internally for ulcers ⁶
<i>Justiciaadhatoda</i>	Leaves	Leaves of <i>Justiciaadhatoda</i> which belongs to family Acanthaceae are used for rheumatism, fever, chest diseases, pneumonia, asthma, tuberculosis, antispasmodic, expectorant, diuretic, antiseptic and to reduce swelling ⁷
<i>Andrographispaniculata</i> , <i>Hygrophilaspinoso</i> , <i>Barleriaprionitis</i> <i>Adhatoda vasica</i>	Leaves	<i>Andrographispaniculata</i> , <i>Hygrophilaspinoso</i> , <i>Barleriaprionitis</i> and <i>Adhatoda vasica</i> are members of Acanthaceae family, which are used traditionally as antiviral, antipyretic, antiasthmatic and in respiratory diseases ⁸

Justiflorinol(**2**), justicinol(**3**), patentiflorin A (**4**), patentiflorin B (**5**), 4'-O-acetylpatentiflorin B (**6**) and 4'-O-acetylmanathoside B (**7**) were separated from leaves and stems of *Justiciapatentiflora* (Acanthaceae) by bioassay-guided purification. These compounds display significant cytotoxic activity against cancer cell lines and arrest the cell cycle [17].

Methanol extract of *Andrographispaniculata* exhibited anti-cancer activity. Andrographolide(**8**), 14-deoxyandrographolide (**9**) and 14-deoxy-11, 12-didehydroandrographolide (**10**) were separated from this extract [18]. Andrographolide(**8**) from the plant *Andrographispaniculata* (Acanthaceae) and its derivative 8, 17 - epoxy andrographolide(**11**) showed cytotoxic activity [19]. Rhinacanthin-A (**12**), rhinacanthin-B (**13**), rhinacanthin-C (**14**), rhinacanthin-D (**15**), rhinacanthin-G, rhinacanthin-H, rhinacanthin-I, rhinacanthin-K, rhinacanthin-M, rhinacanthin-N (**16**), rhinacanthin-Q (**17**) and wogonin(**18**) separated from the roots of *Rhinacanthusnasutus* (Acanthaceae) showed cytotoxic activity. The leaf and root extract of *Rhinacanthusnasutus* (Acanthaceae) showed antiproliferative activity against human cervix adenocarcinoma and other types of cancers [13].

Anti-inflammatory and antipyretic activity

Leaves extracts of *Hygrophilaspinoso* (Acanthaceae) exhibited antipyretic and anti-inflammatory activity [20].

Alcoholic extract of *Lepidegathisanobrya* of family acanthaceae showed analgesic and anti-inflammatory activities[21].

Anti-inflammatory and analgesic activities were reported by the methanol extract of *Diclipteraverticillata* (Acanthaceae)[22]. Ethanol extract of *Justiciagendraruissa* (Acanthaceae) exhibited analgesic activity and anti-inflammatory activity[23].

The aqueous extract of roots of *Barleriaprionitis* L. (Acanthaceae) showed anti-inflammatory activity by using caragennan-induced rat paw edema method[24].

The methanol extract of leaves of *Andrographispaniculata* (Acanthaceae) was tested on inhibition of lipopolysaccharide induced and calcimycin induced mediators in diverse cell models. The results showed that extract was fairly potent in attenuating pro-inflammatory, inflammatory and allergic mediators[25].

Antiviral activity

Rhinacanthin-E and rhinacanthin-F separated from the aerial parts of *Rhinacanthusnasutus* (Acanthaceae) exhibited antiviral activity [13].

Antioxidant activity

Methanol and aqueous extracts of aerial parts of *Justiciaspicigera* of family acanthaceae exhibited antioxidant activity. DPPH radical

scavenge method was used. Water extract has lower activity than that of methanol [26].

Methanol extracts (at 100µg/ml) of *Ruellia* and *Strobilanthesauriculata* showed antioxidant activity. Methanol extracts of *Barleriacristata*, *Justiciaprocumbens*, *Ruellia* and *Strobilanthesauriculata* showed antioxidant activity [27].

The extract of *Rhinacanthusnasutus* (Acanthaceae) exhibited antioxidant activity. Anti-aging effect was produced by the cosmetics containing this extract. The mechanism involved is the removal of superoxide from the human body [13].

Antioxidant activity of the methanol fraction of *Blepharisedulis* (Forssk.) Pers. Family Acanthaceae was determined using the DPPH radical test [28].

Hepatoprotective activity

The extract of *Andrographispaniculata* (Acanthaceae) was examined for hepatoprotective effect by administration to male mice. Andrographolide(8) and its derivatives exhibited hepatoprotective activity [29].

Rhinacanthusnasutus root extracts showed hepatoprotective effect in rats treated with aflatoxin-B1[13].

Insecticidal activity

The alcoholic extract of the aerial parts of *Acanthus montanus* Nees (Family: Acanthaceae) exhibited a significant activity against adult *Aedesegypti*. Phytochemical study of the plant has resulted in isolation of compounds which exhibit variable degrees of insecticidal activity. B-sitosterol-3-O-β-D-glucoside(19) exhibited mosquitocidal activity (100% mortality) against adult *Aedesegypti* at 1.25µg/mg concentration, followed by palmitic acid (20) (90%), linaroside(21) (80%) and acetoside(22) (70%) respectively [30].

Immunomodulatory activity

The extract of *Rhinacanthusnasutus* of family Acanthaceae exhibited immunomodulatory activity [13].

Anti- platelet aggregation activity

The *Rhinacanthusnasutus* (Acanthaceae) plant extract showed the anti-platelet aggregation effect. Rhinacanthin-A (12), rhinacanthin-B (13), rhinacanthin-C (14), rhinacanthin-G, rhinacanthin-H, rhinacanthin-I, rhinacanthin-K, rhinacanthin-M and rhinacanthin-Q (17) separated from the roots of *Rhinacanthusnasutus*. These compounds showed inhibition of rabbit platelet aggregation induced by arachidonic acid [13].

Phytochemical reports on family acanthaceae

Glycosides

From the aerial parts of *Acanthus ilicifolicus*, which is a member of Acanthaceae family, (2R)-2-O-β-D-gluco-pyranosyl-2H-1,4-benzoxazin-3(4H)-one (23), (2R)-2-O-β-D-gluco-pyranosyl-4-hydroxy-2H-1,4-benzoxazin-3(4H)-one (24), (2R)-2-O-β-D-gluco-pyranosyl-7-hydroxy-2H-1,4-benzoxazin-3(4H)-one (25), 7-chloro-(2R)-2-O-β-D-gluco-pyranosyl-2H-1,4-benzoxazin-3(4H)-one (26) and (2R)-2-O-β-D-gluco-pyranosyl-5-hydroxy-2H-1,4-benzoxazin-3(4H)-one(27) have been isolated [31].

Salidroside(28), benzyl β-D-gluco-pyranoside(29), (6S,9R)-roseoside(30), asyngangoside(31), ajugol(32), apigenin 7-O-β-D-gluco-pyranoside(33), apigenin 7-O-neohesperidoside (34) and apigenin 7-O-β-D-gluco-pyranosyl-(1→6)-β-D-gluco-pyranoside(35) have been reported in *Asystasiagangeticawhich* belongs to family Acanthaceae [32].

Olean-12-ene-1β,3β,11α,28-tetraol-28-O-β-D-gluco-pyranosyl-(1→2)-β-D-gluco-pyranoside (36), olean-12-ene-1β,3β,11α,28-tetraol-28-O-β-D-gluco-pyranosyl-(1→2)-β-D-gluco-pyranosyl-(1→2)-β-D-gluco-pyranoside(37), 11α-methoxy-olean-12-ene-1β,3β,28-triol-28-O-β-D-gluco-pyranosyl-(1→2)-β-D-gluco-pyranoside(38) and 11α-methoxy-olean-12-ene-1β, 3β, 28-triol 28-O-β-D-gluco-pyranosyl-

(1→2)-β-D-gluco-pyranosyl-(1→2)-β-D-gluco-pyranoside (39) were reported from *Justiciabetonica*L. belonging to family Acanthaceae [33]. Three phenylethnoid glycosides, desrhamnosylacteoside(40), acteoside (41) and poliumoside(42) were separated and identified from the callus cultures of *Barleriacristata* L. of family Acanthaceae [34].

New phenylethnoid glycoside namely acanmontanoside(43) together with eight known compounds, identified as decaffeoylverbascoside, verbascoside(44), isoverbascoside(45), leucosceptoside A (46), (2R)-2-O-β-D-gluco-pyranosyl-2H-1,4-benzoxazin-3(4H)-one, (2R)-2-O-β-D-gluco-pyranosyl-4-hydroxy-2H-1,4-benzoxazin-3(4H)-one (47), (3R)-1-octen-3-ol-3-O-β-D-xylopyranosyl-(1→6)-O-β-D-gluco-pyranoside (48) and ebracteatoside B (49) have been reported from the methanol extract of aerial portion of *Acanthus montanus*[35].

From the genus *Asystasia* of Acanthaceae family following compounds have been reported: 6β-hydroxyantirrhin (50), angeloside(51), ajugol(32), 6-O-α-L-rhamnopyranosyl-catapol (52), 6-O-α-(3"-O-trans-caffeoyl)-L-rhamnopyranosyl-catapol(53), 6-O-α-(3"-O-trans-p-coumaroyl)-L-rhamnopyranosyl-catapol(54), sinuatol (55), luteolin 7-O-β-D-gluco-pyranoside(56), luteolin 7-O-rutinoside(57), apigenin 7-O-rutinoside (58) and apigenin 7-O-β-D-glucuronide(59) [36].

Ethanol extract of leaves of *Barleriacristata* gave two iridoidal glycosides like barlerin(60) and shanshide methyl ester (61)[37].

Chemical investigation of the methanol fraction of the aerial parts of *Blepharisedulis* (Forssk.) Pers. Family Acanthaceae revealed the presence of phenylethnoids namely verbascoside(44), cis-verbascoside, isoverbascoside(45) and leucosceptoside A (46) [28]. Glycoside compounds; sitosterol-β-D-gluco-pyranoside(62), stigmaterol-β-D-gluco-pyranoside(63), 3, 4-dimethylphenol-β-D-gluco-pyranoside(64) and 3, 4, 5-trimethylphenol-β-D-gluco-pyranoside(65) were isolated from leaves and stems of *Rhinacanthusnasutus* plant of family Acanthaceae [13].

Flavonoids

The preliminary phytochemical screening of *Dipteracanthuspatulus* Jacq. Nees (Acanthaceae) revealed the presence of flavonoids [38].

From the crude ethanol extract of *Brillantaisiapalisatii* (Acanthaceae) 3-epi-ursolic acid (66), verbascoside(44) and lespedin(67) were isolated[39]. Following compounds were reported from *Andrographispaniculata* (Acanthaceae); β-sitosterol(68), andrographolide(8), 14-deoxy-ll, 12-dedihydro andrographolide, 14-deoxyandrographolide (69), 7-O-methyl dihydro wogonin (70), (2S)-5,7,2',3'-tetramethoxyflavone (71), dihydro skullcapflavone I (72), 7-O-methyl wogonin (73), 5-hydroxy-7,8,2',5'-tetramethoxy-flavone (74), 5-hydroxy-7,8,2',3'-tetramethoxyflavone (75), 5-hydroxy-7,2',6'-trimethoxyflavone(76), 5-hydroxy-7,2',3'-trimethoxyflavone(77), skullcapflavone 12-methylether (78), cinnamic acid(79), caffeic acid (80), ferulic acid (81), chlorogenic acid (82), 7-O-methyl wogonin 5-glucoside (83), skullcapflavone I 2'-glucoside (84), 14-deoxy- 15-isopropylidene-11,12-didehydro-andrographolide(85), 14-deoxy-11-hydroxy andrographolide (86), neoandrographolide(87) and andrographoside(88) [40]. Chromatographic resolution of ethyl acetate extract of leaves of *Barleriacristata* furnished two flavonoid compounds, which were further identified and characterized as luteoline(89) and 7-methoxy luteoline(90)[41]. Coumarins, (+)-pracruptorin, umbelliferone(91) and 2, 6-dimethoxy benzoquinone (92) derived from the whole plant of *Rhinacanthusnasutus* plant of family Acanthaceae [13].

Phenolic compounds

Petroleum ether extract of leaves of *Barleriacristata* furnished two phenolic compounds, which were characterized as p-coumaric acid (93) and α-tocopherol(94) [41].

Naphthoquinone

Rhinacanthin-A (12), rhinacanthin-B (13), rhinacanthin-C (14), rhinacanthin-D (15), rhinacanthin-G, rhinacanthin-H, rhinacanthin-I, rhinacanthin-J, rhinacanthin-K, rhinacanthin-L, rhinacanthin-M,

rhinacanthin-N (**16**), rhinacanthin-O, rhinacanthin-P and rhinacanthin-Q (**17**) were isolated aerial parts of *Rhinacanthus nasutus* plant of family Acanthaceae [13].

Benzonoids

The benzonoids compounds p-hydroxy-benzaldehyde(**95**), vanillic acid (**96**), syringic acid (**97**), 2-methoxy-propionolphenol (**98**), methyl valinate(**99**) and syringaldehyde(**100**) were isolated from leaves, roots and stems of *Rhinacanthus nasutus* plant of family Acanthaceae [41].

Triterpenoids

The triterpenoids compounds β -amyrin(**101**), glutinol(**102**) and leupeol(**103**) were derived from roots of *Rhinacanthus nasutus* plant of family Acanthaceae [13].

Pharmacological reports on genus *Aphelandra*

Antibacterial activity and Antifungal activity

From the roots of genus *Aphelandra* 2-benzoxazolinones (**104**) and 6-methoxy-2-benzoxazolinone (**105**) were separated. These compound and their related synthetic derivatives showed antibacterial and antifungal activity [42]. Plants belonging to genus *Aphelandra* (*Acanthaceae*) showed antimicrobial activity against *E. coli*, *P. aeruginosa*, *S. aureus*, and *C. albicans*[43]. The methanol extracts of *Aphelandra squarrosa* showed antibacterial activity against at least one of the following test organisms, *Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris* and *Pseudomonas aeruginosa* using the tube dilution and plate diffusion methods [44].

Immunomodulatory activity

2-benzoxazolinone (**104**) and 2-hydroxy-1, 4-benzoxazin-3-one (**106**) were isolated from *Aphelandra tetragona*. These were bio transformed into 2-amino-3-*H*-phenoxazine-3-one (**107**) by endophytic fungi. 2-amino-3-*H*-phenoxazine-3-one (**107**) has potent anti-inflammatory and immunoregulatory properties. These properties may provide a promising therapeutic strategy for the treatment of T cell-mediated inflammatory auto immune diseases as well as for bacteria induced chronic inflammatory diseases[45].

Both 2-benzoxazolinone (**104**) and 2-hydroxy-1, 4-benzoxazin-3-one (**106**) are compounds called phytoanticipins and present in healthy plants as substances to overcome microbial diseases and herbivore[46].

Phytochemical reports on genus *Aphelandra*

Alkaloids

Macrocyclic polyamine alkaloid aphelandarine(**108**) was isolated from the roots of *Aphelandra tetragona*, which consists of spermine and two units of 4-hydroxycinnamic acid [47].

N¹,N⁵-Di-*p*-coumaroylspermidine (**109**), N⁵,N[10]-di-*p*-coumaroylspermidine (**110**), and N¹,N⁵,N[10]-tri-*p*-coumaroylspermidine (**111**) were isolated from anthers of *Aphelandra tetragona* and *A. chamissoniana*[48].

18-*O*-Methylchaenorpine and iso-18-*O*-methylchaenorpine two novel stereo-isomeric spermine alkaloids were separated from *Aphelandra tetragona*[49].

Macrocyclic spermine alkaloids namely 6-hydroxy-aphelandrine (**112**) and 6-acetoxy-aphelandrine (**113**) were isolated from the roots of *Aphelandra fuscopunctata*[50].

Benzoxazinoids-cyclic hydroxamic acids and their corresponding glucosides

From roots of *Aphelandra squarrosa* and *Aphelandra fuscopunctata* following compounds were separated; 2,4-dihydroxy-1,4-benzoxazin-3(H)-one (**114**), 2,4-dihydroxy-7-methoxy-1,4-benzoxazin-3(H)-3one (**115**), 2-hydroxy-1,4-benzoxazin-3(2H)-one (**116**), 2-hydroxy-7-methoxy-1,4-benzoxazin-3(2H)-one (**117**), and their corresponding glycosides as well as benzoxazolinones[51]

In *Aphelandra squarrosa* glycosides are present in the roots [52].

Flavonoids and Isoflavones

Several compounds were isolated and identified from the leaves and stems of *Aphelandra aurantiaca* which consists of scopoletin(**118**), chrysin(**119**), eucalyptin(**120**), gnaphalin(**121**), nevadensin(**122**) and *p*-coumaric acid (**123**) in the form of ester with glucose [53].

Fig. 1: Structure of compounds present

CONCLUSION

Literature actually reports chemical investigations of a large family of nearly 250 genera and 2500 species, distributed mainly in the tropics and extending to Mediterranean, Australia and Southern U. S. A. In Pakistan it is represented by 18 genera and 60 specific and infraspecific taxa; of which 44 are native. There are no published data concerning either the toxicity of the whole remedies and their isolated compounds. Further investigations on phytochemical discovery and subsequent screening are needed for opening new opportunities to develop pharmaceuticals based on Family Acanthaceae and genus *Aphelandra*.

CONFLICT OF INTERESTS

Declared None

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