ISSN 2582-788X REVIEW ARTICLE

INTERNATIONAL JOURNAL OF
APPLIED CHEMICAL AND BIOLOGICAL SCIENCES

Medicinal properties of phyto-constituents from Rubiaceae family of Assam: Critical Review

Das B. P. and Ghosh A.*

Microbiology Division, Department of Botany, Gauhati University, Assam, India

ABSTRACT

Assam is the gateway to Northeast India and is well-known for its rich biodiversity and wildlife resources. The land of Assam is very fertile and is blessed with different plant species with high medicinal properties. The tribal and ethnic people living here have a vast knowledge of different medicinal plants and have been using these plants as herbal medicines for different diseases and ailments for ages. Rubiaceae, one of the medicinally and economically important plant families are widely distributed over different locations of Assam. Most of them have great medicinal value because of the different phytochemicals present in it. The present review deliberates some commonly found medicinal plant species of the Rubiaceae family, including *Adina cordifolia, Anthocephalous cadamba, Gardenia jasminoides, Gardenia ternifolia, Ixora coccinea, Ixora pavetta, Paederia foetida, Pavetta indica, Randia dumetorum, Rubia cordifolia* in Assam and their phytoconstituents, ethnomedicinal and pharmacological activities.

Keywords: Assam, Rubiaceae, phytoconstituents, ethnomedicinal, pharmacological activity

1. INTRODUCTION

Plants have been used as medicine along with food, fodder, and fuel since primeval periods [1]. Plants produce several chemical compounds that enhance their therapeutic properties, which can be used directly or indirectly [2]. Some commonly isolated phytochemicals from plants are alkaloids, flavonoids, tannins, lignins, terpenoids, saponins, phytosterols, and glycosides [3]. They have many biological activities such as anti-inflammatory, anti-arthritic, antipyretic, anti-gastric ulcer, antifungal, antibacterial, antimalarial, antitumor and immunomodulatory [4] and so on [5].

Assam is located in the northeast part of India and the southern region of the Himalaya. Depending on the two major rivers, Brahmaputra and Barak, Assam is classified into the Brahmaputra valley and Barak valley [6]. 35.48% of the total land of Assam is covered by forest areas. The total area of Assam is 78,523 sq. km, which extends from 24°09' to 27°58' N longitudinal, from 89°42' to 96°01'E latitudinal [6, 7].

The Rubiaceae family comprises 660 genera and 13,200 species and is found all over the world [6]. 551 species and 150 species of Rubiaceae family plants have been reported from India and Assam, respectively [7]. In the present study, ten plants of the Rubiaceae family viz. *Adina cordifolia, Anthocephalous cadamba, Gardenia jasminoides, Gardenia ternifolia, Ixora coccinea, Ixora pavetta, Paederia foetida, Pavetta indica, Randia dumetorum, Rubia cordifolia* have been reviewed for their ethnomedicinal, phytochemical, and biological activities. The reasons for selecting these plants for review because they are found almost everywhere in Assam and commonly used by people of Assam for a long time.

2. PHYTOCHEMICALS AND ETHNOMEDICINAL USES

Phytochemicals are secondary metabolites that plants produce that protect the plant from pathogens and herbivorous animals. They also provide flavor, odor, color, texture, and medicinal value to the plant. Phytochemicals are extracted from all parts of plants, such as leaves, bark, roots, flowers, fruits, etc. [4, 8]. The medicinal properties of plants are due to the presence of phytochemicals [8]. The tribal and ethnic groups of people are mainly associated with these medicinal plants, thus, the medicines obtained from such plants are known as ethnomedicine [1]. All the different phytochemicals obtained from *A. cordifolia, Anthocephalous cadamba, Gardenia jasminoides, Gardenia ternifolia, Ixora coccinea, Ixora pavetta, Paederia foetida, Pavetta indica, Randia dumetorum, and Rubia cordifolia* are compared for proper evalution of metabolites in Rubiace family (Table1). The compounds isolated from different plants and their functions are discussed for the brief (Table 2).

2.1. *Adina cordifolia*

A. cordifolia are distinctly rich with secondary metabolites in various extracts, providing broad range of bioactivity. Many earlier studies reported the presence of flavonoids (ethanol and methanol extract), alkaloids (ethanol extract), carbohydrates (ethanol, methanol, and aqueous extract), saponins (ethanol, methanol, and aqueous extract), phenols (ethanol extract), tannins (ethanol, methanol, and aqueous extract) and terpenoids (ethanol, methanol and aqueous extract) [9]. Plant's different parts such as roots, bark, buds, flowers, and leaves are used to cure various diseases [10]. The roots are used for diarrhea treatment [11, 12]. The bark of the plant has been used in skin disorders, fever, abdominal pain, arthritis, stomach disorders, irregular menstruation, and wounds. Buds can be used as anti-snake venoms [12]. Flowers are useful in headache; leaves are mainly used to cure wounds, cuts, boils, and other infections [11, 12]. Some other medicinally important bioactive compounds isolated from *A. cordifolia* are adifoline, cordifoline, benzoic acid, β-sitosterol, and umbelliferone [11].

2.2. *Anthocephalous cadamba*

Anthocephalous cadamba are tall annual plant with great variant of secondary metabolites. Some of the commonly found bioactive compound from A. cadamba are Tannins (in methanol, chloroform, acetone and ethanol extract), phenols (in methanol extract), alkaloids (in methanol and chloroform extract), saponin (in methanol, chloroform and ethanol extract), iridoids (in petroleum ether and acetone), coumarin (in petroleum ether, chloroform and acetone), 6,7-dimethoxycoumarin (chloroform and acetone), 5-Methoxy genistein (in chloroform extract), anthocyanin (in petroleum ether extract), proanthocyanidins (in petroleum ether extract), flavonoid (in methanol, chloroform and ethanol extract), glycosides (in methanol and chloroform extract), steroids (in petroleum ether, chloroform,

methanol and ethanol), triterpenoid (in petroleum ether and chloroform extract), carbohydrates (in methanol and acetone extract), proteins and amino acids (in chloroform, acetone and ethanol extract) and gums [13, 14, 15]. According to Dubey *et al.* (2011), some workers isolated phytochemicals such as cadambagenic acid (18α-Olean-12ene-3β-hydroxy-27,28-dioic acid), quinovic acid (C30H46O5), and β-sitosterol from the *Anthocephalus cadamba* stem bark. From the leaves of *A. cadamba*, glycosidic indole alkaloids such as cadambine (C27H32N2O10), 3α-dihydrocadambine (C27H34N2O10), isodihydrocadambine (C37H44N2O15), and two non-glycosidic alkaloids viz. cadamine (C21H21N3O3) and isocadamine. Aminocadambine A (C24H27N3O5) and Aminocadambine B (C25H29N3O5) are two novel monoterpenoid indole alkaloids which are found in the leaves of *Anthocephalus cadamba* [16]. Some reports also suggest the extraction of Saponin B (C48H76O17) [17] and chlorogenic acid from *A cadamba*.

Due to presence of wide variety of metabolites *A. cadamba* are used since ages for the treatment of fever, blood diseases, skin diseases, measles, diarrhea, menorrhagia, and improvement of semen quality [18]. Recently, the plant has been reported to contain antimicrobial, wound healing, hypolipidemic, antidiabetic, antioxidant, antimalarial, and hepatoprotective effects [16, 19].

2.3. *Gardenia jasminoides*

Gardenia jasminoides are shrubby flower plant commonly found in Indian household. The bioactive compounds isolated from *Gardenia jasminoides* fruits were geniposide, genipin, and geniposidic acid. All of these are iridoid glycosides and medicinally very important [20]. Other important phytochemicals obtained from the plant are shanzhiside, scandoside, methyl ester, crocin, crocetin, gardoside, jasminoside D, 7α, 8β-epoxy-8a-dihydrogeniposide, genipin-1- β-gentibioside, sinapylglucoside, jasminodiol, rutin, isoquercitrin, nicotiflorin, 11-(6-O-trans-sinapolyglucopyranosyl)- gardendiol, 3,5-dicaffeoylquinic acid, trans-crocin 4, 6”-O-trans-sinapoyl genipin-gentiobioside, 6”-O-p-coumaroyl genipin-gentiobioside, 6'-O-trans-sinapoyl jasminoside L, 5-O-caffeoyl-4-O-sinapoylquinic acid, 6'-O-trans-coumaroyl-geniposide [21]. These plants have various ethnomedicinal properties that are used to cure jaundice, headache, dropsy, fever, liver diseases, high blood pressure, and stomach inflammation [22].

2.4. *Gardenia ternifolia*

Gardenia ternifolia are fragrant, flowering shrubby plant with some prominent secondary metabolites. The leaves extract of *Gardenia ternifolia* with ethanol and water reported the presence of polyphenols, anthocyanin, leuco-anthocyanin, flavonoids, gallic tannins, coumarins, quinones, alkaloids, saponins, terpenes and steroids with some important pharmaceutical properties [23]. These plant has a great ethnomedicinal value that has been used to cure malaria, peptic ulcer, cough, fever, abdominal pain, syphilis, joint inflammation, bronchial asthma, a stimulant laxative, and an antidote to snake poison [24].

2.5. *Ixora coccinea*

Ixora coccinea are flowering plant with some beneficial metabolites. *Ixora coccinea* is an ingredient of many herbal medicines used to treat several severe diseases. The leaves, flowers, and stems of *Ixora coccinea* were collected and extracted with methanol. The phytochemicals from *Ixora coccinea* showed the presence of terpenoids (6), flavonoids, alkaloids, coumarins, and phenolic compounds [25]. The essential oil of *Ixora coccinea* consists of triterpenes,

monoterpenes, sesquiterpenes, and esters. Further recorded phytochemicals include ixorene, β-sitosterol, lupeol, D-mannitol, kaempferol, and camptothecin [26, 27]. The decoction of roots is beneficial for dysentery and is used as a sedative. It is also used for hiccups, nausea, fatigue, fever, and gonorrhea. Flowers and bark are used to cure eye disorders. The decoction of flowers is used to treat cough and bronchitis [28].

2.6. *Ixora pavetta*

Different parts of *Ixora pavetta* are used to treat malnourishment, lesions, urinary tract disease, skin infection, hepatic disorders, calmative, hypertension, dysentery, and cervicitis. Flowers are mainly used to cure coughs and peptic ulcers. Roots are beneficial for jaundice and anemia. Leaves are useful in chest and muscle pain [30]. The ethanol extracts of *Ixora pavetta* flowers were analyzed by gas chromatography-mass spectroscopy (GC-MS) technique, which found the presence of 3-Butyn-2-ol, 3-Butyn- 1-ol, amyl nitrite, 1, 9-Decadiyne, 2-Octyn-1-ol and butyl glyoxylate (Baboo et al. 2011) [29]. Other phytochemicals obtained from stem, leaves, and seeds are chrysin 5-O-β-D-xylopyranoside, flavone glycoside, 6, 7-dimethoxycoumarin and essential oils such as capric, lauric, myristic, palmitic, stearic, arachidic, behenic, oleic and linoleic acids [30].

2.7. *Paederia foetida*

Paederia foetida is a climber plant with small flowers with some important medicinal metabolites. Fresh and dry leaves extract with aqueous, methanol, ethanol, and acetone and reported the presence of phenol, flavonoids, and tannins [31, 32]. Some other phytochemicals found in the plant are paederolone, paederone, β-sitosterol, paederoside, glucosides, iridoid, asperuloside, friedelin, campesterol, ursolic acid, hentriacontane, hentriacontanol, cetyl alcohol, palmitic acid, ellagic acid, terpenoids and methyl mercaptan [33]. People of the Northeast India, especially in Assam, use *Paederia foetida* leaves as vegetables, as it is very helpful for different stomach issues. The leaf juice is slightly bitter which has anti-dysenteric properties. Root and bark decoction is beneficial for piles, spleen inflammation, and chest pain. Fruits can be used during toothache [34].

2.8. *Pavetta indica*

Pavetta indica are large shrubs or small tree with some beneficial phytochmeicals. The leaves of the plant were extracted with petroleum ether and isolated carbohydrates, glycosides, alkaloids, phytosterols, and flavonoids [35], Linoleic acid, proanthocyanidins, epicatechin, fercilic acid and (9z,12z,15z)-octadeca-9,12,15-trienoic acid [36]. Leaves, roots, and fruits of the plant *Pavetta indica* are used as ethnomedicine. The leaves can be applied to dressing wounds and boils. The decoction of leaves is used in piles and nose ulcers. Roots also have the potential to heal boils, itches, and cure headaches. The fruits have anthelmintic properties [36, 37].

2.9. *Randia dumetorum*

Randia dumetorum is a thorny shrub with variety of metabolites. *Randia dumetorum* plant is an important constituent of different Ayurvedic medicines that are commonly used to treat cough, dermatological problems, peptic ulcer, and asthma, etc. The leaves and bark extract of *Randia dumetorum* showed the presence of phenol, flavonoids, saponins, terpenoids, coumarins, and iridoid glycosides [38, 39]. Column chromatography, high-performance thin layer chromatography (HPTLC), and gas chromatography-mass spectrometry (GC-MS) techniques were used to identify triterpenoid esters, cinnamate, naphthalene, phenolic compounds, amines and coumarins [39]. The decoction of the bark is used during diarrhea and

dysentery as well as reduces pain and bone aches. Fruits are used to cure ulcers, inflammation, tumor, abscesses, and different skin diseases [40].

2.10. *Rubia cordifolia*

Rubia cordifolia plays a vital role in skin infections, skin lesions, and nerve damage, itchy skin, dysentery, ulcer, and anti-snake venom [41]. The roots, stems, and leaves of *Rubia cordifolia* were extracted with hexane, chloroform, acetone, and methanol and isolated anthraquinones, glycosides, saponins, terpenoids, and resins [42]. The aqueous, ethanol, acetone, methanol, and hexane extract isolated carbohydrates, alkaloids, protein, saponins, glycosides, phenolic compounds, and tannins [43]. Roots contain hydroxyanthraquinone, which is named rubiadin, along with GSH and vitamin C [44]. Nordamnacanthal, rubiadin, Hydroxy-1 methyl-2 anthraquinone, and xanthopurpurin were isolated from the root extract of *R. cordifolia* [45]. Furomollugin, mollugin, and dehydro-α-lapachone isolated from *R. cordifolia* roots have an anti-allergic effect [46]. The roots of *Rubia cordifolia* have been used because of their potential wound healing capacity along with blood coagulation and clumping of platelets.

Table 1. Comparative study different phytochemicals isolated from *Adina cordifolia*, *Anthocephalous cadamba*, *Gardenia jasminoides, Gardenia ternifolia, Ixora coccinea, Ixora pavetta, Paederia foetida, Pavetta indica, Randia dumetorum, Rubia cordifolia*

Phytochemicals	*A. cordifolia*	*A. cadamba*	*G. jasminoides*	*G. ternifolia*	*I. coccinea*	*I. pavetta*	*P. foetida*	*P. indica*	*R. dumetorum*	*R. cordifolia*
Flavonoid	+	+	+	+	+	+	+	+	+	-
Alkaloids	+	+	+	+	+	+	+	+	+	+
Carbohydrates	+	+	-	-	-	-	+	+	-	+
Saponin	+	+	+	+	-	+	+	-	+	+
Phenol	+	+	+	+	+	+	+	-	+	+
Tannins	+	+	-	+	-	+	+	-	-	+
Terpenoids	+	-	+	+	+	+	+	-	+	+
Steroids	-	+	+	+	-	+	-	+	-	-
Adifoline	+	-	-	-	-	-	-	-	-	-
Cordifoline	+	-	-	-	-	-	-	-	-	-
Benzoic acid	+	-	-	-	-	-	-	-	-	-
β-sitosterol	+	+	-	-	+	+	-	-	-	-
Umbelliferone	+	-	-	-	-	-	-	-	-	-
Iridoids	-	+	+	+	-	-	+	-	+	-
Coumarin	-	+	-	+	+	-	-	-	+	-
6,7-dimethoxycoumarin	-	+	-	-	-	+	-	-	-	-

5-Methoxy genistein	-	+	-	-	-	-	-	-	-	-
Anthocyanin	-	+	-	+	-	-	-	-	-	-
Proanthocyanidins	-	+	-	-	-	-	-	+	-	-
Glycosides	-	+	+	-	-	+	-	+	+	+
Cadambagenic acid	-	+	-	-	-	-	-	-	-	-
Quinovic acid	-	+	-	-	-	-	-	-	-	-
Cadambine	-	+	-	-	-	-	-	-	-	-
3α-dihydrocadambine	-	+	-	-	-	-	-	-	-	-
Isodihydrocadambine	-	+	-	-	-	-	-	-	-	-
Cadamine	-	+	-	-	-	-	-	-	-	-
Chlorogenic acid	-	+	-	-	-	-	-	-	-	-
Aminocadambine A	-	+	-	-	-	-	-	-	-	-
Aminocadambine B	-	+	-	-	-	-	-	-	-	-
Geniposide	-	-	+	-	-	-	-	-	-	-
Genipin	-	-	+	-	-	-	-	-	-	-
Geniposidic acid	-	-	+	-	-	-	-	-	-	-
Crocin	-	-	+	-	-	-	-	-	-	-
Crocetin	-	-	+	-	-	-	-	-	-	-
Shanzhiside	-	-	+	-	-	-	-	-	-	-
Scandoside	-	-	+	-	-	-	-	-	-	-
Gardoside	-	-	+	-	-	-	-	-	-	-
Jasminoside D	-	-	+	-	-	-		-	-	-
Genipin-1- β-gentibioside	-	-	+	-	-	-	-	-	-	-
Sinapylglucoside	-	-	+	-	-	-	-	-	-	-
Jasminodiol	-	-	+	-	-	-	-	-	-	-
Rutin	-	-	+	-	-	+	-	-	-	-
Isoquercitrin	-	-	+	-	-	-	-	-	-	-
Nicotiflorin	-	-	+	-	-	-	-	-	-	-
11-(6-O-*trans*-sinapolyglucopyranosyl)- gardendiol	-	-	+	-	-	-	-	-	-	-
3,5-dicaffeoylquinic acid	-	-	+	-	-	-	-	-	-	-
trans-crocin 4	-	-	+	-	-	-	-	-		-
6”-O-trans-sinapoyl genipin-gentiobioside, 6	-	-	+	-	-	-	-	-	-	-
6”-O-p-coumaroyl genipin-gentiobioside	-	-	+	-	-	-	-	-	-	-
6'-O-trans-sinapoyl jasminoside L	-	-	+	-	-	-	-	-	-	-
5-O-caffeoyl-4-O-sinapoylquinic acid	-	-	+	-	-	-	-	-	-	-
6'-O-trans-coumaroyl-geniposide	-	-	+	-	-	-	-	-	-	-
Quinones	-	-	-	+	-	-	-	-	-	-
Ixorene	-	-	-	-	+	-	-	-	-	-

Lupeol	-	-	-	-	+	-	-	-	-	-
D-mannitol	-	-	-	-	+	-	-	-	-	-
Kaempferol	-	-	-	-	+	+	-	-	-	-
Camptothecin	-	-	-	-	+	-	-	-	-	-
3-Butyn-2-ol	-	-	-	-	-	+	-	-	-	-
3-Butyn- 1-ol	-	-	-	-	-	+	-	-	-	-
Amyl nitrite	-	-	-	-	-	+	-	-	-	-
1, 9-Decadiyne	-	-	-	-	-	+	-	-	-	-
2-Octyn-1-ol	-	-	-	-	-	+	-	-	-	-
Butyl glyoxylate	-	-	-	-	-	+	-	-	-	-
chrysin 5-O-β-D-xylopyranoside	-	-	-	-	-	+	-	-	-	-
Flavoneglycoside	-	-	-	-	-	+	-	-	-	-
Paederolone	-	-	-	-	-	-	+	-	-	-
Paederone	-	-	-	-	-	-	+	-	-	-
Paederoside	-	-	-	-	-	-	+	-	-	-
Asperuloside	-	-	-	-	-	-	+	-	-	-
Friedelin	-	-	-	-	-	-	+	-	-	-
Campesterol	-	-	-	-	-	-	+	-	-	-
ursolic acid	-	-	-	-	-	-	+	-	-	-
Hentriacontane	-	-	-	-	-	-	+	-	-	-
Hentriacontanol	-	-	-	-	-	-	+	-	-	-
cetyl alcohol	-	-	-	-	-	-	+	-	-	-
palmitic acid	-	-	-	-	-	-	+	-	-	-
ellagic acid	-	-	-	-	-	-	+	-	-	-
methyl mercaptan	-	-	-	-	-	-	+	-	-	-
Linoleic acid	-	-	-	-	-	-	-	+	-	-
epicatechein,	-	-	-	-	-	-	-	+	-	-
fercilic acid	-	-	-	-	-	-	-	+	-	-
(9z,12z,15z)-octadeca-9,12,15-trienoic acid	-	-	-	-	-	-	-	+	-	-
triterpenoid esters	-	-	-	-	-	-	-	-	+	-
Cinnamate,	-	-	-	-	-	-	-	-	+	-
Naphthalene	-	-	-	-	-	-	-	-	+	-
Rubiadine	-	-	-	-	-	-	-	-	-	+
Nordamnacanthal,	-	-	-	-	-	-	-	-	-	+
Hydroxy-1 methyl-2 anthraquinone	-	-	-	-	-	-	-	-	-	+
Xanthopurpurin	-	-	-	-	-	-	-	-	-	+
Furomollugin	-	-	-	-	-	-	-	-	-	+
Mollugin	-	-	-	-	-	-	-	-	-	+
Dehydro-α-lapachone	-	-	-	-	-	-	-	-	-	+

(+): indicates the presence of bioactive compound, (-): indicates the absence of bioactive compound.

Table 2. Chemical structure of the compounds and their function isolated from the medicinally important plant belong to Rubiaceae family.

Sl. No.	Name of the compound	Used in treatments	References
1.	**Flavonoid** (*A.cordifolia, A.cadamba, G. jasminoides, G. ternifolia, I. coccinea, I. pavetta, P. foetida, P. indica, R. dumetorum)*	Anticancer, anti-inflammatory, hepatoprotective, antibacterial and antiviral	[89]
2.	**Alkaloids** (*A.cordifolia, A.cadamba, G. jasminoides, G. ternifolia, I. coccinea, I. pavetta, P. foetida, P. indica, R. dumetorum, R. cordifolia)*	Antiseptic, pain killer, anti-stress, stomatics, antioxidant, anti-inflammatory, antimicrobial activity	[90]
3.	**Saponins** (*A.cordifolia, A.cadamba, G. jasminoides, G. ternifolia, I. pavetta, P. foetida, P. indica, R. dumetorum, R. cordifolia)*	Anti-inflammatory, antioxidant, cardiac stimulants, increase the frequency of urine and helps to reduce obesity	[91]
4.	**Phenols** (*A.cordifolia, A.cadamb, , G. ternifolia, I. coccinea, I. pavetta, P. foetida, R. dumetorum, R. cordifolia)*	Cancer, cardiovascular diseases, diabetes, obesity and microbial diseases	[92]
5.	**Tannins** (*A.cordifolia, A.cadamba, G. ternifolia, (I. pavetta, P. foetida, R. cordifolia)*	Cure burns and inflamed skin, diarrhea, ulcer and sore throat. Have antimicrobial and antioxidant effects	[93,94]
6.	**Terpenoids** (*A.cordifolia., G. jasminoides, G. ternifolia, I. coccinea, (I. pavetta, P. foetida, R. dumetorum, R. cordifolia)*	Antibacterial, antifungal, antiviral, anti-cancer and anti-malarial activity	[95]
7.	**Steroids** *(A.cadamba, G. jasminoides, G. ternifolia, (I. pavetta, P. indica)*	Reduction of sepsis, pneumonia, reduce nausea and vomiting, control blood pressure, ulcer and eye disorders	[96]
8.	**Benzoic acid** (*A.cordifolia)*	Antibacterial, antifungal and antiviral effect	[97]
9.	**β-sitosterol** (*A.cordifolia, A.cadamba, I. coccinea, I. pavetta)*	Heart disorders, tumor, joint inflammation, TB and hair loss as well as improve immune system	[98]
10.	**Umbelliferone** (*A.cordifolia)*	Antimicrobial, antioxidant, antidiabetic, anticancer	.[99]
11.	**Iridoids** *(A.cadamba, G. jasminoides, G. ternifolia, P. foetida, R. dumetorum)*	Cure pain, breathing problem, diarrhea, liver diseases and have antimicrobial, antidiabetic, antioxidant property	[100]
12.	**Coumarin** *(A.cadamba, G. ternifolia, I. coccinea, R. dumetorum)*	Anti-inflammatory, antioxidant, and antibacterial activity	[101,102]
13.	**6,7-dimethoxycoumarin** *(A.cadamba, I. pavetta)*	Decrease blood pressure	[103]
14.	**Anthocyanin** *(A.cadamba, G. ternifolia)*	anti-inflammatory, antioxidant, and antibacterial activity	[101,102]
15.	**Proanthocyanidins** *(A.cadamba, P. indica)*	Antioxidant, anticancer, antimicrobial, neuro and cardio protective	[104]
16.	**Glycosides** *(A.cadamba, G. jasminoides, (I. pavetta, P. indica, R. dumetorum, R. cordifolia)*	Loweing blood pressure	[105]
17.	**quinovic acid** *(A.cadamba)*	Inflammation and urinary tract disease	[106]
18.	**Chlorogenic acid**	Anti-diabetic, anti-cancer, analgesic and	[107]

	(A.cadamba)	helps in lipid metabolism. It also has liver and gastrointestinal health benefits	
19.	**Geniposide** *(G. jasminoides)*	Antidiabetic, anti-inflammatory and antidepression activity	[20]
20.	**Genipin** *(G. jasminoides)*	Anti-inflammatory	[20]
21.	**Crocin** *(G. jasminoides)*	Antidepression activity	[20]
22.	**Crocetin** *(G. jasminoides)*	Prevent insulin resistance, kidney damage and improve sleep.	[108]
23.	**Shanzhiside** (G. jasminoides)	Blood clotting	[109]
24.	**Scandoside** *(G. jasminoides)*	Antioxidant activity	[110]
25.	**Rutin** *(G. jasminoides)*	Analgesic effect, antiulcer effect, anticancer and sunscreen effect	[111]
26.	**Isoquercitrin** *(G. jasminoides)*	Antidiabetic, anticancer, anti-allergic activity	[112]
27.	**Nicotiflorin** *(G. jasminoides)*	Decrease blood pressure, hepatoprotective, anti-inflammatory, anti-nociceptive effect, antioxidant and neuroprotective	[113]
28.	**3,5-dicaffeoylquinic acid** *(G. jasminoides)*	Neuroprotective effect	[114]
29.	**Quinones** *(G. ternifolia)*	Renal diseases	[115]
30.	**Lupeol** *(I. coccinea)*	Anti-inflammatory activity	[116]
31.	**D-mannitol** *(I. coccinea)*	Renal protection and tissue injury	[117]
32.	**Kaempferol** *(I. coccinea and I. pavetta)*	Anti-inflammatory, antioxidant and antitumor activity	[118]
33.	**Camptothecin** *(I. coccinea)*	Anticancer activity	[71]
34.	**Amyl nitrite** *(I. pavetta)*	Cure heart diseases and act as vasodilator	[119]
35.	**Flavoneglycoside** *(I. pavetta)*	Antioxidant activity	[120]
36.	**Paederoside** (*P. foetida)*	Cure digestive problems, antimicrobial, antitumor, anti-inflammatory	[121]
37.	**Asperuloside** (*P. foetida)*	Anti-inflammatory effect.	[122].
38.	**Friedelin** (*P. foetida)*	Antimicrobial, antidiarrheal, anti-inflammatory, antoradical. gastroprotective	.[123]
39.	**Campesterol** (*P. foetida),*	Reduce cholesterol absorption	[124]
40.	**Ursolic acid** (*P. foetida)*	Hepatoprotective activity	[125]
41.	**Hentriacontane** (*P. foetida)*	Cure hepatic disorder and stress	.[126]
42.	**Hentriacontanol** (*P. foetida)*	Antibacterial activity	[127]
43.	**Palmitic acid** (*P. foetida)*	Anti-inflammatory effect	128]
44.	**Ellagic acid**	Anticancer and antioxidant	.[129]

	(P. foetida)		
45.	**Linoleic acid** *(P. indica)*	Treatment for skin diseases, heart disorder, cancer and inflammation	[130]
46.	**Epicatechein** *(P. indica)*	Antioxidant, anti-inflammation, antidiabetic and anticancer property	[131]
47.	**Triterpenoid esters** *(R. dumetorum)*	Anti-inflammatory effect	[81]
48.	**Cinnamate** *(R. dumetorum)*	Vasorelaxant and hypotensive effect.	[132]
49.	**Naphthalene** *(R. dumetorum)*	Traditionally used as anti-malarial agent and have antioxidant activity	[133]
50.	**Rubiadin** *(R. cordifolia)*	Antimicrobial	[59]
51.	**Nordamnacanthal** *(R. cordifolia)*	Antimicrobial	[59]
52.	**Hydroxy-1 methyl-2 anthraquinone** *(R. cordifolia)*	Antimicrobial	[59]
53.	**Xanthopurpurin** *(R. cordifolia)*	Antimicrobial	[59]
54.	**Furomollugin** *(R. cordifolia)*	Anti-allergic	[45]
55.	**Mollugin** *(R. cordifolia)*	Anti- allergic	[45]
56.	**Dehydro-α-lapachone** *(R. cordifolia)*	Anti-allergic	[45]

Table 3: Biological properties of *Adina cordifolia, Anthocephalous cadamba, Gardenia jasminoides, Gardenia ternifolia, Ixora coccinea, Ixora pavetta, Paederia foetida, Pavetta indica, Randia dumetorum, Rubia cordifolia* with their common name, habit and active phytochemicals.

Plant	Common name	Habit	Biological activities	Plant parts used	Active phytochemicals
Adina cordifolia	Kadami, Tarakchapa	Tree	Antioxidant	Leaves	Polyphenol
			Antimicrobial	Bark and leaves	flavonoid, tannins and phenolic compound
			Antidiabetic	Leaves	–
			Hepatoprotective	Leaves	phenolic compounds, tannins, flavonoids
			Analgesic	Stem bark	–
			Anti-inflammatory	Leaves	–
Anthocephalous cadamba	Kadam	Tree	Antioxidant	Bark, flowers, fruits, leaves	Flavonoids

			Antimicrobial	Bark, leaves, flowers	_
			Antidiabetic	Roots	alkaloids, saponins, flavonoid, tannins
			Hepatoprotective	Leaves	chlorogenic
			Antidiarrheal	Flowering top	indole alkaloids, iridoids, triterpenes, saponins
			Analgesic	Flower	_
			Anti-inflammatory	Stem bark	Triterpenoid
Gardenia jasminoides	Gandharaaj	Shrub	Antidiabetic	Fruit	Geniposide
			Anti-inflammatory	Fruits	Geniposide, genipine
			Anti-depression	Fruits	Geniposide and crocin
Gardenia ternifolia	Dekamali	Shrub	Antimicrobial	Leaves	Anthocyanin, organic acids
			Anti-sickling	Leaves	Anthocyanin, organic acids
Ixora coccinea	Rugmini, Rangan	Shrub	Antioxidant	Flowers and leaves	total phenolic content
			Antimicrobial	Leaves	_
			Hepatoprotective	Roots	Ursolic acid
			Anticancer	Leaves	Camptothecin
			Antidiarrheal	Leaves	_
			Analgesic	Leaves	Alkaloids, flavonoids
			Anti-inflammatory	Leaves	Lupeol
			Anti-depression	Flowers	_
Ixora pavetta	Gandhal	Tree	Antidiabetic	Leaves	Alkaloids, flavonoids, steroids, phenolic compound
			Analgesic	Leaves	_
			Anti-inflammatory	Leaves	_
Paederia foetida	Bhedailota,	climber	Antioxidant	Leaves	Phenols

	paduri lota		Antimicrobial	Leaves	_
			Antidiabetic	Leaves	_
			Antidiarrheal	Leaves	_
			Analgesic	Whole plant	_
			Anti-inflammatory	Leaves	_
Pavetta indica.	Kothachampa, samsuku	Shrub	Antimicrobial	Leaves	_
			Antidiabetic	Leaves	_
			Analgesic	Leaves	_
			Anti-inflammatory	Leaves	_
Randia dumetorum	Madanphal, behmona	Shrub	Antimicrobial	Fruits	_
			Antidiabetic	Leaves	
			Hepatoprotective	Leaves, bark	Phenol, flavonoids
			Anti-inflammatory	Dried fruit	_
			Anti-allergic	Dried fruits	_
			Immunomodulatory	Roots	Saponins
Rubia cordifolia	Majathi, Manjistha	Climber	Antioxidant	Roots	Rubiadine
			Antimicrobial	Roots	Nordamnacanthal, Rubiadine, Hydroxy-1 methyl-2 anthraquinone, Xanthopurpurin
			Antidiabetic	Roots	_
			Hepatoprotective	Roots	_
			Anticancer	Roots	_
			Analgesic	Roots	_
			Anti-inflammatory	Roots	_
			Anti-allergic	Roots	Furomollugin, mollugin, dehydro-α-lapachone
			Anti-depression	Roots	_

			Radioprotective	Roots	–

3. BIOLOGICAL ACTIVITIES

Different plants from Rubiaceae family describes various biological properties of *Adina cordifolia, Anthocephalous cadamba, Gardenia jasminoides, Gardenia ternifolia, Ixora coccinea, Ixora pavetta, Paederia foetida, Pavetta indica, Randia dumetorum, Rubia cordifolia*, and their common name, habit, parts used, and bioactive compounds (Table 3).

3.1. Antioxidant activity

The methanol extract of the leaves of *A. cordifolia* showed antioxidant properties due to the presence of total polyphenolic compounds against 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical and nitric oxide (NO) scavenging activity [47]. Different plant parts of *Anthocephalous cadamba* including bark, flowers, fruits, and leaves, were extracted with petroleum ether, acetone, chloroform, ethanol, and water. The extract showed an increase in superoxide dismutase and catalase activity as well as an inhibited lipid peroxidation level in mice, indicating that the plant has antioxidant activity. It has been reported that the antioxidant property of the *Anthocephalous cadamba* is due to the flavonoids present in the plant [48]. The methanol extracts of the flowers and leaves of *Ixora coccinea* also contain antioxidant properties, which were determined using xanthine oxidase (XO) inhibition assay and DPPH radical scavenging assays. The total phenolic content of the plant is responsible for its antioxidant activity [49]. Fresh leaves and dried leaf extracts of *P. feotida* were studied for their antioxidant activity by 2, 2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) radical cation assay and β-carotene bleaching. Among the two samples, the phenolic content of fresh leaves showed higher antioxidant activity than the dried leaves [50]. The ethanol extract of roots of *Rubia cordifolia* contains a high amount of rubiadine as well as GSH, vitamin C, and metals that possess antioxidant activity and can reduce lead toxicity [51].

3.2. Antimicrobial activity

The bark extract of *A. cordifolia* has shown antimicrobial activity against *Bacillus cereus, Bacillus megaterium, Bacillus subtilis, Staphylococcus aureus, Sarcina lutea, Escherichia coli, Pseudomonas aeruginosa, Salmonella paratyphi, Salmonella typhi, Shigella boydii, Shigella dysenteriae, Vibrio mimicus and Vibrio parahaemolyticus* [52]. The flavonoid, tannins, and phenolic compounds isolated from *A. cordifolia* leaves have potent antimicrobial activity against *Staphylococcus aureus, Bacillus subtilis, Escherichia coli, and Klebsiella pneumonia* [53]. The fruits, leaf, and bark extract of *Anthocephalus cadamba* (Roxb.) show potent antimicrobial activity against *Bacillus subtilis, Escherichia coli, Staphylococcus aureus, and Enterobacter aerogenes* [54]. The fruit extract showed the highest antimicrobial activity compared to leaf and bark extract against all the pathogens. Antibacterial assay of ripe and unripe fruits of *Anthocephalus cadamb* were investigated and the test organisms taken were *Staphylococcus aureus, Bacillus cereus, Escherichia coli, Salmonella abony, and Shigella boydii* [55]. The fruits were extracted with methanol, ethyl acetate, ethanol, and methanol. The antibacterial property was evaluated by the agar well diffusion method and MIC and MBC were obtained. The ripened fruits showed more antibacterial activity than the unripe fruits. The highest antibacterial activity was shown by ethyl acetate extract against the pathogen. The MIC value was between 0.312 and 25.0 mg/ml. The leaves extract of *Gardenia ternifolia*

was studied for antibacterial activity against *Lactobacillus fermentum, Salmonella typhimurium, Staphylococcus aureus, and Enterococcus faecalis* by disc diffusion method. The anthocyanins and organic acid present in the leaves extract showed large inhibition zones around *Lactobacillus fermentum* and *Salmonella typhimurium* as compared to *Staphylococcus aureus* and *Enterococcus faecalis* [23]. The leave extract of *Paederia feotid* were tested against five bacteria *Bacillus subtilis, Staphylococcus aureus, Proteus vulgaris, Escherichia coli, and Pseudomonas aeruginosa* [31]. Among the five bacteria, only *Bacillus subtilis* and *Staphylococcus aureus* showed an inhibition zone [31]. The ether extract of *Ixora coccinea* leaves showed strong antimicrobial activity against *Escherichia coli, Pseudomonas aeruginosa, Salmonella typhimurium, Sarcina lutea, Staphylococcus aureus, and Bacillus subtilis* [56]. Methanol, chloroform, benzene, and aqueous extract of *Pavetta indica* leaves showed a bactericidal effect against *Bacillus subtilis* and growth inhibition effects against *Escherichia coli* and *Saccharomyces cerevisiae* [57]. Among six different bacteria tested for antimicrobial activity, the fruits extract of *Randia dumetorum* showed potent antibacterial activity against *Escherichia coli* and a minimum inhibitory effect against *Staphylococcus aureus* [58]. Antimicrobial agents isolated from *Rubia cordifolia* are Nordamnacanthal, Rubiadine, Hydroxy-1 methyl-2 anthraquinone, Xanthopurpurin extracted from the roots of the plants [59].

3.3. Antidiabetic activity

Aqueous ethanol extract of *Adina cordifolia* leaves showed antidiabetic activity in the Wistar rats which were injected with alloxan monohydrate at 500mg/kg body weight [60]. Geniposide present in the Gardenia jasminoides has been considered as an antidiabetic agent since it reduces blood sugar, blood pressure, chelerythrine, triglyceride, and lipid peroxidase when injected orally in rats [20]. The methanol and aqueous extract of roots of *Anthocephalus cadamba* contain alkaloids, saponins, flavonoids, and tannins that reduced the blood glucose concentration of swiss albino mice at a dose of 400mg/kg [61]. Butanol extract of leaves of *Ixora pavetta* has shown the presence of alkaloids, flavonoids, steroids, and phenolic compounds which possess antidiabetic activity induced by Streptozotocin in adult female albino rats at 500mg/kg dose [62]. *Paederia feotida* leaves extract showed a body weight gain of mice treated with Streptozotocin which causes muscle loss due to diabetes. It indicates that leave extract of *Paederia foetida* has antidiabetic [63]. The diabetic male Wistar rats having high blood glucose levels can be reduced by using methanol extract of *Pavetta indica* plant leaves at a dose of 400mg/kg body weight [35]. The ethanol extract of Randia dumetorum mature leaves have shown to prevent Streptozotocin-induced diabetes in rats [64]. Bioactive compounds present in the *Rubia cordifolia* roots extract showed potential antidiabetic activity against diabetic mice injected with Streptozotocin [65].

3.4. Hepatoprotective activity

Adino cordifolia leaves were extracted with acetone and water that reveal the presence of different major phytochemicals among which phenolic compounds, tannins, and flavonoids can reduce the level of serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) that causes the damage of hepatic tissues [66]. Chlorogenic acid isolated from leaves extracts of Anthecephalus cadamba which have hepatoprotective activity and reduced liver damage [67]. Leaf and bark of *Randia dumetorum* were extracted with methanol which shows the presence of phenol and flavonoid that can reduce hepatotoxic effects brought by [38]. The aqueous methanol extract of *Rubia cordifolia* roots enhanced hepatic condition in mice damaged by acetaminophen and [68] Triterpenoids ursolic acid extracted from roots

of *Ixora coccinea* have potent hepatoprotective activity and cure liver diseases [69].

3.5. Anticancer activity

The crude ethanol extract of *Rubia cordifolia* roots shows significant activity against the human larynx carcinoma cell line (HEp-2) and human cervical cancer cell line (HeLa) but did not show any activity against the human epithelial kidney cell line (HEK 293) [70]. Camptothecin, an alkaloid extracted from the *Ixora coccinea* plant possesses potent anticancer activity [71].

3.6. Antidiarrheal activity

The ethanol extract of *Paederia feotida* has shown antidiarrheal activity against castor oil and magnesium sulfate-induced diarrhea in mice [72]. The leaves of *Ixora coccinea* extracted with water showed a reduction of castor oil-induced diarrhea by reducing intestinal motility and intestinal fluid accumulation in albino Wistar rats [73]. The aqueous ethanol extract of *Anthocephalus cadamba* flowering top isolates indole alkaloids, iridoids, triterpenes, and saponins have potent antidiarrheal activity against castor oil-induced diarrhea and reduce the accumulation of intestinal fluids [74].

3.7. Analgesic activity

Ethyl acetate extract and petroleum ether extract of fresh stem bark of *Adina cordifolia* showed a significant analgesic effect in mice induced by the tail-flick method [75]. The aqueous extract of *Ixora coccinea* possesses an analgesic effect due to the alkaloid and flavonoids content in the [76]. Ethanol extract of *Ixora pavetta* leaves can reduce pain in mice induced by hot plate and acetic acid [77]. The whole plant of *Paederia feotida* was extracted with hexane and methanol that showed analgesic activity induced by acetic acid [34]. The ethanol extract of flowers of *Anthocephalus cadamba* was reported to have an analgesic effect induced by acetic acid-induced writhing test, hot plate test, and hot tail-flick test. Triterpenoids present in the plant help to reduce pain [78]. The analgesic effect of the ethanolic extract of leaves of *Pavetta indica* was also reported induced by hot plate and tail clip method [37]. Roots of *Rubia cordifolia* extracted with methanol showed a significant analgesic effect but the active bioactive compound involved was not isolated [79].

3.8. Anti-inflammatory activity

The petroleum ether extract of *Adina cordifolia* leaves has potent anti-inflammatory activity induced by the hind paw volume method [75]. Geniposide and genipin isolated from *Gardenia jasminoides* have anti-inflammatory activity by reducing lipid peroxidation and nitric oxide production [20]. Inflammation can be cured by methanol extract of leaves of *Paederia feotida* [80]. The anti-inflammatory activity of *Anthocephalus cadamba* was investigated by carrageenan-induced rat paw edema, dextran induced paw edema, histamine, and serotonin-induced inflammation, and cotton-pellets induced granuloma. The triterpenoids isolated from the methanol extract of the stem bark of the plant showed anti-inflammatory activity against all the four methods [81]. Significant anti-inflammatory activity was also shown by dry fruits extract of *Randia dumetorum* [82]. The methanol extract of roots of *Rubia cordifolia* has shown anti-inflammatory activity produced by carrageenan and tail-flick test [79]. Carrageenan and arachidonic acid-induced inflammation can be reduced by ethanol extract of *Ixora pavetta* leaves [77]. Lupeol extracted from leaves of *Ixora coccinea* can reduce inflammation in albino rats [83]. Inflammation in rats induced by carrageenan, histamine, and dextran can be reduced by methanol extract of *Pavetta indica* leaves which can be compared

with non-steroidal anti-inflammatory drug indomethacin [84].

3.9. Antiallergic activity

The chloroform extract of dried fruits of *Randia dumetorum* showed an anti-allergic effect against milk induced leukocytosis and eosinophilia in mice model [82]. Furomollugin, mollugin, and dehydro-α-lapachone isolated from *Rubia cordifolia* roots showed an anti-allergic effect [45].

3.10. Anti-anxiety and Anti-depression activity

Geniposide and crocin extracted from *Gardenia jasminoides* possess significant anti-depression activity [20]. Alcoholic extract of dried *Rubia cordifolia* roots increases brain γ-amino-n-butyric acid (GABA) levels that act as an anti-depression agent [85]. *Ixora coccinea* flowers extract shows an anti-anxiety effect which was investigated by in-vivo neuro-pharmacological test [86].

3.11. Anti-sickling activity

Anthocyanin and organic acid extracted from *Gardenia ternifolia* leaves showed anti-sickling activity. Anthocyanin interacted with hemoglobin S and thus prevents the sickling of erythrocytes [23].

3.12. Radioprotective activity

Root alcoholic extract of *Rubia cordifolia* has radiation protection effect and radiation-induced lipid peroxidation, hemopoietic injury, and genotoxicity [87].

3.13. Immunomodulatory effect

Saponins isolated from chloroform fraction of fruits of *Randia dumetorum* have an immunomodulatory activity that increases the humoral antibody [88].

4. CONCLUSION

This review is an aim to study the phytochemical, ethnomedicinal, and pharmacological properties of commonly existing plants of the Rubiaceae family in Assam. The medicinal properties of certain bioactive chemicals have been studied which can be used to treat various severe diseases. All the plants discussed here have some common phytochemicals, including alkaloids, flavonoid, tannins, terpenoids, phenolic compounds, saponins, steroids, carbohydrates, etc. and some unique compounds that are only found in some specific plant for example geniposide, genipin and geniposidic acid have isolated from *Gardenia jasminoides* only [20]. All these plants have been commonly used as ethnomedicine to cure diseases like cough, fever, stomach disorders, eye diseases, skin diseases, and so on by the people of Assam. It is observed that all the plants have some common pharmacological activities like anti-inflammatory, antimicrobial, antioxidant, antidiarrheal, and hepatoprotective activity. But anti-sickling and radioprotective activities have been found only in *Gardenia ternifolia* and *Rubia cordifolia* plant, respectively. The particular bioactive compound responsible for defense against certain specific diseases has been recognized for a few plants only. Therefore, advanced studies should be carried out to identify the phytochemicals that take part in different biological activities.

The increasing demand and importance of medicinal plants encourage to develop more plant-based medicine because of their fewer side effects. From the present study, it can be concluded that the ten plants of the Rubiaceae family are of high medicinal importance. The phytochemicals isolated from these plants have potential health benefits. These chemical compounds can be used to manufacture drugs for different diseases. The realization of the potentials of

these phytochemicals to mankind needs further specific scientific studies in near future.

5. ACKNOWLEDGEMENT

We would like to acknowledge Prof. D.K. Jha, Microbial Ecology Laboratory, Department of Botany, Gauhati University, for his constant support and DIST-FIST, Govt. of India, support to the Department of Botany, Gauhati University.

6. CONFLICT OF INTEREST

The author have declared that there is no conflict of interest.

7. REFERENCES

1. Ullah, S., Khan, M. R., Shah, N. A., Shah, S. A., Majid, M., & Farooq, M. A. (2014). Ethnomedicinal plant use value in the Lakki Marwat District of Pakistan. Journal of ethnopharmacology, **158**, 412-422.
2. Dogra KS, Chauhan S, Jalal JS (2015), Assessment of Indian Medicinal Plants for the Treatment of Asthma, Journal of Medicinal Plants Research; **9**(*32*): 851-862.
3. Njeru SN, Matasyoh J, Mwaniki CG, Mwendia CM, Kobia GK (2013), A Review of Some Phytochemicals Commonly Found in Medicinal Plants, International Journal of Medicinal Plants; **105**: 135-140.
4. Chikezie PC, Ibegbulem CO, Mbagwu FN (2015), Bioactive Principles from Medicinal Plants, Research Journal of Phytochemistry; **9** (*3*): 88-115.
5. Banerjee RK, Biswas K, Chattotadhyay I, Bandyopadhyay U (2002), Biological Activities and Medicinal Properties of Neem (Azadirachta indica), Current Science; **82**(*11*): 1336-1345.
6. Barbhuiya HA, Dutta BK, Das AK, Baishya AK (2014), The family Rubiaceae in Southern Assam with Special Reference to Endemic and Rediscovered Plant Taxa, Journal of Threatened Taxa; **6**(*4*): 5649–5659.
7. Choudhury KD, Choudhury MD, Paul S, Baruah MK (2012) Bioactivities of Some Ethno-medicinal Rubiaceous Plants Available from Assam – A Review, East Himalayan Society for Spermatophyte Taxonomy; **6**(*1*): 56 - 65.
8. Ingl KP, Deshmukh AG, Padole DA, Dudhare MS, Mohail MP, Khelurkar VC (2017), Phytochemicals: Extraction methods, Identification and Detection of Bioactive Compounds from Plant Extracts, Journal of Pharmacology and Phytochemistry; **6**(*1*): 32-36.
9. Saxena S, Prakash V, Gupta S, Saxena AK, Yadav R, Singh SK (2015), Preliminary Phytochemical screening and Biological Activities of Adina cardifolia, Microbial & Biochemical Technology; **7**(*1*): 033-038.
10. Sharma A, Sangameswaran B, Jain V, Saluja MS (2012), Hepatoprotective Activity of Adina cordifolia Against Ethanol Induce Hepatotoxicity in Rats, International Current Pharmaceutical Journal; **1**(*9*): 279-284.
11. Singh AP, Kumar S (2019), Applications of Tannins in Industry, IntechOpen; 1-19.
12. Dash PP, Sarkar S, Mishra A (2019), Haldina cordifolia: A Potential Plant in Drug Discovery Research, Journal of Pharmacognosy and Phytochemistr; **8**(*6*): 311-314.
13. Kare M, Dhotre R, Maheboob S (2018), Phytochemical Screening of Anthocephalus cadamba (Roxb.) Miq.: Bark, International Journal of Research in Pharmacy and Pharmaceutical Science; **3**(*1*): 228-230.
14. Jeyalalitha T, Murugan K, Umayavalli M (2015), Preliminary Phytochemical Screening of Leaf Extracts of Anthocephalus Cadamba,

International Journal of Recent Scientific Research; **6**(*10*): 6608-6611.

15. Verma R, Chaudhary F, Kumar J (2019), Pharmacognostical Evaluation and Phytochemical Screening of Neolamarckia Cadamba, Journal of Complementary Medicine & Alternative Healthcare; **9**(*2*): 1-4.
16. Dubey A, Nayak S, Goupale DC (2011), Anthocephalus Cadamba: A Review, Pharmacognosy Journal; **2**(*18*): 71-76.
17. Banerji N (1977), New Saponin from Stem Bark of Anthocephalus cadamba Miq, Ind j chem. B; **15**: 654-655.
18. Mishra RP (2011), Antibacterial Properties of Anthocephalus Cadamba Fruits, Webmed Central Ayurvedic Medicine; **2**(*8*): 2073.
19. Palshikar G, Padalkar S, Firake GB, Parekh P (2013), Pharmacognostic Evaluation and Phytochemical Screening of Anthocephalus cadamba, Asian journal of Research in Biological and Pharmaceutical Sciences; **1**(*2*): 86 - 96.
20. Liu H, Chen YF, Li F, Zhang HY (2012), Fructus Gardenia (Gardenia jasminoides J. Ellis) Phytochemistry, Pharmacology of Cardiovascular, and Safety with the Perspective of New Drugs Development, Journal of Asian Natural Products Research; **15**(*1*): 94–110.
21. Song F, Wang L, Liu S, Xing J, Liu Z (2016), Characterization of Interaction Property of Multi-Components in Gardenia jasminoides with Aldose Reductase by Microdialysis Combined with Liquid Chromatography Coupled to Mass Spectrometry, Rapid Commun. Mass Spectrum; **30**(*1*): 87-94.
22. Xu YQ, Wei GY, Zhou Y, Ge F, Luo GM (2014), Isolation and Characterization of Twenty-Two Polymorphic Microsatellite Markers from Gardenia jasminoides (Rubiaceae), Journal of Genetics; **93**: 22-24.
23. Mpiana PT, Ngbolua KN, Tshibangu DST., Mihigo SO., Mavakala BK., Ashande MC, Muanyishay LC (2015), Anti-sickling and Antibacterial Activities of Some Extracts from Gardenia ternifolia subsp. Jovis-tonantis (Welw.) Verdc. (Rubiaceae) and Uapaca heudelotii Baill. (Phyllanthaceae), Journal of Advances in Medical and Pharmaceutical Sciences; **2**(*1*): 10-19.
24. Omosa L, Awas E, Midiwo JO, Ndakala A, Mwaniki J (2016), Antioxidant Activities of Flavonoid Aglycones from Kenyan Gardenia ternifolia Schum and Thonn, IOSR Journal of Pharmacy and Biological Sciences; **11**(*3*): 136-141.
25. Murugaiyah V, Marimuthu MM, Aruldass CA, Sandrasagaran UM, Mohamad S, Ramanathan S, Mansaor SM (2011), Antimicrobial Activity and Phytochemical Screening of Various Parts of Ixora coccinea, Journal of Medicinal Plant Research; **8**(*10*): 423-429.
26. Dontha S, Kmurthy H, Mantripragada B (2015), Phytochemical and Pharmacological Profile of Ixora: A Review, International Journal of Pharmaceutical Science and Research;. **6**(*2*): 567-584.
27. Ragasa CY, Tiu F, Rideout JA (2003), New Cycloartenol Esters from Ixora coccinea, Natural Product Research; **18**(*4*): 319–323.
28. Ratnasooriya WD, Deraniyagala SA, Bathige SDNK, Goonesekara CL, Jayakody JRAC (2004), Ant nociceptive Activity of Aqueous Extract of the Leaves of Ixora coccinea, Acta Biologica Hungarica; **56**(*1-2*): 21-34.
29. Baboo RBC, Srinivas K (2011), GC-MS Study of Ixora pavetta Vahl, International Journal of Pharmaceutical Science and Research; **2**(*8*): 2100-2102.
30. Mondal S, Raja S, Prasad PNVSS, Suresh P (2015), Investigation of Phytochemical, Analgesic, Anti-inflammatory and Antipyretic

Effects of Ixora pavetta Andrews Leaf, Journal of NPA; **27**(*1*): 20-27.

31. Upadhyaya S (2013), Screening of Phytochemicals, Nutritional Status, Antioxidant and Antimicrobial Activity of Paederia foetida Linn. from
32. Different Localities of Assam, India, Journal of Pharmacy Research, **7**: 139-141.
33. Roy S, Ojha S, Raj A, Roy A (2018), Extraction of Total Phenolics, Flavonoids and Tannins from Paederia foetida L. Leaves and their Relation with Antioxidant Activity, Pharmacogn J; **10**(*3*): 541-547.
34. Patel DK (2017), Paederia foetida Linn.: A Potential Climbing Medicinal Herb in Central India, International Journal of Environmental Sciences & Natural Resource; **6**(*5*): 118-124.
35. Hossain MM, Ali MS, Saha A, Alimuzzaman M (2006), Antinociceptive Activity of Whole Plant Extracts of Paederia foetida, Dhaka Univ. J. Pharm. Sc; **5**(*1-2*): 67-69.
36. Natarajan P, Thangathirupathi A, Ramarajan S, Jaya S, Bellamkonda H, Gollapalli L (2013), Preliminary Study of antidiabetic Activity of Methanolic Extract of Pavetta indica Linn in Diabetic Rats, Asian Journal of Pharmaceutical and Clinical Research; **6**(*1*): 131-133.
37. Raamamurthy J, Venkataraman S, Meera R, Prasad S, Devi P (2009), Phytochemical Investigation of Pavetta indica, Int. J. Chem. Sci.; **8**(*3*): 1517-1522.
38. Golwala DK, Patel LD, Bothara SB, Patel PM, Vaidya SK, Raval MK (2009),. Analgesic Activity of Ethanolic Leaf Extract of Pavetta Indica, International Journal of Pharmaceutical Sciences and Drug Researc; **1**(*2*): 119-120.
39. Kandimalla R, Kalita S, Saikia B, Choudhury B, Singh YP, Kalita K, Dash S, Kotoky J (2016), Antioxidant and Hepatoprotective Potentiality of Randia dumetorum Lam. Leaf and Bark via Inhibition of Oxidative Stress and Inflammatory Cytokines, Frontiers in Pharmacology; **7**: 1-8.
40. Govindappa M, Mahabaleshwara K, Chandrasekhar N (2016), Phytochemical Investigations of Methanol Leaf Extracts of Randia spinosa using Column Chromatography, HPTLC and GC-MS, Natural Products Chemistry & Research; **4**(*1*): 1-15.
41. Patel A, Patel T, Macwan C, Patel M, Chauhan K, Patel J (2010), Evaluation of Anti-inflammatory and Analgesic activity of Roots of Rubia cordifolia in rats, J. Pharm. Sci. & Res; **2** (*12*): 809-813.
42. Bafna A, Karodi R, Jadhav M, Rub R (2009), Evaluation of the Wound Healing Activity of a Crude Extract of Rubia cordifolia L. (Indian madder) in Mice, International Journal of Applied Research in Natural Product; **2**(*2*): 12-18.
43. Siril EA, Devi PM (2013), Pharmacognostic Studies on Indian Madder (Rubia cordifolia L.), Journal of Pharmacognosy and Phytochemistry; **1**(*5*): 112-119.
44. Gupta R, Gupta B (2017), Phytochemical Analysis of Manjishtha (Rubia cordifolia Linn.) and Its Therapeutic Relevance, The Pharma Innovation Journal; **6**(*7*): 164-169.
45. Lodia S, Kansala L (20120, Antioxidant Activity of Rubia Cordifolia Against Lead Toxicity, International Journal of Pharmaceutical Science and Research; **3**(*7*): 2224-2232.
46. Bobbarala V, Naidu KC, Lalam R (2009), Antimicrobial Agents from Rubia cordifolia and Glycyrrhiza glabra Against Phytopathogens of Gossypium, International Journal of PharmTech Research; **1**(*4*): 1512-1518.
47. Verma N, Gutpa PP, Srimal RC, Tandon JS (1999), Biological Activity of Rubia cordifolia and Isolation of an Active Principle, Pharmaceutical Biology; **37**(*1*): 46–49.

48. Baral P, Dubey A, Tewari S, Vasmatkar P, Verma AK (2016), Total Polyphenolic Contents and Antioxidant Activity of Leaf, Bark and Root of Adina cordifolia Benth. & Hook, Journal of Pharmaceutical, Chemical and Biological sciences; **4**(*3*): 394-401.
49. Umachigi SP, Kumar GS, Jayaveera KN, Kishore Kumar OV, Ashok Kumar CK, Dhanpal R (2007), Antimicrobial, Wound Healing and Antioxidant Activities of Anthocephalous cadamba, Complementary and Alternative Medicines; **4**(*4*): 481-487.
50. Torey A, Sasidharan S, Latha LY, Sudhakaran S, Ramanathan S (2010), Antioxidant Activity and Total Phenolic Content of Methanol Extracts of Ixora coccinea, Pharmaceutical Biology; **48**(*10*): 1119-1123.
51. Osman H, Rahim AA, Isa NM, Bakhir NM (2009), Antioxidant Activity and Phenolic Content of Paederia foetida and Syzygium aqueum, Molecules; **14**: 970-978.
52. Lodia S, Kansala L (2012), Antioxidant Activity of Rubia Cordifolia Against Lead Toxicity, International Journal of Pharmaceutical Science and Research, **3**(*7*): 2224-2232.
53. Tahia F, Sikder AA, Sayeed A, Rashid A (2014), Bioactivities of Murraya koenigii (Linn.) and Adina cordifolia (Roxb.), Bangladesh Pharmaceutical Journal; **18**(*1*): 25-29.
54. Saxena S, Prakash V, Gupta S, Saxena AK, Yadav R, Singh SK (2015), Preliminary Phytochemical screening and Biological Activities of Adina cardifolia, Microbial & Biochemical Technology; **7**(*1*): 033-038.
55. Ghosh A, Das A (2017), In-vitro Antimicrobial Screening of Plant Extracts of Anthocephalus cadamba (Roxb.), Journal of Advanced Plant Science; **9**(*2*): 40-43.
56. Datar H, Datar A (2016), Antimicrobial Activity of Anthocephalus cadamba and Scirpus kysoor Roxb. Against Food Pathogens, International Journal of Current Pharmaceutical Research; **8**(*4*): 13-18.
57. Annapurna J, Amarnath PVS, Kumar DA, Ramakrishna SV, Raghavan KV (2003), Antimicrobial Activity of Ixora coccinea Leaves, Fitoterapia; **74**: 291–293.
58. Roy A, Gupta VK. Kaur C, Simlai A (2013), Antimicrobial Activity of Pavetta indica Leaves, Journal of Applied Pharmaceutical Science; **3**(*4*): 078-082.
59. Dharmishtha M, Falguni G (2009), Antibacterial Activity of Methanolic Fruit Extract of Randia dumetorum Lamk, International Journal of PharmTech Research; **1**(*3*): 679-681.
60. Bobbarala V, Naidu KC, Lalam R (2009), Antimicrobial Agents from Rubia cordifolia and Glycyrrhiza glabra Against Phytopathogens of Gossypium, International Journal of PharmTech Research; **1**(*4*): 1512-1518.
61. Goel B, Chaudhary P, Ghosh AK (2012), Antidiabetic Activity of Adina cordifolia (Roxb) Leaves in Alloxan Induced Diabetic Rats, Asian Pacific Journal of Tropical Biomedicin; 630-632.
62. Acharyya S, Dash DK, Mondal S, Dash SK (2010), Studies on Glucose Lowering Efficacy of The Anthocephalus cadamba Root, Int. j. pharma and bio sciences; **1**(*2*): 1-9.
63. Kanhere RS, Reddy KR, Jayveera KN (2015), Evaluation of Anti-Diabetic Potential of Ixora Pavetta in Streptozotocin Induced Diabetic Rats, International Journal of Pharmacy and Pharmaceutical Science; **7**(*4*): 230-236.
64. Kumar V, Anwar F, Ahmed D, Verma A, Ahmed A, Damanhouri ZA, Mishra V, Mujeeb M (2014), Paederia foetida Linn. Leaf Extract: An Antihyperlipidemic, Antihyperglycaemic and Antioxidant Activity, BMC Complementary and Alternative Medicine; **14**(*76*): 1-16.

65. Stella Bai GV, Gandhimathi S (2014), Antidiabetic Activity of Randia dumetorum Against Streptozotocin (STZ) Induced Diabetics in Rats, International Journal of Pharmacological Research; **4**(*3*): 126-129.
66. Baskar R, Bhakshu LMD, Bharathi GV, Reddy SS, Karuna R, Reddy GK, Saralakumari D (2006), Antihyperglycemic Activity of Aqueous Root Extract of Rubia cordifolia. in Streptozotocin-Induced Diabetic Rats, Pharmaceutical Biology; **44**(*6*): 475-479.
67. Sharma A, Sangameswaran B, Jain V, Saluja MS (2012), Hepatoprotective Activity of Adina cordifolia Against Ethanol Induce Hepatotoxicity in Rats, International Current Pharmaceutical Journal; **1**(*9*): 279-284.
68. Kapil A, Koul IB, Suri OP (1995), Anti-hepatotoxic Effect of Chlorogenic Acid from Anthocephalus cadamba, Phytotherapy Research; **9**: 189-193.
69. Gilani AH, Janbaz KH (1995), Effect of Rubia cordifolia Extract on Acetaminophen and - induced Hepatotoxicity, PHYTOTHERAPY RESEARCH; **9**: 372-375.
70. Shyamal S, Latha et al. (2010), Hepatoprotective Effect of Three Herbal Extracts on Aflatoxin B1-intoxicated Rat Liver, Singapore Med J; **51**(*4*): 326-331.
71. Patel PR, Nagar AA, Patel RC, Rathod DK, Patel VR (2011) In-vitro Anticancer Activity of Rubia cordifolia Against HELA AND HEP-2 Cell Lines, International Journal of Pharmacy and Pharmaceutical Sciences; **3**(*2*): 70-71.
72. Saravanan P, Boopalan E (2011), Occurrence of Camptothecin an Anticancer Drug from Ixora coccinea Linn., Intl. J. Appl. Biol; **2** (*2*): 30-34.
73. Afroz S, Alamgir M, Khan MTH, Jabbar S, Nahar N, Choudhuri MSK (2006), Antidiarrhoeal Activity of the Ethanol Extract of Paederia foetida Linn. (Rubiaceae), Journal of Ethnopharmacology; **105**: 125–130.
74. Yasmeen M, Prabhu B, Agashikar NV (2010), Evaluation of Antidiarrheal Activity of Leaves of Ixora coccinea Linn. in Rats, Journal of Clinical and Diagnostic Research; **4**: 3298-3303.
75. Sarker SD, Alam MA, Akter R, Shuban N, Rahman MM, Majumder MM, Nahar L, (2008), Antidiarrheal property of hydroethanolic extract of the flowering top of Anthocephalus cadamba, Brazilian Journal of Pharmacognosy; **18**(*2*): 155-159.
76. Singhai A, Jain AP, Pawar RS (2014), Anti-inflammatory and Anti-Nociceptive Activity of Adina cordifolia Bark, Nig. J. Nat. Prod. And Med; **10**: 90-93
77. Ratnasooriya WD, Deraniyagala SA, Galhena G, Liyanage SSP, Bathige SDK, Jayakody JRAC (2005), Anti-inflammatory Activity of the Aqueous Leaf Extract of Ixora coccinea, Pharmaceutical Biolog; **43**(*2*): 147-152.
78. Mondal S, Raja S, Prasad PNVSS, Suresh P (2014), Investigations of Phytochemicals, Analgesic, Anti-inflammatory and Antipyretic Effects of Ixora pavetta Andrews Leaf, Journal of NP.; **27**(*1*): 20-27.
79. Alam MA, Shuban N, Hasan R, Hossain MM, Akter R, Majumder MM, Rahman MM, Ahmed K, Ghani A (2009), Antinociceptive and Gastroprotective Effect of the Ethanolic Extract of the Flowering Top of Anthocephalus cadamba Roxb, Oriental Pharmacy and Experimental Medicin; **9**(*4*): 326-334.
80. Patel A, Patel T, Macwan C, Patel M, Chauhan K, Patel J (2010), Evaluation of Anti-inflammatory and Analgesic activity of Roots of Rubia cordifolia in rats, J. Pharm. Sci. & Res; **2** (*12*): 809-813.
81. De S, Ravishankar B, Bhavsar GC (1994) Investigation of the Anti-inflammatory Effects

of Paederia foetid, Journal of Ethnopharmacology; **43**: 31-38.

82. Kodangala SC, Borthakur A, Kodangala SP (2010), Anti-inflammatory Effect of the Methanol Extract from Anthocephalus cadamba Stem Bark in Animal Model, International Journal of Plant Biolog; **1**(*6*): 30-32.
83. Kumar D, Mudgade SC, Bhat ZA, Bhujbal SS, Rub R (2011), Anti-allergic and Anti-inflammatory Effects of the Fruits of Randia dumetorum Lamk, Orient Pharm Exp Med; **11**: 161–167.
84. Panicker V, Zachariah R, Nair S (1993), Anti-inflammatory and Anti-Mitotic Activities of Lupeol is Isolated from the Leaves of Ixora coccinea Linn., Indian Journal of Pharmaceutical Sciences; 129-132.
85. Mandal SC, Lakshmi SM, Ashok Kumar CK, Sur TK, Boominathan R (2003), Evaluation of Anti-inflammatory Potential of Pavetta indica Linn. Leaf Extract (Family: Rubiaceae) in Rats, PHYTOTHERAPY RESEARCH; **17**: 817–820.
86. Patil RA, Jagdale SC, Kasture SB (2006), Antihyperglycemic, Antistress and Nootropic Activity of Roots of Rubia cordifolia Linn., Indian Journal of Experimental Biology; **44**: 987-992.
87. Nasir Uddin MM, Basak A, Amin MR, Shahriar M (2014), Pharmacological Investigations on Flowers of Ixora Coccinea, International Journal of Pharmacognosy and Phytochemistry; **29**(*1*): 1209-1213.
88. Tripathi YB, Singh AV (2007), Role of Rubia cordifolia Linn in Radiation Protection, Indian Journal of Experimental Biolog;. **45**: 620- 625.
89. Patil MJ, Satpute KL, Jadhav MM, Karodi RS, Katare YS, Rub R, Bafna AR (2009), Immunomodulatory Activity of Fruits of Randia dumetorum Lamk., Journal of Pharmacognosy and Phytotherapy; 1.
90. Kumar S, Pandey AK (2013), Chemistry and Biological Activity of Flavonoids: An Overview, The Scientific World Journal; 1-16.
91. Bribi N (2018), Pharmacological Activity of Alkaloids: A Review, Asian Journal of Botany; **1**: 1-6.
92. Mishra N, Rajput PS, Mishra RC (2017), Phytomedicinal Uses of Saponin Containing Herbs, International Journal of Chemistry Studies: **1**(*2*): 12-16.
93. Bhuyan DJ, Basu A, Utilization of Bioactive Compounds from Agricultural and Food Production Waste: 2017, Chapter 2: Phenolic compounds: Potential Health Benefits and Toxicity, Publisher: CRC Press, Taylor & Francis Group. Editors: Quan V. Vuong : 27-59.
94. Jaiswal H, Sing OJ, Chauhan A, Sahu MK, Prakash DVS (2018), A Review on Tannins, European Journal of Biotechnology and Bioscience; **6**(*3*): 16-17.
95. Singh AP, Kumar S (2019), Applications of Tannins in Industry, IntechOpen; 1-19.
96. Wang G, Tang W, Bidigare RR (2005), Terpenoids as Therapeutic Drugs and Pharmaceutical Agents; 197-227.
97. Shaikh S, Verma H, Yadav N, Jauhari M, Bullangowda J (2012), Applications of Steroid in Clinical Practice: A Review, International Scholarly Research Network; 1-11.
98. Olmo AD, Calzada J, Nunez M (2015), Benzoic Acid and Its Derivatives as Naturally Occurring Compounds in Foods and as Additives: Uses, Exposure and Controversy, Critical Reviews in Food Sciences and Nutrition.
99. Saeidnia S, Manayi A, Gohari AR, Abdollahi M (2014), The Story of Beta-sitosterol- A Review, European Journal of Medicinal Plants; **4**(*5*): 590-609.

100. Mazimba O (2017), Umbelliferone: Sources, Chemistry and Bioactivities Review, Bulletin Facult Pharmacy Cairo Univ; 1-10.
101. Hussain H, Green IR, Saleem M, Raza ML, Nazir M (2019), Therapeutic Potential of Iridoid Derivatives: Patent Review, Inventions; **4**(*9*):1-16.
102. Wu-Yang H, Yi-Zhong C, Yanbo Z (2009), Natural Phenolic Compounds from Medicinal Herbs and Dietary Plants: Potential Use for Cancer Prevention, Nutrition and Cancer; **62**(*1*): 1-20.
103. Kowalczyk E, Pawel K, Kura M, Szmigiel B, Blaszczyk J (2003), Anthocyanins in Medicine, Polish Journal of Pharmacology; **55**: 699-702.
104. Lee YT, Huang HC, Lee CR, Weng YI, Lee MC (1992), Vasodilator Effect of Scoparone (6,7-dimethoxycoumerin) from a Chinese Herb, European Journal of Pharmacology; **218**: 123-128.
105. Pan X, Rauf A, Imran M, Izneid TA, Haq IU, Patel S, Naz S, Silva AS, Saeed F, Suleria HAR (2019), Proanthocyanidines: A Comprehensive Review, Biomedicine and Pharmacotherapy; **116**: 1-6.
106. Yadav RNS, Agarwala M (2011), Phytochemical Analysis of Some Medicinal Plants, Journal of Phytology; **3**(*12*): 10-14
107. Dietrich F, Pietrobon, Martins J, Kaiser S, Madeira SRB, Rockenbach L, Albano E, et al. (2015), The Quinovic Acid Glycosides Purified Fraction from Uncaria tomentosa Protects against Hemorrhagic Cystitis Induced by Cyclophosphamide in Mice, PLoS ONE; **10**(*7*).
108. Tajik N, Tajik M, Mack I, Enck P (2017), The Potential Effect of Cholorogenic Acid, the Main Phenolic Compound in Coffee, on Health: A Comprehensive Review, European Journal of Nutrition.
109. Xiao W, Li S, Wang S, Ho CT (2017), Chemistry and Bioactivity of Gardenia jasminoides, Journal of Food and Drug Analysis; **25**(*1*): 43-61.
110. Bubueanu C, Iuksel R, Panteli M (2019), Heamostatic Activity of Butanolic Extracts of Lamium album and Lamium purpureum Aerial Parts, Acta Pharm; **69**: 443-449.
111. Raju BL, Lin SJ, Hou WC, Lai ZY, Liu PC, Hsu FL (2004), Antioxidant Iridoid Glucosides from Wendlandia formosana, Nat Prod Res; **18**(*4*): 67-64.
112. Ganeshpurkar A, Saluja AK (2017), The Pharmacological Potential of Rutin, Saudi Pharm J; **25**(*2*).
113. Valentova K, Vrba J, Bancirova M, Ulrichova, J, Kren V (2014), Isoquecitrin: Pharmacology, Toxicology and Metabolism, Food and Chemical Toxicology; **68**: 267-282.
114. Keïta JN, Traor N, Diarra N, Koné D, Mariko B, Pelcouliba D, Poisson JF (2019), Isolation and Identification of Nicotiflorin Leaves of Costus spectabilis (Fenzl) K. Schum, iMedPub Journals; **10**(*1*): 1-5.
115. Kim SS, Park RY, Jeon HJ, Kwon YS, Chun W (2005), Neuroprotective Effects of 3,5-dicaffeoylquinic acid on Hydrogen Peroxide-induced Cell Death in SH-SY5Y cells, Phytother Res; **19**(*3*): 243-245.
116. Madeo J, Zubair A, Marianne F (2013), A Review on the Role of Quinones in Renal Disorders, Springerplus; **2**(*1*): 139.
117. Panicker V, Zachariah R, Nair S (1993), Anti-inflammatory and Anti-Mitotic Activities of Lupeol is Isolated from the Leaves of Ixora coccinea Linn., Indian Journal of Pharmaceutical Sciences; 129-132.
118. Shawkat H, Westwood MM, Moerimer AM (2012), Mannitol: A Review of its Clinical Uses, Continuing Education in Anarsthesia, Critical Care & Pain; **2**(*2*): 82-85.

119. Zhao L, Wang J, Fang X, Ge L, Cao F, Wang Z, Xiao W (2018), Antitumor, Antioxidant and Anti-inflammatory Activities of Kaempferol and its Corresponding Glycosides and the Enzymatic Preparation of Kaempferol, PLoS ONE; **13**(*5*): 1-12.
120. Nossaman VE, Nossaman BD, Kadowitz PJ (2010) Nitrates and Nitrates in the Treatment of Ischemic Cardiac Disease, Cardiol Rev; **18**(*4*): 190-197.
121. Heyerick A, Hoyweghen LV, Karalic I, Calenbergh SV, Deforce D (2010), Antioxidant Flavone Glycosides from the Leaves of Fargesia robusta, J. Nat. Prod; **73**: 1573-1577.
122. Zheng C, Qin L, Wang L, Jiang Y, Han T (2014), A Phytochemical, Pharmacological and Clinical Profile of Paederia feotida and Paederia scandens, Natural Product Communication; **9**(*6*): 879-886.
123. Liu M, He J, Lu X, Wei T, Dong T, Cai Z, Tang L (2018), Asperuloside and Asperulosidic Acid Exert an Anti-inflammatory Effect via Suppression of the NF-KB and MAPK Signaling Pathways in LPS-Induced RAW 264.7 Macrophages, International Journal of Molecular Sciences; **19**: 1-12.
124. Kekuda TRP, Raghavendra HL (2017), Phytochemistry, Traditional Uses and Pharmacological Activities of Azima tetracantha Lam. (Salvadoraceae) – An updated Review, International Journal of Green Pharmacy; **11**(*4*): 217-229.
125. Choudhary SP, Tran LS (2011), Phytosterol: Perspective in Human Nutrition and Clinical Therapy, Current Medicinal Chemistr; **18**(*29*): 57-67.
126. Shyamal S et al. (2010), Hepatoprotective Effect of Three Herbal Extracts on Aflatoxin B1-intoxicated Rat Liver, Singapore Med J; **51**(*4*): 326-331.
127. Shankaranarayan S, Bama P, Ramachandran J, Kalaichelvan PT, Deccarama M, Vijayalkshimi M, Dhamotharan R, Dananjeyan B, Bam SS (2010), Ethnobotanical Study of Medicinal Plants Used by Traditional Users in Villupuram District of Tamil Nadu, India, Journal of Medicinal Plants Research; **4**(*2*): 1089-1101.
128. Akram M, Hamid A, Khalil A, Ghaffar A, Tayyaba N, Saeed A, Ali M, Naveed A, (2014), Review on Medicinal Uses, Pharmacological, Phytochemistry and Immunomodulatory Activity of Plants, International Journal of Immunopathology and Pharmacology; **27**(*3*): 313-319.
129. Korbecki J, Rsinek KB (2019), The Effect of Palmitic Acid on Inflammatory Response in Macrophages: An Overview of Molecular Mechanisms, Inflammation Researc, **68**: 915-932.
130. Mirsane SA, Mirsane SM (2017), Benefits of Ellagic Acid from Grapes and Pomegranates Against Colorectal Cancer, Caspian J. Intern Med; **8**(*3*): 133-134.
131. Whelan J, Fritsche K (2013), Linoleic Acid, Advanced in Nutrition; **4**: 311-312.
132. Shay J, Elbaz HA, Lee I, Zielske SP, Malek MH, Huttemann M (2015), Molecular Mechanisms and Therapeutic Effects of (-)-Epicatechin and Other Polyphenols in Cancer, Inflammation, Diabetes and Neurodegeneration, Oxidative medicine and cellular longevity; 1-13.
133. Othman R, Ibrahim H, Ali MM, Awang K, Gilani AH, Mustafa MR (2002), Vasorelaxant Effects of Ethyl Cinnamate Isolated from Kaempferia galena on Smooth Muscle of the Rat Aorta, Planta Med; **68**: 655-657.
134. Asres K, Paulos B, Birsat D, Gedif T (2011), Antimalarial and Antioxidant Activities of the Leaf Exudate and a Naphthalene Derivative

from Aloe otallensis Baker, Ethiop. Pharma. J;

29: 100-107.