ABSTRACT

Objectives: To review the phytoconstituents and pharmacological activities of some common Indian weed plants. Materials and Methods: The information was collected and compiled from scientific literature present in different databases viz., Science Direct, PubMed, MEDLINE, Elsevier and Google Scholar. Results: Literature search revealed that weeds possess diverse group of phytoconstituents such as phenolics, flavonoids, alkaloids, terpenes, steroids, saponins etc. Weeds have been used for their therapeutic values in Ayurveda and Unani systems of medicine. The phytoconstituents present in them are responsible for the biological activities. Conclusion: Natural products of plant origin have been used for the treatment of various infectious and degenerative diseases. The diversity of phytochemicals present in plants provides drug leads for the development of novel therapeutic agents.

Key words: Phytochemicals, P. hysterophorus, S. xanthocarpum, C. calatropis, anticancer, antioxidant, antibacterial.

INTRODUCTION

Natural products have been used for their therapeutic properties and are the main source of drugs since long time. According to WHO 80% of the earth’s population are estimated to use some form of herbal medicine in their health care [1]. There are about 45,000 plant species in India. The officially documented plants with medicinal potential are 3000 but traditional practitioners use more than 6000. India is the largest producer of medicinal herbs and is appropriately called the botanical garden of the world [2, 3]. In rural India, 70% of the population is dependent on the traditional system of medicine, the Ayurveda. Plants are reported to possess diverse phytochemicals which are responsible for biological activities such as antioxidant, antibacterial, anticancer, lipoprotective and anti-HIV activities [4-6]. It is estimated that approximately one quarter of prescribed drugs contain plant extracts or active ingredients obtained from plants [7-10]. Aspirin, atropine, artemisinin, colchicine, digoxin, ephedrine, morphine, phytosigmine, pilocarpine, quinine, quindine, reserpine, taxol, tubocurarine, vincristine and vinblastine are a few important examples of plant derived medicinal products [11].

The term weed is used for the unwanted plants in human controlled settings, such as farm fields, gardens, lawns, and parks. In other words weed is the plant that grows and reproduces aggressively outside its native habitat [12]. They have adaptations that allow them to proliferate in disturbed environments such as dunes, shifting soils, alluvial flood plains, river banks/deltas, and areas that are often burned. They often grow and reproduce quickly, have seeds that persist in the soil for many years, or have short lifespan with multiple generations in the same growing season. Many weeds have moved out of their natural geographic ranges and spread around the world in tandem with human migrations and commerce [13]. While the term “weed” generally has a negative connotation, many plants known as weeds can have beneficial properties. *Achyranthes aspera* (Amaranthaceae) is a common weed found throughout India. It finds therapeutic use in rheumatism, bronchitis, skin diseases and rashes. It is also used to ease the symptoms of malaria. The alkaloid memosine in the extracts of *Mimoso pubica* (Mimosaceae) are shown to possess anti-proliferative and apoptosis inducing activities. In Ayurveda and Unani system of medicine the plant is used for treatment of jaundice, leprosy, ulcers and small pox. *Sida cordifolia* (Malvaceae), an invasive weed native to India, is also known for its medicinal property in Ayurveda. It is used in the folk medicine for the treatment of oral mucosal inflammation and asthmatic bronchitis [14]. A number of weeds are known for their potent biochemical and pharmacological activities.

Distribution, Chemistry And Biological Activities Of Common Weeds

Adhatoda vasica

*Adhatoda vasica* (Acanthaceae) is a weed, with opposite ascending branches grows throughout the Indian peninsula. For over 2000 years it has been used in the indigenous, Ayurvedic and Unani systems of medicine [15, 16, 17]. In the WHO manual “The Use of Traditional Medicine in Primary Health Care” plant is recommended for the treatment of asthma, cough, and bleeding piles; for making sputum more fluid. There is evidence that the flowers and leaves are cooked as vegetable by the tribal communities in India and Nepal. People used a decoction of the leaves orally to stimulate heal before and after delivery. It is also used to induce abortion in pregnant women [18]. Vasicine a bitter quinazoline alkaloid present in the flowers, leaves and roots of *A. vasica* is the pharmacologically most studied chemical component of this plant. Other alkaloids include vasicinol, vasicinone, deoxyvasicinone adhatonine, adhatodine, adhavasinone, peganine, anisotine, vasicinol, vasicinacnone (Figure 1). Beside these other phytocompounds such as betaene, steroids, carbohydrates, alkanes, triterpenes and flavonoids are present [19].

Figure 1: Structure of Vasicine (R₁-H₂; R₂-OH), Vasicinone (R₁-O; R₂-OH) and Deoxyvasicinone (R₁-O; R₂-H)

Srinivasrao et al. (2006) reported antioxidant and anti-inflammatory activity of an alkaloid (vasicine) isolated from *A. vasica*. Extracts of the plant is known for antilipid peroxidation activity in liver. Methanolic extract of leaf is known for blood cholesterol lowering activity [20, 21]. Several studies established the genoprotective role of *A. vasica* extracts (methylolic and ethanolic) in radiation induced damage. At a dose of 50 to 100mg/kg body weight *A. vasica* leaf extract showed significant hepatoprotective effect on liver damage induced by d-galactosamine and carbon tetrachloride induced hepatotoxicity in
rats [22]. Derivatives of compounds (e.g. vasicine) isolated from the plant showed stimulatory effects on uterus muscle, tracheal and other tissues of experimental animal models. Vasicine can potentiate the action of oxytocin and also have stimulant activity on smooth muscle thus used for bronchodilatation and abortion. The aqueous and ethanolic extracts of the plant showed ovicidal and larvicidal properties against gastrointestinal nematodes of sheep [23]. The plant is also known for anti-diabetic, anticestral, and anti-helminthic activity. Aqueous, ethanolic and petroleum ether extracts of A. vasica and semi-synthetic derivatives of vasicine (benzylamines, bromhexine and ambroxol) are known to possess antibacterial activity against many bacteria viz. Mycobacterium tuberculosis, Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Proteus vulgaris, Klebsiella pneumoniae and Candida albicans [22].

### Argemone mexicana

Argemone mexicana L. (Papaveraceae) is a tropical annual weed found everywhere by road sides and fields in India [24]. It is native to tropical America, widely distributed throughout the subtropical and tropical regions of the world and is commonly known as Mexican prickly poppy and Sotiyanashi [25]. Low concentrations of allelochemicals from this weed could expand the rhizosphere and increase endophytic populations and subsequent antagonistic activity of the introduced bacteria [24]. Chemical investigations of this plant have revealed the presence of alkaloids (berberine, protopine, sarguarine, optines, chelerythrine), amino acids, phenolics and fatty acids (myristic, palmitic, oleic, linoleic acids) (Figure 2) [25, 26]. Mexicanol and mexicanic acid, the two aliphatic compounds have been isolated from leaves. Literature revealed that A. mexicana, has important medicinal activity and is traditionally used as a potent diuretic agent.

![Figure 2: Structure of Berberine](image1)

The alkaloids (Benzopenanthridine (+/-)-6-acetoxydihydro chelerythrine) isolated from methanolic extract of the A. mexicana exhibited significant anti-HIV activity [27]. Pretreatment with aqueous and methanol extracts of stem in mice showed significant reduction in leucocytes and eosinophil count in milk induced leucocytosis and eosinophilia. Polar constituents of stem are reported for antistress and antiallergic activity [25]. The aqueous extract of whole plant possesses significant protective activity against CCl\textsubscript{4} induced hepatotoxicity [28]. The methanol extract of leaves and seeds showed inhibition against S. aureus, B. subtilis, E. coli, and Pseudomonas aeruginosa. The plant is also known for its antimarial, antiplasmodial, larvicidal and antiastmatic activities [25]. The alkaloid (chelerythrine, angoline and (+)-argenaxine) isolated from the chloroform extract of aerial part showed cytotoxicity against human nasopharyngeal carcinoma (HONE-1) and gastric cancer (NUGC) cell lines [29].

### Calotropis procera

Calotropis procera Linn. (Asclepiadaceae) also known as milkweed is a xerophytic, erect shrub about 6m high, growing widely throughout the tropics of Africa and Asia [30]. It is known as Aak, Sodom apple and Usher. In India it grows abundantly in Rajasthan. Plant is a useful bio-indicator to monitor pollution in varying concentrations of Br, Mn, Se, Cr and Zn between urban and suburban samples [31]. The inner bark is used to make strong fibers called madar which are used in the manufacture of carpets, ropes, sewing thread and fishing nets [32]. Calotropis is primarily harvested because of its distinctive medicinal properties. Plant has shown the presence of triterpenoids, calotropuseryl acetate, caloephedrilenol, procerelan A and B, cardiac glycosides, calotropin (Figure 3), calotxin, cardenolides and anthocyanins [32]. Some chemicals are dominantly found in root bark (benzoylsoflavone and benzoylsoflavone); leaves and stalk (calotropin and calotropagenin); flower (calotropenyl acetate, and multiflavonol); and latex (uzarigenin and terpenol ester) of the plant [32].

![Figure 3: Structure of Calotropin (R-CHO)](image2)

Root extract and protein fraction of the latex has been found to produce a strong cytotoxic effect on COLO-320 (colon), Huh-7 (hepatoma), COS-1 (Kidney), and MCF-7 (breast) cell lines. The cytotoxic activity of latex is due to the partial inhibition of DNA synthesis which triggers apoptosis [33]. Dried latex treatment of mice has been shown to provide complete protection against hepatocarcinogenesis. Aqueous and methanolic extracts of latex has been reported to exhibit potent anti-inflammatory activity by inhibiting histamine, bradykinin and prostaglandin E2 [33]. The latex of C. procera has shown larvicidal efficacy against Aedes aegypti, Anopheles stepheni and Culex quinquefaciatus, vectors of dengue, malaria and lymphatic filariasis, respectively. Leave and flower extracts are toxic against Heterotermes indicola and Coptotermes heimi termites species [33]. Leaf extracts and latex have inhibitory effect against Candida albicans. Cardenolide and proceragenin found in the plant were active against Pseudomonas pseudomallei, a causative agent of melioidosis. Kumar et al (2013) determined phenolic and flavonoid contents in roots and reported the antioxidant and membrane protective activities of C. procera aqueous extract. Besides these C. procera has been reported for its wound healing, analgesic, acarcidal, antinoceptive, antiulcer and anti-cocsidial activity [34]. Various polar and non polar extracts of stem bark/root were found to be active growth inhibitor of Trichophyton rubrum, Microsporum gypseum, and Aspergillus niger [33, 34].

### Euphorbia hirta

Euphorbia hirta L. (Euphorbiaceae) is an herb frequently seen occupying open waste spaces and grasslands, road sides, and pathways. E. hirta is a very common herb in the pan-tropical and partly subtropical areas worldwide, including China, India, Philippines, Australia, Africa, Malaysia etc. [35]. It is a slender-stemmed, annual hairy plant with many branches from the base to top. The fruits are yellow, three celled, hairy, capsules containing three brown wrinkled seeds [36]. The leaves of E. hirta are found to contain tannins, sterols, alkaloids, glycosides, triterpenoids, flavonoids and polyphenols [36]. The whole plant contains quercitrin, myricitrin, shikmic acid, tannixylin, kaempferol (Figure 4), gallic acid, protocatechuic acid, β-amin and choline [36]. It is a very popular herb in traditional system of medicine to treat a variety of diseases including asthma, coughs, diarrhoea and dysentery. Whole parts of this plant secrete milky latex. Local tribes and Van Guljars use latex in the treatment of wart. The plant has a reputation for increasing milk flow in women and also used for other female complaints [37].

Protective effect of E. hirta alcoholic extract against antitubercular drug-induced cytotoxicity has been observed in HepG2
hepatocytes. The activity was comparable to standard hepatoprotective drug silymarin [38]. Aqueous leaf extract causes decreased gastrointestinal motility in normal rats and counter acts effect of castor oil-induced diarrhoea in mice [39]. *E. hirta* has been used to treated asthma in folk medicine. This effect could be mediated due to synergistic anti-inflammatory and antioxidant activities of flavonoids, sterols and triterpenoids [40]. The anti-inflammatory activity of ethanol extract is attributed to mast cell membrane stabilization by inhibiting the release of inflammatory mediators [41]. In *vitro* studies showed potential dose dependent antioxidant activity comparable with that of ascorbic acid. Daily treatment of ethanol and petroleum ether flower extracts for three weeks significantly reduced aloxan-induced hyperglycemia, triglycerides and cholesterol [42, 43]. Methanol extracts of whole plant has been shown to produce potent antimicrobial activities against *S. aureus*, *B. subtilis*, *B. thuringiensis*, *E. coli*, *K. pneumonia*, *S. typhi* and *P. mirabilis* [44]. The methanol extract of the leaves also exhibit anti-proliferative activity against Hep-2 cell lines (Larynx epithelial). Flavonol (afzelin, quercitin and myricitrin,) isolated from *E. hirta* possess antimalarial activity as shown by proliferation inhibition of *Plasmodium falciparum* [45].

**Lantana camara**

*Lantana camara* Linn. (Verbenaceae) is a flowering ornamental plant distributed world across. It is native to Caribbean, Central and Northern South America. The plant is also known as Wild sage, Surinam tea plant, Spanish flag and West Indian lantana. In India it was probably introduced before 19th century and currently distributed throughout [46]. It is a low erect or subscandent vigorous shrub with tetragonal stem, stout recurved prickles and a strong odour of black currents. Leaves and stem are covered with rough hairs. Small flower are held in clusters (called umbels) with usually orange colour. Inflorescences are compact, dome shaped containing 20-40 sessile flowers and are produced in pairs in the axils of opposite leaves [46]. Phytochemical analysis of the different parts of *L. camara* revealed the presence of alkaloids, essential oils, phenolics compounds, flavonoids, iridoid glycosides, phenyl ethanoid, quinine, saponins, steroids, triterpens, sesquiterpenoids and tannin [46].

Differential distribution of carbohydrates and lipids are found among flower and leaves of *L. camara*. In India the leaves of the plant are boiled for tea and the decoction is a remedy against cough and it is used as a lotion for wounds [47]. In Central and South America, the leaves and preparation from other part of the plant are used to treat sores, chicken pox, measles, fever, cold, rheumatism, asthma and high blood pressure [48].

**Figure 4: Structure of kaempferol**

**Solanum nigrum**

*Solanum nigrum* (Solanaceae) also known as makoi or black nightshade is a fairly common herb. It grows as weed in moist habitat as well as in dry, stony, shallow or deep soils. Many pharmacological active components viz., alkaloids, reducing sugars, gallic acid, flavonoids, phlobatannins, steroids, tannins, catechin, protocatechuic acid, caffeic acid, epicatechin (Figure 6), rutin, and naringenin etc are reported to be present in *S. nigrum* [52]. It has been used traditionally to treat various ailments such as inflammation, pain, fever and enteric diseases.

**Figure 5: Structure of (a) Limoen and (b) Luteolin a polymethoxylated flavones**

Lancamarone (a steroid) isolated from leaves exhibit cardio tonic properties [47]. An alkaloid (lantamine) from the stem, bark and roots show antipyretic and antiinflammatory properties comparable to those of quinine [49]. Methanolic extract of leaves exhibited noticeable antioxidant potential in terms of reducing power as well as DPPH and nitric oxide free radical scavenging ability [47]. Polar and nonpolar extracts of plant possess antibacterial activity against *E. coli*, *P. aeruginosa*, *S. aureus*, and *S. saprophiticus* [47, 50]. The essential oil (containing β-caryophyllene, geranyl acetate, terpinyl acetate, bornylacetate and limonene) and polymethoxylated flavones isolated (Figure 5) from plant are known to possess antifungal activity [47]. Flower extracts (methanol and ethanol) and essential oil from leaf have larvicidal activities against *A. aegypti* and *C. quinquefasciatus*. Essential oil is also known to possess adulticidal activity against vectors of malaria, dengue, yellow fever and chikungunya. Oral administration of leaves methanolic extract in aloxan induced diabetic rats showed significant hyperglycemica activity by reduction of blood glucose concentration [47, 51]. Oleanonic acid isolated from *L. camara* exhibit potent cytotoxicity against human melanoma (A375) cell lines. Methanolic extract of leaves are reported to exhibit cytotoxicity against laryngeal (HEp-2) and lung (NCI-H292) cancer cell lines [46].

**Figure 6: Structure of (a) catechin and (b) epicatechin**

The flavonoids present in the ethanolic extract of *S. nigrum* berries are supposed to be a responsible for anti-inflammatory and anticonvulsant activity [52]. Aqueous extracts of leaf and fruit possess significant hypoglycemica effect at 200mg/kg body weight in Sprague Dawley rats. Oral administration of ethanolic extract in albino rats at dose of 200mg/kg body weight revealed significant decrease in blood sugar level compared to control showing antidiabetic property of the plant [53]. Methanolic extract of leaf
possess antibacterial activity against several pathogenic bacteria viz., E. coli, S. aureus, E. aerogenes, P. aeruginosa, X. campestris, A. hydrophila, S. flexenari, and Y. aldovae. The ethyl acetate seed extracts exhibited strong activity against P. vulgaris [52]. In a study methanolic extract of S. nigrum berries showed antilucrigenic effects on aspinin induced ulceration in rats. Gastro-protective effect might be due to free radical scavenging potential of the extract. Oral administration of ethanolic and aqueous extracts in carbon tetrachloride induced rat at 250mg/kg body weight for 10 days showed decrease in serum aspartate and alanine transaminase (AST), alanine amino transferase (ALT) and alkaline phosphates (ALP) activities. The study indicated hepatoprotective potential of the plant [54, 52]. Extracts showed antioxidant potential in various in vitro and in vivo studies. The plant is also reported for analgesic, anti-inflammatory, antitumor, antidiabetic, and larvicidal activities [52].

**Parthenium hysterophorus**

*Parthenium hysterophorus* L. (Asteraceae), is an invasive weed throughout world. In India it was first reported in the late 1950s in Pune. It is commonly known as altanis, caroll grass, bitter weed, star weed, white top, wild feverfew, the "Scourge of India" and the congress grass. Parthenen, a sesquiterpenoid (Figure 7) is the major active compound present in *P. hysterophorus*. The flower and root extracts show presence of flavonoids, terpenoids, alkaloids and cardiac glycosides. Plant has been used as folk remedy for the treatment of infectious and degenerative diseases [55, 56]. All parts of the plant are reported to be used as bitter tonic, febrifuge, emmenagogue, antisydenticum etc. Some researchers have reported its use in traditional medicine for treatment of wounds, ulcercated sores, fever, anemia and heart troubles [56].

**Solanum xanthocarpum**

*Solanum xanthocarpum* Schrad. & Wendl. (Solanaceae) commonly known as Yellow Berried Nightshade (syn: kantakari), is a prickly diffuse bright green perennial herb, woody at the base, 2–3m height. It is found throughout India, mostly in dry places as a weed on roadsides and waste lands. *S. xanthocarpum* is a non toxic weed and has been reported to be safe for human use [58, 59]. Different parts of plant such as leaves, stem, flower, fruit, root and seeds are used in traditional systems of medicine. Plant contains alkaloids, steroids, saponins, flavonoids amino acids etc. Fruits are rich in solasodine glycosides and contain tomatidenol (Figure 8), glycoalkaloid, diosgenin, carperester.

The stem, flowers and fruits are prescribed for relief in burning sensation in the feet accompanied by vesicular eruptions. Fruits are berry, yellow or with white green veins, surrounded by enlarged calyx [59, 60]. Fruits are edible and local people of Manipur (India) use it as folk medicine for treatment of various ailments. Irula tribes of Hassanur Hills (Tamil Nadu, India) have history of consuming the cooked unripe fruits of *S. xanthocarpum* (Sx) as vegetable. In Kerala, the Kattunakka, Paniya and Kuruma tribes of Wayanad district consume fruits and seeds as food [61]. The fruit is known for several medicinal uses like antiptotic, anthelmintic, anti-inflammatory, cytotoxic activities, antitumor, antipsammocidal, antiasthmatic, and hypotensive [53, 54]. Root is an expectorant and prescribed in cough, asthma, chest pain, used in the form of elcutary. Aqueous extract of root is also one of the constituents of Jigrine, a polypharmaceutical herbal formulation, used for treatment of liver ailments [51, 52]. Kumar et al. [51, 52, 53] reported the antioxidant, antibacterial, lipoprotective activities of *S. xanthocarpum* root extracts. They also reported the presence of phenolics and flavonoid content in the root extract of the plant.

**CONCLUSION**

In recent years traditional uses of ethno-botanicals has received much attention as they are well known for their efficacy and are generally believed to be safe for human consumption. In this review an attempt has been made to compile the biological activities of weeds. Many weeds possess phytochemicals which have been shown as a promising alternative to the synthetic drugs.

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