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Review

An overview on phytomedicinal approaches of *Zanthoxylum armatum* DC.: An important magical medicinal plant

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This paper compile a review on pharmacological studies, phytochemical analysis and problem associated with *Zanthoxylum armatum* DC. The different plant parts like leaves, fruits, stem, bark, seeds and roots are used in indigenous medicine preparation against various diseases. It shows antioxidative, antitumor, antiinflammatory, analgesic, antimicrobial and insecticidal/larvicidal activity. For their bioactive principles extensive chemical analysis resulted in this specie. Due to significant medicinal properties and continuous increasing demand put this plant in endangered category (IUCN). This plant has effective phytomedicinal action.

Key words: *Zanthoxylum armatum*, endangered, propagation, medicinal plant.

INTRODUCTION

India has richest plant based medicinal traditional system because of its rich biodiversity. Like India, in other developing countries, herbal plants constitute very important national resources of health sector. These herbal medicines are mainly used for health care due to their cost value, effectiveness and lesser side effects on human body (Sekar et al., 2010). So, the pharmaceutical industries are directly or indirectly dependent upon the plant material. The Indian Himalayan region (IHR) recognized amongst 34 biodiversity, hot spots in the world. It contains about 1,748 different species of medicinal plants (Samant et al., 1998).

Among different medicinal plants of IHR, *Zanthoxylum* (family: Rutaceae) is one of such genus which possess high medicinal, economical as well as ecological importance and have about 250 species spreading all over the world. In India, 11 species of this genus is reported. These are; *Z. budrunga, Z. oxyphyllum, Z. ovalifolium, Z. acanthopodium, Z. planispinum, Z. armatum, Z. nitidium, Z. rhesta, Z. simulans, Z. avicennae* and *Z. limonella*. Out of these, 4 species; Z. *armatum* DC., *Z. acanthopodium* DC., Z. *oxyphyllum* Edgew, and Z. *budrunga* are present in Uttarakhand (Kala et al., 2005).

Z. armatum is a deciduous shrub or small tree which grows in well drained alluvial, black soil. In India, it has been reported from the warmer valleys of the Himalaya from Jammu and Kashmir to Assam and Khasi (1,000 to 2,100 m amsl), in the Eastern Ghats in Orissa and Andhra Pradesh (1,200 m) and the lesser Himalayan regions in the northeastern part of India for example, Naga Hills, Meghalaya, Mizoram, and Manipur (Kala et al., 2005). *Z. alatum* is synonyms to it (Gupta et al., 2011). In previous studies, Z. *alatum* was later named as Z. *armatum* and Z. *planispinum*, but Flora Hupehensis regards both Z. *armatum* and Z. *planispinum* as distinct species (Gardener, 1995).

The English name of the plant is 'Winged prickly ash' and commonly known as 'Timur' or 'Toothache tree'. In its natural habitat, it grows up to 6 m in height with dense foliage and armed branched flattened prickles. Leaves are compound, 4 to 20 cm long, imparipinnate, rachis winged, serrate with gland dots and aromatic, containing a flavor like lime and mint. The ripe fruit follicles are

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Figure 1. Different developmental stages of *Z. armatum*. (a) Tree growing in its natural habitat (photograph taken from village Dummar, Munsiari in the month of October, (b) initial stage of seed development during the last week of June, (c) ripen fruits in natue, photograph taken in month of October, (d) mature dried fruits with seeds, (e) potted plant in the departmental nursery, (f) compound leaf, (g) *in vitro* bud proliferation in *Z. armatum* by using nodal explant

usually reddish in color and 4 to 5 mm in diameter. The dried fruit also contain an aroma that is present in brown fruit wall (pericarp-shell). It may be able to develop numbing or anesthetic feeling on the tongue. Seeds are solitary, globose, shining and have bitter taste. Flowering occurs in the months of March and April. The green or yellow flowers are present in dense terminal and axillary sparse panicles. In nature, the different developmental stages are shown in Figure 1a to f and Figure 1g shows *in vitro* bud proliferation by using nodal explant. This could also be a good alternative for the propagation and conservation of *Z. armatum* DC.

CHEMICAL CONSTITUENTS

Monoterpenes like linalool and limonene are the major constituents of the essential oil, listed in Table 1. Armatamide, an amide was identified from the stem bark of it (Kalia et al., 1999). From the alcoholic extract of the stem bark, a new flavonoidal glycoside1 has also been isolated (Sati et al., 2011). Seeds contain hydroxylic (4Z) enolic acid and various volatile compounds (Ahmad et al., 1993). The various alkaloids, flavonoids, flavonal glycosides, lignins, phenolics, sterols, terpenoids, fatty acids, alkenicacids, amino acids, various aromatic and volatile and number of other compounds have been identified and isolated from *Z. armatum* essential oil in good quantity. Gas chromatography-mass spectrometry (GC-MS) analysis reveals that essential oil of seeds contains 22 different components (Waheed et al., 2011).

Traditional/folk uses

Timur is known as an important magical plant because plant parts like leaves, stem, bark, fruits, seeds and roots possess medicinal properties and are used in indigenous

Table 1. Major constituents of essential oil.

S/N	Monoterpenes	Yoshihito et al. (2000), % value		Jain et al. (2001), % value		Tiwary et al. (2007), % value		Bhattacharya et al. (2009), % value		Gupta et al. (2011), % value	
1	Linalool	62.2	seeds	71	seeds	57	seeds	23.3	fruits	35.57	leaves
2	Limonene	12.6		8.2		19.8		12.9		6.46	

medicine preparation against various diseases. In traditional health system, it is valuable because of its stomachic, carminative and anthelmintic properties. Seeds of Timur are important ingredients to Zuroor-e-Qula (powdered polyherbal Unani formulation) which contain antimicrobial and anti-inflammatory activity (Paridhavi and Agrawal, 2007). Its younger twigs are used as tooth brush and the fruits are also used as flavoring agent and spices in traditional dishes preparation. The bark is utilized as traditional dye yielding resource (Gaur, 2007).

Pharmaccological uses

Z. *armatum* fruits, seeds and stem bark are used in the treatment of asthma, bronchitis, indigestion, toothaches, varicose veins, diarrhea, rheumatism, dyspepsia, cholera and toothache (Kanjilal, 1997; Kirtikar and Basu, 1993). Various medicinal properties are given in Table 2. The different chemical extracts from stem, bark, fruits and roots have different pharmacological activities:

Antioxidative activity

The ethanolic and methanolic extract of *Z. armatum* fruits shows 2,2-diphenyl-1-picrylhydrazyl (DPPH) radial scavenging activity observed by *in vitro* system in albino wistar rats; due to presence of free radical activity, the extract are used as a good source of antioxidant (Batool et al., 2010; Upadhyaya and Ashok, 2010).

Antiinflammatory activity

The ethanolic stem bark extract causes significant reduction in paw edema in male wistar rats due to the inhibition of cyclooxygenase (Sati et al., 2011) and fruits extract also show inhibition of carrageenan that induced paw edema in wistar rats (Mehta et al., 2011). It also has analgesic activity due to the presence of lignans components (Kaur et al., 2011; Guot et al., 2010).

Antimicrobial activity

It possesses inhibitory activity against microorganism. The largest zone of inhibition was obtained against *Bacillus subtilis* (23 mm) and minimum bactericidal concentration (MBC) value of 2.5 mg/l was obtained (Joshi et al., 2009). Essential oils of it is assessed for their fungitoxicity against *Alternaria brassicicola* (Parajuli et al., 2005).

Insecticidal and larvicidal activity

In combination, *Z. armatum* seed oil, vanillin and fruit oil of *Z. piperitum* have been able to enhance repellent activity against female *Aedes aegypti*, the effect was compared with N,N diethyl-3methylbenzamide(DEET) repellent (Kwon, 2011). The essential seed oil singly showed larvicidal activity against the mosquito spp. *Culex quinquefasciatus*, *Aedes aegypti*, *Anopheles stephensi* (Tiwary et al., 2007) and also effective against *Aedes albopictus* and *C. pipiens* (Yunl et al., 2010).

Piscicide activity

Fruits of this plant can be used as an effective piscicide in fish nursery management. The ethyl alcohol extract was evaluated on Mg^{2+}- and Na^{+}, K^{+}-ATPase activity in different tissues of *Heteropneustes fossilis* (air-breathing catfish). Kinetic studies on Mg^{2+}-ATPase activity suggested that as piscicide, it is a non-competitive inhibitor (Ramanujam and Ratha, 2008).

Hepatoprotective activity

Administration of its ethanolic leaves extract protect mice liver against the CCl_4 induced hepatotoxicity and inflammation (Verma and Khosa, 2010). The extract of the bark increased the level of antioxidant enzyme and also regulate the serum enzymatic levels; in this way, it was able to induce protective mechanism against the CCl_4 hepatotoxicity in mice liver (Ranawat et al., 2009).

Antitumor activity

Z. armatum has potential as anticancer drug because the crude extract of leaves and fruits show cytotoxicity (Barkatullah et al., 2011). It contains a monoterpene, lupeol which act as therapeutic and chemopreventive

Table 2. Medicinal properties shown by different parts of *Z. armatum*.

S/No	Activity	Active Parts	Preparation	Reference
1	Antioxidative activity	Fruits	Methanolic extract	Upadhyay and Ashok (2010)
		Fruits	Ethanolic extract	Batool F et al. (2010)
2	Antitumor activity	Leaves/fruits	Ethanolic extract	Barkatullah et al. (2011)
3	Antiinflammatory activity	Stem bark	Ethanolic extract	Sati et al. (2011)
		Fruits	Methanolic extract	Mehta et al. (2011)
		Roots	Ether extract	Kaur et al. (2011)
4	Analgesic activity	Leaves/stem	Ethanolic extract	Guo et al. (2010)
5	Antibacterial activity	Seeds/leaves	Essential oil	Joshi et al. (2009)
6	Antifungal activity	Leaves	Essential oil	Parajuli et al. (2005)
7	Larvicidal activity	Fruits	Essential oil	Kwon et al. (2011)
		Seeds	Essential oil	Yun et al. (2010)
		Seeds	Essential oil	Tiwary et al. (2007)
8	Piscicide activity	Fruits	Ethanolic extract	Ramanujam and Ratha (2008)
9	Hepatoprotective activity	Leaves	Ethanolic extract	Verma and Khosa (2010)
		Bark	Ethanolic extract	Ranawat et al. (2009)

agent for the treatment of inflammation and cancer.

Immunomodulation activity

It also shows a stimulating effect upon the lymphatic system, circulation, mucous membranes and also act as stimulation liniment for rheumatism and fibrositis. Its crude extract useful in the treatment of gastrointestinal, respiratory and cardiovascular disorder, resulted concentration effect on the K^+ and Ca^{++} channel (Gilani et al., 2010).

Commercial value

Z. armatum contains a number of medicinal properties, so in view of high demand for this plant, the various pharmaceutical companies generally purchase it from the market. In the 2000, the price value in local market (Pithoragarh and Chamoli district in Kumaun region) was 45Rs per kg, in the same year the price in the plains increased from 150 to 200Rs per kg (Kala et al., 2005).

Problems associated with the plant

A growing demand of *Z. armatum* has caused a serious reduction in native population as a consequence of over harvesting and deforestation. As a result, target species has been reported as a “endangered” species as per International Union for Conservation of Nature (IUCN) criteria (Samant et al., 2007). Natural regeneration mainly takes place through seeds. Seed germination is the easiest method but in Zanthoxylum, it is not uniform and takes few months to years for germination and establishment of seedling that is, exhibit strong dormancy apparently imposed by seed coat (Bonner, 1974). So propagation through seeds accounts for longer interval.

CONCLUSION

The widespread uses of *Z. armatum* in medicine revealed its properties as antimicrobial, insecticidal, larvicidal, antiinflammatory, analgesic etc. This way, the plant has effective pharmacological action and has proven its potential for future researches because not much information is available to use as anticarcinogenic agent therefore, further studies may be carried out to prove its promising uses. It is a high value medicinal plant of IHR and there has been increasing pressure on the collection of this species. People collect these plants from wild area for their economic benefits. So characterization of genetic diversity for this plant is helpful for developing the conservation strategies and protection of intellectual properties. *In vitro* propagation method offer highly efficient tool for mass multiplication of many threatened plants. Hence there is an urgent need to develop reproductive propagation protocol for multiplication and

conservation of this plant.

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