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Medicinal, pharmaceutical and pharmacological properties of *Zanthoxylum armatum*: A Review

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Abstract

Zanthoxylum armatum DC is a sub deciduous aromatic, branched shrub, belongs to family *Rutaceae*. Its maximum length up to approximately 5 m with alternate imparipinnate leaves and flowers are small, pale yellow in colour. It is widely spread in the hot valleys of Himalayas from Jammu to Bhutan, Nepal and Pakistan. In India, the most part of Orissa and Andhra Pradesh is covered by *Z. armatum* plants. This plant is significantly used to cure stomachic, toothache, carminative, antiseptic and chest infections. This review has collecting information about its botanical position, morphology, phytochemical and pharmacological information on *Z armatum*.

Various researchers have shown that *Zanthoxylum armatum* possesses valuable biological and pharmacological activities. A large number of phytochemical compounds such as alkaloid, tennins, amino acids, terpenoids, glycosides are present in the extract of the leaves of *Zanthoxylum armatum*. This review focuses on the detailed medicinal uses, phytochemical composition and pharmacological properties of different parts of *Zanthoxylum armatum*.

Keywords: *Zanthoxylum armatum*, ethno-medical, pharmacology, antiseptic, carminative, terpenoids, botanical, alkaloids

Introduction

Zanthoxylum armatum is one of the most important medicinal plants in Indian medicinal Literature. In India about 10 species are grown. Almost all parts of this plant are used in Indian traditional system for the treatment of various ailments and the significant medicinal properties was further reported through scientific investigation. Plants containing active ingredients used to cure disease or relieve pain are called medicinal plants ^[1]. Plants play a therapeutic and pharmaceutical role in protecting human beings from the effects of diseases and other complications, thus considered to have a significant role in healthcare system. That is the main reason that large people of the developing countries still rely on herbal medicines. Medicinal plants are handled within an organized manner and exploited for the future ^[2]. Progressive increase in medicinal plants usage has been recorded continuously both for traditional users and pharmaceutical industry.

Medicinal plants provide chances for biological screening, methods useful for the industry and trends in the pharmacological investigations of natural products. Plants are the natural and most easy accessible source of therapeutically active biological principles. Therefore, there is an extreme need to screen out plant for development of new drugs. However, detailed information on this plant is not available. In this review the main focus was on the botany, phytochemistry, pharmacology and ethno-medicinal uses of *Zanthoxylum armatum*.

Nomenclature of *Zanthoxylum armatum*

Kingdom	:	<i>Plantae</i>
Subkingdom	:	<i>Viridaplantae</i>
Phylum	:	<i>Tracheophyta</i>
Subphylum	:	<i>Euphyllophytina</i>
Class	:	<i>Magnoliopsida</i>
Subclass	:	<i>Rosidae</i>

Vernacular Names

English name	-	Prickly Ash
Nepali name	-	Timur, Nepali peeper
Oriya name	-	Tundopoda
Bengali name	-	Gaira, Tambul
Manipuri	-	Mukthruhi

Ayurvedic name	-	Tejovati, Tumbru (fruit)
Unani name	-	Kabab-e-Khanda
Hindi name	-	Tejphal, Nepali dhaniya
Trade name	-	Timru, Timur

Therapeutic uses

It is used to treat diseases viz; Asthma, Bronchitis, Cholera, Fever, Fibrosis's, Indigestion, Rheumatism, Skin diseases, Toothache, Varicose veins. Prickly Ash is used in many chronic problems such a rheumatism and skin diseases; cramp in the leg, ulcers. It is also used for low blood pressure, fever, and inflammation. Externally it may be used as stimulation

for rheumatism and fibrositis. It has a stimulating effect upon the lymphatic system, circulation and mucous membranes. The fruit and seeds are used to cure in fever dyspepsia and cholera and the bark used for intoxicating fishes. The bark, fruits and seeds are widely used in indigenous system of medicine as a carminative, stomachic and anthelmintic and antifungal. The bark is pungent and used to clean teeth. The fruits and seeds are employed as an aromatic tonic in fever and dyspepsia^[3].

The traditional uses of different parts of *Zanthoxylum armatum* DC.

Sr. No.	Part used	Traditional uses
1.	Leaves	The leaves are mainly used for catching fishes, and also used to cure ingestion and cholera.
2.	Seeds	The seeds are used to cure fever, dyspepsia and cholera, ingestion, flatulence and depression and employed as an aromatic tonic.
3.	Bark	The bark of the tree is highly used as a carminative, stomachic and anthelmintic. In some countries, the bark powder is applied on gums for relief hence it is known as "toothache tree".
4.	Fruit	The fruit juice is used for expelling roundworms from the stomach part. The fruit part is highly used to cure dental problems because of its deodorant, disinfectant and antiseptic properties. The pickles of fruit are used to cure cold, cough, abdominal pains, tonsils, limbs numbness. While the fruit powder with hot water is used against dysentery, diarrhoea.
5.	Berries	The berries are carminative and antispasmodic in nature and used against skin diseases.
6.	Whole plant	The whole plant is used to cure scabies and also used for expelling worms from the infecting ear.

Morphological characteristics

Zanthoxylum armatum is an evergreen, thorny shrub or small tree; attaining a height up to 6 m. Leaves are 4–20 cm long, imparipinnate, pungent, and aromatic with glabrous, narrowly winged petiole having two stipular prickles at the base. Leaflets are glabrous on the underside, and occur in two to six pairs. The plant can be recognized by its shrubby habit, dense foliage, with pungent aromatic taste, prickled trunk and branches, and small red, subglobose fruits^[4].

Floral characteristics

Flowers occur in dense terminal or sparse axillary panicles and are green to yellow in colour. Calyx consists of six to eight sub-acute lobes. Stamens are about six to eight in number. Ripe carpels or follicles are usually solitary, pale red, and tubercled. Seeds are globose, shining, and black. Flowering occurs from March to May, while fruiting occurs from July to August^[5].

Distribution: It is commonly known as Timur found in Northern India, Pakistan to eastward China, Korea and Japan. In India, it is found in the hot valleys of the Himalayas from Jammu to Bhutan at an altitude of 1000-2100 m and in Eastern Ghat in Orissa and Andhra Pradesh at 1200m.

Climate and soil: The plant is adapted to subtropical climate of lower warm valleys of the Himalayas with sufficient rainfall. Loamy or clayey soil rich in organic content is preferred for its cultivation.

Propagation Material: Freshly harvested seeds are best for the large-scale cultivation of *Zanthoxylum* species. Mature seeds can be collected in June-July. In the absence of sufficient seeds, air layering is also used for propagation.

Constituents of *Zanthoxylum armatum*

Parts used- Stem bark, fruits, and seeds

Root: It contains magnoflorine, xanthoplanine, skimmianine, dictamine and gamma-fagarine.

Seeds: This contains flavonoids tambulin and tambulol.

Oil: The essential oil obtained from dried fruits contains linalool (64%), linalyl acetate, citral, geraniol methyl cinnamate, limonene and sabinene.

Bark: Dried bark contain lignans-sesamin, fargesin, eudesmin, a lactone pulviatide, dictamine, 8-hydroxydictamine and gamma-fagarine, magnoflorine and xanthoplanine.

Leaves: This contains methyl-n-nonylketone, linalyl acetate, sesquiterpenhydrocarbons and tricosane.

Chemical Constituents

Bark: Alkaloids: g-fagarine, b-fagarine (skimmianine), magnoflorine, laurifoline, nitidine, chelerythrine, tambetarine and candicine Coumarins: xanthyletin, zanthoxyletin, alloxanthyletin, Resin, tannin, volatile oil. Bark yields a bitter crystalline principle, identical to berberine, and a volatile oil and resin. The carpels yield a volatile oil, resin, a yellow acid principle, and crystalline solid body, xanthoxylin.

Phenolic Constituents

Study isolated two new phenolic constituents from the seeds - 3-methoxy-11-hydroxy-6, 8 dimethylcarboxylate biphenyl and 3, 5, 6, 7- tetrahydroxy-3', 4'- dimethoxyflavone-5- β - d-xylopyranoside along with five known compounds^[6].

Two new phenolic constituents characterized as 3-methoxy-11-hydroxy-6,8-dimethylcarboxylate biphenyl and 3,5,6,7-tetrahydroxy-3',4'-dimethoxyflavone-5- β -d-xylopyranoside along with the five known compounds, 1-methoxy-1,6,3-antraquinone, 1-hydroxy-6,13-antraquinone, 2-hydroxybenzoic acid, 2-hydroxy-4-methoxy benzoic acid, and stigmasta-5-en-3 β -d-glucopyranoside, on the basis of spectral data and chemical analyses^[7].

Phytochemistry of zanthoxylum armatum: Several alkaloids have been isolated from the stem-bark and root-bark. Essential oils are extracted from fruits of this species. A number of alkaloids has been isolated and reported from the

various parts of the *Zanthoxylum armatum* DC. berberine (bark), dictamnine (stem-bark), magnofluorine (0.02% as picrate), xanthoplanine (0.01% as picrate) (wood and bark), magnofluorine (0.17% as picrate), xanthoplanine,

skimmianine, dictamnine and fagarine. The bark of timur has main constituents viz; armatamide along with two lignans, asarinin and fargesin, α - and β -amyryns, lupeol, and β -sitosterol- β -D-glucoside.

Sr. No.	Compounds Name	Percentage of essential compound	Source	References
1	Terpenoids α -Fenchol	0.68	Seed	[8]
2	α -Terpinene	0.40	Seed	[9]
3	α -Thujene	1.65	Seed	[8]
4	α -Thujone	0.10	Seed	[9]
5	α -Pinene	0.10	Seed	[9]
6	α -Terpineol	0.31	Seed	[8]
		1.10	Seed	[9]
		4.10	Leaf oil	[10]
7	β -Pinene	0.10	Seed	[9]
8	β -Cymene	1.30	Leaf oil	[10]
9	β -Phellandrene	5.70	Seed	[11]
		5.30	Pericarp of fruit	[12]
10	β -Terpineol	2.10	Leaf oil	[10]
11	Camphor	0.25	Seed	[8]
12	Carvone	0.20	Seed	[8]
		0.40	Seed	[9]
13	Citral	-	Dry fruit	[13]
14	Citronellol	-	Seed	[14]
15	Citronellal	-	Seed	[14]
16	1,8-Cineole	0.25	Seed	[8]
		trace	Seed	[9]
		41.0	Leaf oil	[10]
		15.7	Aerial part	[15]
17	cis-Ocimene	0.12	Seed	[8]
18	Geraniol Apigenin	-	Dry fruit	[13]
		0.40	Seed	[9]
		-	Fruit	[16]
19	γ -Terpinene Luteolin	0.08	Seed	[8]
20	(<i>E</i>)-Carveol	2.60	Seed	[9]
21	(<i>E</i>)-Linalool oxide	1.00	Seed	[9]
22	Limonene	24.46	Seed	[8]
		19.80	Seed	[9]
		08.20	Seed	[11]
		06.20	Pericarp of fruit	[12]
		12.60	Seed	[13]
23	Linalool	58.3	Seed	[8]
		57.0	Seed	[9]
		-	Leaf oil	[10]
		4.50	Seed	[11]
		71.0	Pericarp of fruit	[12]
		62.2	Seed	[14]
		18.8	Apical part	[15]
		-	Fruit	[17]
		87.7	Seed oil	[18]
72.0	Seed	[19]		
24	Linanyl acetate	-	Dry fruit	[13]
		-	Fruit	[17]
25	Myrcene	3.55	Seed	[8]
		1.30	Seed	[9]
26	Nerol	0.30	Seed	[9]
27	1- α -Phellandrene	-	Seed	[19]
28	Phellandrene	-	Fruit	[20]
29	<i>p</i> -Cymene	0.65	Seed	[8]
30	Piperitone	0.30	Seed	[9]
31	Sabinene	0.10	Seed	[9]
		8.4	Leaf oil	[10]
		-	Fruit	[16]
		-	Fruit	[20]
32	Tagetonol	0.16	Seed	[8]
33	Terpinen-4-ol	2.30	Seed	[9]
		5.20	Leaf oil	[10]
34.	(<i>Z</i>)-Sabinene hydrate	trace	Seed	[9]
35.	(<i>Z</i>)-Linalool oxide	1.0	Seed	[9]
36.	(<i>Z</i>)-Pinene hydrate	0.50	Seed	[9]

37.	<i>allo</i> -Aromadendrene	0.98	Seed	[8]
38.	β -Caryophyllene	0.50	Seed	[8]
39.	(<i>E</i>)-Nerolidol	0.60	Seed	[9]
40.	α -Amyrins	-	Bark	[21]
41.	α -Amyrone	-	Bark	[22]
42.	β -Amyrins	-	Bark	[21]
		-	Bark	[22]
43.	Lupeol	-	Bark	[21]
	Alkaloids			
1	Berberine	-	Bark	[23]
2	Chelelactam	-	Part not specified	[24]
3	Dictamnine	-	Root	[19]
4	Fargarine	-	Part not specified	[24]
5	Haplopine	-	Part not specified	[24]
6	Magnoflorine	-	Root	[19]
7	Nitidine	-	Part not specified	[24]
8	Nevadensin	-	Seed oil	[18]
9	Robustine	-	Part not specified	[24]
10	Sanguinarine	-	Part not specified	[24]
11	Skimmianine	-	Bark	[25]
		-	Root	[19]
12	Zanthonitrile	-	Bark	[25]
	Sterols And Steroids			
1	β -Daucosterol	-	Bark	[22]
2	β -Sitosterol	-	Bark	[22]
		-	Seed oil	[18]
3	Stigmasta-5-en-3 β -D-glucopyranoside	trace	Seed	[26]
4	β -Sitosterol- β -D-glucoside	-	Bark	[23]
	Lignins			
1	Asarinin	-	Bark	[23]
		-	Part not specified	[27]
		-	Part not specified	[28]
2	Eudesmin	-	Part not specified	[28]
3	Epieudesmin	-	Part not used	[28]
4	Fargesin	-	Bark	[21]
		-	Part not specified	[28]
5	Kobusin	-	Part not specified	[28]
6	<i>L</i> -Asarinin	-	Bark	[22]
7	<i>L</i> -Sesamin	-	Bark	[22]
8	<i>L</i> -Planinin	-	Bark	[22]
9	Magnolol	-	Part not specified	[11]
10	Phylligenin	-	Part not specified	[28]
11	Planinin	-	Part not specified	[28]
12	Sesamin	-	Part not specified	[27]
		-	Part not specified	[28]
	Flavonoids			
1	3,5-Diactyltambulin	-	Bark	[25]
2	Kaempferol	-	Bark	[25]
3	Tambulin	-	Part not specified	[30]
		-	Seed	[29]
4	3,5,3'-Trihydroxy-6,7-dimethoxy-4'-(7''-hydroxygeranyl-1''-ether) flavone	-	Seed	[30]
5	3,5,3',4'-Tetrahydroxy-7,8-dimethoxy flavones	-	Seed	[30]
6	Tambuletin	-	Seed	[30]
	Coumarins			
1	Bergapten	-	Bark	[25]
2	Umbelliferone	-	Bark	[25]
		-	Seed oil	[18]
	Amides			
1	Armatamide	-	Bark	[21]
2	Hydroxy- α -sanshooil	-	Whole plant	[31]
3	Hydroxy- β -sanshooil	-	Whole plant	[31]
	Carbonyl Compounds			
1	Cuminal	-	Fruit	[20]
2	Cuminaldehyde	0.30	Seed	[9]
3	Cuminic aldehydes	-	Fruit	[32]
4	Cinnamic aldehyde	-	Fruit	[32]
5	Dimethylic ether of phloroacetophenon	-	Fruit	[32]

6	Phellandral	1.30	Seed	[9]
7	2-Tridecanone	1.80	Leaf oil	[10]
8	Undecan-2-one	17.0	Apical part	[15]
Aromatic Compounds				
1	1-hydroxy-6,13-anthraquinone	0.0064	Seed	[26]
2	2-hydroxybenzoic acid	0.0038	Seed	[26]
3	2-hydroxy-4-methoxy benzoic acid	0.0047	Seed	[26]
4	<i>trans</i> -Cinnamic acid	-	Seed oil	[18]
5	Vanillic acid	-	Bark	[22]
6	(<i>E</i>)-Methyl cinnamate	5.70	Seed	[9]
7	Methyl cinnamate	8.92	Seed	[8]
		8.80	Seed	[14]
		12.2	Pericarp of fruit	[12]
8	(<i>Z</i>)-Methyl cinnamate	4.9	Seed	[11]
9	3-Methoxy-11-hydroxy-6,8-dimethylcarboxylate biphenyl	0.0211	Seed	[26]
10	3,5,6,7-Tetrahydroxy-3',4'-dimethoxyflavone-5- β -D-xylopyranoside	0.0075	Seed	[26]
11	Monoterpenetriol-3,7-dimethyl-1-octane-3,6,7-triol	-	Seed oil	[18]
12	1-Methoxy-1,6,3-anthraquinone	0.0083	Seed	[26]
Other Aliphatic Compounds				
1	<i>cis</i> -9-Hexa-decenoic	15.40	Seed oil	[33]
2	<i>cis</i> -10-Octadecenoic acid	25.50	Part not specified	[34]
		-	Seed oil	[35]
3	<i>cis</i> -9,12-Octadecadienoic acid	18.76	Part not specified	[34]
4	<i>cis</i> -9,12,15-Octadecatrienoic acid	12.65	Part not specified	[34]
5	2,6-Dimethyl-1,3,5,7-octatetraene	1.50	Leaf oil	[10]
6	6-Hydroxynonadec-(4 <i>Z</i>)-enoic acid	-	Seed	[8]
7	8-Hydroxypentadec-(4 <i>Z</i>)-enoic acid	-	Seed	[8]
8	7-Hydroxy-7-vinylhexadec-(4 <i>Z</i>)-enoic acid	-	Seed	[8]
9	Hexadec-(4 <i>Z</i>)-enoic acid	-	Seed	[8]
10	6-Methylheptanoic	-	Seed	[14]
11	8-Methylnonanoic acid	-	Seed	[14]
12	Oleic acid	trace	Seed	[9]
13	Palmitic acid	10.5	Part not specified	[34]
		0.90	Seed	[9]
14	Palmitolic acid	31.47	Part not specified	[34]
15	Methyl palmitate	trace	Seed	[9]

Ayurvedic properties and action

Tumburu (Nepali Dhaniya) seeds are bitter and pungent in taste and dry, sharp and light in action. Its taste after digestion is pungent. It aggravates pitta and alleviates aggravated Vata / Vayu and Kapha. It cures krimi (parasitic infection), low appetite and durgandhya (foul smell coming out of the body). It mainly acts on excretory, circulatory, digestive and respiratory system.

Rasa (Taste on tongue): Katu (Pungent), Tikta (Bitter)

Guna (Pharmacological Action): Laghu (Light), Tikshna (Sharp), Ruksha (Dry)

Virya (Action): Ushna (Heating)

Vipaka (transformed state after digestion): Katu (Pungent)

Action Dipan (promote appetite but do not aid in digesting undigested food)

Krimighna (destroys worms)

Kapha-Vata har (Remover of the Humor of Kapha-Vata)

Pachan (assist in digesting undigested food, but do not increase the appetite)

Ruchikarak (improve taste).

Important medicinal properties

Tumburu is rich in medicinal properties. The understanding of these properties will help us to better utilize this herb. Below is given medicinal properties along with the meaning. Tumburu is a medicinal tree. Its leaves, roots, and seeds are

used for medicinal purpose. In Ayurveda, the seeds are used in treatment of digestive impairment, piles, heart diseases, hiccups, cough, throat disorders, asthma, and dental diseases. Stem bark is used in cough, asthma, difficult breathing, and rheumatism.

1. Astringent, Antibacterial and Antiseptic
2. Antiplaque: Acting to prevent or remove plaque
3. Carminative: Preventing the formation or causing the expulsion of flatulence.
4. Diaphoretic: promote sweating.
5. Hypoglycemic: Reducing level of the sugar glucose in the blood.
6. Stomachic: stimulates gastric activity.
7. Tonic: Restore or improve health or well-being.
8. Vermifuge: destroys or expels parasitic worms (anthelmintic).

Other medicinal uses of tumburu / toothache tree

1. Asthma, difficult breathing

Chewing few seeds of tree are useful.

2. Arthritis, joint swelling, pain in joints

Prepare a decoction, by boiling 5 grams of fresh leaves or 10 grams of dried leaves in one glass water till water reduces to one fourth. Filter this and drink once-twice a day.

3. Boils: The fine paste of roots is applied externally.

4. Cough

Prepare decoction of seeds and drink once-twice a day.

5. Cholera (Vishuchika in Ayurveda)

The decoction of bark is used traditionally to treat cholera.

6. Ear ache

Tumburu + Sonth + Hing are cooked in mustard oil to prepare medicated oil. This is used as an ear drop.

7. Gum bleeding

Bark powder mixed with honey, massaged on gums give relief in gum bleeding.

8. Mouth-freshener

The fruits of plant are chewed.

9. Skin diseases, Eczema, vitiation of blood

Prepare a decoction, by boiling 5 grams of fresh leaves or 10 grams of dried leaves in one glass water till water reduces to one fourth. Filter this and drink once-twice a day.

10. Swelling

The poultice of warm leaves is applied topically.

11. Stomatitis

Prepare decoction and use as gargle.

12. Roundworms

The decoction of seeds or intake of seeds in any form helps to expel roundworms.

13. Toothache

Crush the seeds and put under aching tree.

The bark of tree is chewed to get relief from tooth ache.

14. Tooth powder

Mix powder of (in equal amount) Tumburu seeds + Amal + Haritaki + Vibhitaki + Haldi + Sendha Namak to make a Tooth powder.

15. Teeth cleaning

Use twig of tree as Datun.

16. Ulcers, drying up and healing old wounds

The powdered bark is applied topically.

- It is hot in potency.
- Hot potency medicines should not be used in pregnancy.
- Fruits of plant are emmenagogues (emmenagoges) and stimulate blood flow in the pelvic area and uterus. It can stimulate menstruation.
- It is rough, hot and irritant.
- It may cause burning sensation in abdomen.
- It increases sweating.

Ethno-medicinal uses: *Z. armatum* is used as medicinal plants as well as fuel wood species. The edible part of *Zanthoxylum armatum* plant is fruit and seeds. The plant extract is used to cure Pneumonia and tick infestation [36]. Young shoots are used as toothbrush and for curing gum diseases. Fruit is used for toothache, dyspepsia, as a carminative and stomach ache. Seeds are used as flavouring agent. Wood is used to make walking sticks [37]. To cure chest infection and digestive problems the powdered fruit is mixed with table salt and *Mentha* species. The fruits and seeds are used as an aromatic tonic for fever and dyspepsia. Fruit is used for toothache, dyspepsia, as a carminative and stomach-ache. Seeds are used for condiment and flavouring agent. The

fruit is used for expelling roundworm from the stomach. The fruits are also used to treat dental problems, and their lotion is used against scabies. Dried fruits are used as an essential oil and also have antiseptic, antifungal and antibacterial preparations. The bark is pungent and used to clean teeth. Timur is used in the production of several health-care products due to its aromatic nature [38].

Pharmacological activities of *Zanthoxylum armatum*

The bark, fruits and seeds are extensively used in indigenous system of medicine as a carminative, stomachic and anthelmintic. The stem has exhibited hypoglycaemic activity in the preliminary trials. The bark is pungent and used to clean teeth. The fruits and seeds are employed as an aromatic tonic in fever and dyspepsia. An extract of the fruits is reported to be effective in excreting roundworms from the stomach of children. The fruits are used in dental troubles, and their lotion for scabies due to its deodorant, disinfectant and antiseptic properties. The essential oil is also having antiseptic, disinfectant and deodorant properties

1. Larvicidal activities: The essential oil from the seeds of *Zanthoxylum armatum* DC (Rutaceae) used against three mosquito species viz; *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus*. Study of essential oil yielded at least 28 compounds, consisting mainly of oxygenated monoterpenes and monoterpenes. The larvae of three mosquito species were susceptible to the essential oil composition [39].
2. Antioxidant Activities: Ethanolic extract of stem bark of *Zanthoxylum armatum* shows antioxidant activities. In vivo, anti oxidant activity was judged in Wistar species of rats by using Carrageenan induced paw edema, where as in vitro activity was performed by DPPH free radical method. The plant extract exhibited significant antioxidant activities [40].
3. Hepatoprotective: Study of the ethanolic extract of leaves of *Z. armatum* on CCl₄-induced hepatotoxicity in rats showed significant decrease in liver enzymes and liver inflammation, supported by histopatho studies on the liver. Results exhibited significant hepatoprotective activity [41].
4. Insecticidal: The essential oil of *Zanthoxylum armatum* showed large and rapid poison activity against *Aedes albopictus* and *Culex quinquefasciatus*, showing a potential as natural insecticides against mosquitoes [42].
5. Spasmolytic: Crude extract of *Zanthoxylum armatum* caused concentration-dependent relaxation of spontaneous and high K⁺ induced contractions in isolated rabbit jejunum. Results indicated *Zanthoxylum armatum* shows spasmolytic effects, mediated possibly through Ca⁺⁺ antagonistic mechanism, which provides pharmacologic base for its medicinal use in the gastrointestinal, respiratory, and cardiovascular disorders.
6. Anti-inflammatory: The coumarin (Bergapten) extract of *Zanthoxylum* shows significant inhibition of the production of two pro-inflammatory cytokines tumour necrotic factor- α (TNF- α) and interleukin-6 (IL 6). Other two linalool and linalyl acetate are also shown some inflammatory activity [43].
7. Anti-bacterial activities: Antibacterial activities of the plant were carried out by agar well diffusion method. Bacterial strains were first cultured on nutrient broth and incubated for 24 hours prior to experiments. Nutrient agar was melted, cooled to 40°C and poured into sterilized petridishes. Wells were then bored in media using 6mm

diameter with the help of sterile metal cork borer and keeping a distance of 24 mm between two adjacent wells. 4-8 hour old bacterial culture was spread on the surface of nutrient agar with the help of sterilized cotton swab. These processes were repeated thrice turning the plate 60° between each streaking. About 100 µl of 3 mg/ml of respective extract, dissolved in DMSO was then added to the wells. Other wells were supplemented with DMSO and 10 µg Imipenem served as positive and negative controls. The plates were then incubated for 24 hours at 37 °C. The plates were then observed for zones of inhibition. All the experiments were conducted in three replicates.

Cytotoxicity: The cytotoxic activity of essential oil from the leaves of *Zanthoxylum armatum* was tested using brine shrimp assay following recommended method. About 20 mg of each extract was dissolved in 2 ml of respective solvent and from this solution transfer 5, 50 and 500 µl to vials (3 vials /concentration). This concentration was equivalent to 10, 100 and 1000 µg/ml, respectively. The solvent were allowed to evaporate overnight. 5 ml with seawater solution (38 g/L) were added to each vial. After 36 h of hatching and maturation of larvae as nauplii, 10 larvae were transferred to each vial using a Pasteur pipette. The vials were then placed at room temperature (25-27°C) under illumination. Other vials were supplemented with brine solution served as positive controls.

Phytotoxicity

The phytotoxic activity of essential oil of the leaves of *Zanthoxylum armatum* were evaluated using *Lamna minor* as test species following recommended procedure. 15 mg of respective extract was dissolved in 15 ml of respective solvent and from this solution transfer 5, 50 and 500 µl to the flask (3 flasks for each concentration). This concentration was made equivalent to 10, 100 and 1000 µg/ml respectively. The solvent was kept to evaporate overnight under sterilized condition in laminar flow. 20 ml of E. medium was added to each flask. Other flasks (3 for each) were supplemented with E. medium and standard drug (Atrazine) served as negative and positive control. To each flask ten plants with 2-3 fronds were transferred and kept all the flasks under about 12 h day light conditions. Plants were observed daily and on each seventh day the numbers of fronds were counted [44].

Biological activity of the isolated compounds from *Zanthoxylum armatum*:

Various biological activities have been reported in *Zanthoxylum armatum* and some major ones are discussed below.

1. Mosquito repellent- The mosquito repellent property of its oil extracted from seeds is used to kill mosquitoes [45]. The two mustard and coconut oils were compared with synthetic repellent (DMP). It indicated that at 0.57 mg/cm² concentration the oil gave higher protection in both oils than DMP. But when we compare both mustard and coconut oil the significant protection was found in the mustard oil than coconut oil.
2. Piscicidal: The Piscicidal activity was found in the ethyl alcohol extract of fruits. It was experimented on the activity of Mg⁺ and Na⁺, K⁺-ATPase enzymes in various tissues of carnivorous air-breathing catfish and *Hetropneustes fossilis* [46].

3. Leech Repellent: Essential oil of *Z. armatum* possesses leech repellent activity. Experiments on persistence of repellents properties of N, N diethyl phenyl acetamide (DEPA) N, N diethyl phenyl m-toluamide (DEET), 3-acety 2 (2,6-dimethyl-5-heptenyl) oxazolidine (citronyl), Dimethyl phthalate (DMP) and N-benzoyl piperidine (NBP) on cloth were tested against land leeches in evergreen rain and deciduous forests of Assam [47]. Results obtained were compared with volatile oil of it to evaluate its efficacy as leech repellent.
4. Inhibits skin sensitivity: A lipophilic extract of fruits were reducing mouth irritation due to food [48]. Dilution of this extract with oleyl alcohol gives ingredients of cosmetic which is easy to formulate and is endowed with a remarkable soothing effect based on inhibition of sensory irritation from sun bathing, shaving, depilation, insect bites, chemical treatments and other causes.



Fig 1: Whole tree of *Zanthoxylum armatum*



Fig 2: Leaves arrangement in *Zanthoxylum armatum*

Conclusion

It is concluded that medicinal plants are the centre of the drug discovery and providing traditional and western medicines by using ingredients. The above review provides the update information regarding the *Zanthoxylum armatum*. Essential oils of *Z. armatum* exhibited good antibacterial, antifungal and anthelmintics activities. All are the essential oil of the seeds of *Zanthoxylum armatum* has Antimicrobial potential and drugs used for the treatment of microbial diseases. Essential oils of *Z. armatum* exhibited good antibacterial, antifungal and anthelmintics activities. Every part of this plant has a significant medicinal use.

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