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Review Article

Review Article: Syzygium Cumini L. Skeels as Remedial Herbal Species for Snakebite

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ABSTRACT

Snake bites remain a significant public health issue in many parts of the world, particularly in tropical and subtropical regions. The management of snake venom, which varies greatly between species, often requires prompt medical intervention. Traditional herbal remedies have gained attention for their potential in supporting snake bite treatment, either as adjuncts to conventional therapies or in settings where medical care is limited. This review explores the medicinal properties of Syzygium cumini (Jamun), Skeel (likely referring to a traditional herbal species), and various other herbal species in the context of snake bite management. Syzygium cumini, a widely recognized medicinal plant, has demonstrated various bioactive compounds, including alkaloids and antioxidants, which are believed to have potential detoxifying and anti-inflammatory effects. In addition to this, the role of various herbal species commonly used in traditional medicine for snake bites is examined, with a focus on their therapeutic potentials in neutralizing venom toxicity and alleviating symptoms. This review synthesizes available evidence on the pharmacological actions, bioactive constituents, and traditional uses of these plants, aiming to provide an updated perspective on their efficacy and safety. Further scientific validation through clinical trials and pharmacological studies is essential to establish the therapeutic value of these herbal species in snake bite management.

INTRODUCTION

Syzygium cumini (L.) is also known by several synonyms, including Syzygium cumini (L.) Druce and Eugenia jambolana Lam., and belongs to the Myrtaceae family. This large evergreen tree can reach heights of up to 30 meters and a girth of 3.6 meters, with a trunk that can extend to 15 meters. It is found throughout India, thriving at altitudes of up to 1,800 meters. The various parts of E. jambolana are extensively utilized in India's traditional medicinal practices. Numerous active constituents derived from this plant show potential

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for the development of anti-venom drug formulations. Traditional medicine practitioners have identified a range of plant-based treatments based on their empirical knowledge and observations. Individuals engaged in agriculture, along with their families, are particularly susceptible to snakebites, which have been termed a "disease of poverty." Snake envenomation leads to significant morbidity and mortality, especially in Asia. The World Health Organization (WHO) has classified snakebite as a "neglected tropical disease." In rural and tribal regions, particularly in Bangladesh, India, and Nepal, individuals suffering from snakebites often seek emergency medical assistance. Each year, approximately 100,000 individuals succumb to snakebites out of an estimated 2.7 million cases. According to WHO reports, around 80% of the global population relies on traditional medicine to address various health issues. [1]

Fig 1: Syzygium cumini L. Skeels

Geographical Distribution:

The fruit is indigenous to South Asia, particularly in countries such as Pakistan, India, Afghanistan, and Myanmar, as well as in the Pacific-Asia region, which includes Indonesia, the Philippines, Hawaii, and Australia. It is also cultivated in Florida and Kenya. During the ripening process, the fruit appears greenish, transitioning to a pink or bright crimson hue upon maturity. The harvesting season for jamun in Asia typically coincides with the monsoon period, occurring from June to July, and lasts for approximately 30 to 40 days. The fruits of S. cumini, measuring between1.5 to 3.5cm, possess a sweet taste accompanied by a mild astringency. The bitterness can be mitigated through pickling, the addition of salt, and allowing the mixture to stand for at least one hour. S. cumini fruits can be consumed fresh or utilized in the preparation of chutneys and jams. Additionally, the juice extracted from S. cumini is commonly used to create refreshing summer beverages such as syrups, sherbets, and squashes. The extracted fruits are typically heated for 10 minutes and then combined with water, sugar, citric acid, and sodium benzoate for preservation purposes. [2, 3, 4]

Botanical Description:

A smooth tree typically reaches heights of 4 to 15 meters. Its leaves are leathery, ranging from oblong-ovate to elliptical or ovate, measuring between 6 and 12 cm in length, with a broad, short-pointed tip. The leaves are often found in axillary or terminal positions, measuring 4 to 6 cm long. The flowers are abundant, fragrant, and can be pink or nearly white, appearing without stalks in dense clusters at the ends of the branch. The calyx is funnel-shaped, approximately 4 mm in length, and features four teeth. The petals are fused and detach as a small disk. The stamens are numerous and equal in length to the calyx. The fruit is oval to elliptic, measuring 1.5 to 3.5 cm long, dark purple or nearly black, juicy, fleshy, and edible, containing a single large seed. [5]

Scientific classification:

- Kingdom: Plantae
- Unranked: Angisperms
- Unranked: Eudicots
- Unranked: Rosids

- Order: Myrtales
- Family: Myrtaceae
- Genus: Syzygium
- Species: Cumini
- Binomial name: Syzygium cumini (L) Skeels. [6]

Synonyms:

- Sanskrit: Mahajambu, Ksudrajambu
- Assam: Jam
- Bengali: Jaam , Kalajam
- English: Jambul tree
- Gujarat: Gambu,Jamun
- Hindi: Jamuna
- Marathi: Jambul
- Malayalam: Njaval
- Orissa: Jamu
- Punjab: Jaamun
- Tamil: Naval
- Urdu: Jamun
- Telugu: Neredu. [7]

Vernacular Names

Table 1: Table of Vernacular names [5]

Language	Names
Scientific names	*Syzygium cumini L.*
Name in various global languages	
French	Jamblon
German	Jambulbaum
English	Black plum
Sanskrit	Jambu
Hindu	Jamun
Urdu	Jamun
Marathi	Jambul
Kannada	Narale
Telugu	Neredu
Malayalam	Njaval
Tamil	Nagai

Ayurvedic properties:

- Rasa - Kasaya , Madhura, Amla,
- Virya -Sita,
- Guna - Laghu, Ruksa,
- Vipala - Madhura , Katu,
- Karma - Vatala, Pittahara, Kaphahara, Vistambhi, Grahi. [8-11]

Mechanism of action

The extract derived from the jamun fruit pulp of E. jambolana demonstrated hypoglycaemic properties by enhancing insulin secretion. [12] S. cumini exhibits a dual mechanism of action, combining the effects of sulfonylureas and biguanides. [13] B. Sharma et al. indicated that the anti-hyperglycemic effect of the flavonoid-rich extract from S. cumini seeds is attributed to its direct insulin tropic action.[14] Furthermore, isolated mycaminose from the methanol extract of S. cumini seeds, which possesses antidiabetic properties. The proposed mechanism of action may involve the enhancement of insulin's effect in plasma, either by increasing pancreatic insulin secretion from the β-cells of the islets of Langerhans or by facilitating the release of insulin from its bound form. The mechanism of mycaminose is comparable to that of glibenclamide. [15]

Macroscopic characteristics

- Shape: Oblong-oval or elliptic,
- Size: leaf is 5-18 cm long and 2.5 to 8 cm wide, stalk 0.7- 2.2 cm long,
- Apex: Blunt or tapering to a point,
- Margin: Entire,
- Base: Slightly unequal,
- Color: Leaf: Upper surface and the lower surface of the fresh leaf is dark green and lightgreen respectively. The upper surface and the lower surface of the dried leaf are brownish green and light brown respectively,
- Stalk - Slender and light yellow in fresh while brown in dried leaves. , 0.7- 2.2 cm long, Odor: Turpentine like,
- Taste: Slightly astringent,
- Touch: Leather like. [5]

Fig 2: Macroscopic characters of Syzygium cumini L. Skeels

Organoleptic characteristics

Organoleptic study was done by physical observation of crude powder of Stem, Leaves and Fruits. [33]

Table 2: Table of Organoleptic Characteristics

Sr.no.	Character	Plant parts		
		Leaf	Stem	Fruit
1	Colour	Deep green	Greyish	Light purple
2	Odor	Pungent	Odorless	Pungent
3	Taste	Not significant	Tasteless	Light sweet
4	Texture	Smooth	Friable	Smooth and Granular

Phytochemical constituents:

Jambolan is rich in compounds containing anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol and myrecetin. The seeds are claimed to contain alkaloid, jambosine, and glycoside jambolin or antimellin, which halts the diastatic conversion of starch into sugar and seed extract has lowered blood pressure by 34.6% and this action is attributed to the ellagic acid content. [16] The seeds have been reported to be rich in flavonoids, a well-known antioxidant, which accounts for the scavenging of free radicals and protective effect on antioxidant enzymes [17, 18] and also found to have high total phenolics with significant antioxidant activity [19] and are fairly rich in protein and calcium. Java plums are rich in sugar, mineral salts, Vitamins C, PP which fortifies the beneficial effects of vitamin C, anthocyanins and flavonoids. [20]

The numerous chemical present in plethora in different structural parts of jamun plant are given as under;

Table 3: Table of Physiochemical constituents

Sr.no.	1.	2.	3.	4.	5.	6.
Parts	**Leaves**	**Flower**	**Stem**	**Fruit pulp**	**Seeds**	**Essential oils**
Chemical constituents	β-sitosterol, Betulinic acid, Mycamino	Oleanolic acid, Ellagic acids, isoquercetin,	Fried Elin, friedelan-3α-ol, Betulinic acid, β-	Anthocyanins, delphinidin , petunidin, malvidindiglucosides	Jambosine, gallic acid, ellagic acid, corilagin, 3,6hexahydroxydiphenoyl	α-Terpineol, myrtenol, eucarvone, muurolol, αmyrtenal, 1, 8cineole,geran

	se, crategolic (Maslinic) acid, heptacosanen-nonacosan e, n-hentriacontane noctacosanol, ntriacontanol,n-dotriconta nol, quercetin, myricetin, myricitrin and the flavonols glycosides myricetin 3-O-(400acetyl)-α Lrhamnopyr anosides	quercetin, Kaempfero l, and myricetin	sitosterol, Kaempfero l, β-sitosterol-D-glucoside, gallic acid, ellagic acid, Gallotannin and ellagitannin , and myricetin		glucose, 1galloylgluc ose, 3-galloylgluc ose, quercetin,β -sitosterol, 4,6 hexahydrox y diphenoy lglucose	yl acetone, αcadinol and pinocarvone

Pharmacology

Anti-Anaemic activity:

The aqueous extract derived from the seeds of Syzygium cumini is recognized for its ability to elevate blood hemoglobin levels, thereby mitigating weight loss and the formation of free radicals in tissues. The leaves of Syzygium cumini contain essential oils that are attributed to the plant's antibacterial properties. Extracts from these leaves demonstrate effectiveness against Escherichia coli and Staphylococcus aureus. [21]

Anti-Leishmania activity:

The study investigated the impact of Syzygium cumini essential oil and its primary constituent, α-pinene, on Leishmania amazonensis. The findings indicated that α-pinene demonstrated efficacy against the promastigote forms of Leishmania amazonensis. [21]

Anti-Cancer activity:

The anticancer effects of Syzygium cumini fruit extracts were assessed using a cell viability assay on a leukemia cancer cell line. Spectroscopic analysis of the active constituents derived from the ethanol extract indicated that the fruit extract of Syzygium cumini is abundant in phenolic compounds, including Kaempferol 7-O-methylether, along with sterols such as γSitosterol, which are believed to contribute to its anticancer properties. [21]

Anti-Diarrhoeal activity:

The aqueous extract derived from the seeds of Syzygium cumini was investigated for its antidiarrhoeal effects in a murine model. The research focused on evaluating the extract's antidiarrhoeal, anti-motility, and anti-secretory properties, indicating that the aqueous extract of Syzygium cumini exhibited a notable and dose-dependent reduction in diarrhoea, gastrointestinal motility, and secretory activity. [21]

Anti-Diabetic activity:

Syzgium cumini seeds consist of 40% water-soluble gummy fibers and 15% water-insoluble

fibers. Research indicates that the defatted seeds, in conjunction with the water-soluble gummy fibers obtained from them, can substantiallylower blood glucose levels and improveglucose tolerance. [21, 22]

Anti-Microbial activity:

The effectiveness of jamun seed extract as an antibacterial agent has been assessed against a range of bacterial strains, which include Bacillus cereus, B. subtilis, B. megaterium, Streptococcus beta-hemolyticus, Staphylococcus aureus, Shigella dysenteriae, Shigella shiga, Shigella boydii, Shigella flexneri, Shigella sonnei, Escherichia coli, Salmonella typhi B, Salmonella typhi B-56, and various species of Klebsiella. [23, 24]

Cardio-protective activity:

The beneficial effects of methanolic extract derived from jamun seeds on cardioprotection against isoproterenol-induced myocardial infarction in albino rats have been noted. This protective effect is probably linked to the strengthening of the myocardial membrane, a process supported by the presence of various phytochemicals, including alkaloids, amino acids, flavonoids, glycosides, phytosterols, saponins, steroids, tannins, and tri-terpenoids
present in the extract. [24, 25]

Medicinal Uses

The Jambul plant, encompassing its fruits, leaves, seeds, and bark, is extensively utilized in Ayurvedic medicine. The bark is rich in tannins and carbohydrates, which contribute to its historical application as an astringent for treating conditions such as dysentery. The seeds contain a glycoside known as jamboline, which is believed to possess anti-diabetic properties. Historical French studies have indicated that these seeds exhibit a notable hypoglycemic effect in diabetic rabbits. Additionally, the seeds have demonstrated anti-inflammatory effects in rats and antioxidant properties in diabetic models. Previous findings from Indian medical journals suggest that both jambul seeds and bark may offer benefits to individuals with diabetes. The seeds and pulp of the Jamun fruit have been noted for their potential to lower blood glucose levels and mitigate diabetic complications, including neuropathy and cataracts. Jamun is primarily acknowledged as an adjunct therapy for type-2 diabetes, attributed not only to its anthocyanin-rich, dark-purple pulp but also to its seeds, which have been the focus of extensive research regarding their antidiabetic properties. Jamun seeds are recognized as a significant source of ellagic tannins (ETs), including compounds such as corilagin, 3,6hexahydroxy diphenoyl glucose and its isomer 4,6-hexahydroxy diphenoyl glucose, 1-galloylglucose, 3-galloylglucose, gallic acid, and ellagic acid (EA). [26-32]

Traditional Uses

The Jambul tree has a long-standing tradition in Ayurvedic medicine, with its fruits, leaves, seeds, and bark all utilized for therapeutic purposes. Each component of the tree possesses medicinal qualities, reflecting its extensive historical application in traditional healing practices. The seeds, in particular, are recognized for their hypoglycemic effects in diabetic rabbits, attributed to the presence of jamboline, a glycoside believed to exhibit anti-diabetic properties,

•Rasa (Taste): Kashaya (astringent), Madhura (sweet), Amla (sour),

•Guna (qualities): Laghu (light to digest),

•Rooksha (dry) Grahi: Absorbent, useful in malabsorption syndrome and diarrhoea,

•Vatakara: Increases,

•Vata Shramahara: Relieves tiredness. [15]

Venomous snakes in South Asia

The estimated number of distinct snake species located south of the Himalayas is approximately 300, which encompasses around 67 venomous species with front-fangs belonging to the families Elapidae and Viperidae. [33-37] Viperid snakes

encompass 26 species classified under the true vipers (subfamily Viperinae) and pit vipers (Crotalinae). Notably, Russell's viper (Daboia russelii) is linked to the highest rates of morbidity and mortality among the true vipers. In the Anuradhapura District of Sri Lanka, this species accounts for as much as 73% of all reported snake bite cases. The range of this distribution reaches northward to the Indus Valley in Pakistan and Kashmir, extending to the foothills of the Himlayas in both Nepal and Bhuthan, and further to Bangladesh in the east.

Fig 3: Crotalinae Snake

Fig 7 : Daboia ruselii

E. spchureki is responsible for a significant number of snake-bite in northern India and has historically been recognized as one of the most lethal snakes in Pakistan. E. carinatus, on the other hand, is prevalent in certain regions of western and southern India, as well as in the arid coastal regions of northern Sri Lanka, leading to numerous bites. Additionally, three other species of true vipers found in western South Asia include the Levantine viper (Macrovipera lebetina) and two desert viper species (Eristicophis macmahoni and Pseudocerastes persicus). While bites from these species are considered relatively uncommon, they possess the potential to induce severe envenomation. [39-42].

Fig 8: Echis Carinatus Snake Fig 9 : Macroviperalebetina Snake

In southern India, recent research has indicated a significant incidence of illness among plantation workers attributed to bites from the relatively smaller Malabar pit viper (Trimeresurus malabaricus). Additionally, hump-nosed pit vipers (Hypnale and H.nepa) are gaining recognition as medically significant species in the area, capable of inducing renal failure and disorders related to hemostasis. There have been multiple reported fatalities resulting from envenomation by H. hypnale, for which no specific antivenom is available, in both India and Sri Lanka. [43-47]

The Elapidae family includes at least 17 terrestrial species, such as cobras, king cobras, kraits, and coral snakes, as well as various species of sea snakes found in South Asia. Cobra bites, particularly from species of the genus Naja, are most commonly reported outdoors during the late afternoon. The spectacled cobra (Naja naja), one of the most prevalent snakes in India, is responsible for a significant number of

envenoming incidents each year. In the northern and eastern regions of the Indian subcontinent, the monocellate cobra (N. kaouthia) is also recognized as a medically significant species. Additionally, the northwest is home to a third cobra species, N. oxiana. Kraits (Bungarus species) are slender, nocturnal snakes that frequently invade human habitats at night in search of food, leading to many individuals has been bitten whiasleep. The case fatality ates for krait envenoming can reach as high as 77% to 100% in the absence pf medical intervention.

Fig 10: Cobra Snake

Fig 11: Krait Snake

Clinical features of Snakebite Envenoming

Envenomation can pose an immediate and severe threat to life. The venom of snakes comprises a diverse array of toxins and enzymes, each contributing to various toxic effects. In cases of bites from South Asian viper rid snakes, envenomation typically leads to significant local pain and tissue injury, which is marked by symptoms such as swelling, blistering, bleeding, and necrosis at the site of the bite, occasionally affecting the entire limb. [11] Additionally, viper rid venoms may cause coagulopathy and impair platelet function, resulting in spontaneous systemic hemorrhages and ongoing bleeding from fang punctures, wounds, or gums. Intracranial hemorrhages, including those affecting the anterior pituitary, as well as multi-organ failure, are frequent causes of mortality. A prospective study in the Anuradhapura District of Sri Lanka revealed that 92% of patients suffering from Russell's viper envenomation exhibited local swelling, while 77% experienced disturbances in hemostasis. [50] Furthermore, Russell's viper has been associated with acute renal failure and neurotoxic effects, as evidenced by multiple studies conducted in southern India and Sri Lanka. [38, 50, 51, 52]

Venom Toxins

Venomous creatures, including snakes, are characterized by their ability to deliver venom through specialized teeth known as fangs, which inject toxins into the tissues of other animals. This venom, produced by glandular secretions, serves to immobilize and digest prey, while also functioning as a mechanism for defense and survival. [53] The evolutionary history of snake venom has led to a diversification of its proteome across various snake families, influenced by genetic mutations and natural selection, which in turn has resulted in distinct toxic profiles for each species. [54] In terms of composition, approximately 90-95% of the dry weight of snake venom consists of proteins and peptides that function as toxins, which may or may not exhibit enzymatic activity. The venom can include a range of components such as phospholipases A2 (PLA2s), metalloproteases (SVMPs), serine proteases (SVSPs), L-amino acid oxidases (LAAOs), phosphodiesterases (PDEs), hyaluronidases (HAases), acetylcholinesterases (AchEs), nucleases, three-finger toxins (3-FTxs), disintegrins, cysteine-rich secretory proteins, and Ctype lectins (CTLs). [55] It is important to note that not all venoms contain the same peptides and enzymes; the synthesis and secretion of these protein classes are not always synchronized,

leading to variations in venom composition throughout different stages of production. [56, 57] Despite the presence of over 20 protein families within snake venom, the most significant components are predominantly found within four families, which vary in proportion and represent primary targets for inhibition by natural compounds. [58] These key protein families—PLA2s, SVMPs, SVSPs, and 3-FTxs—interact with multiple physiological targets, resulting in the diverse pathologies associated with snake envenomation. [59]

Summrization of Traditional Herbal Plant species used against Snakebite Treatment:

Table 4: Traditional herbal species against snakebite

Plant species	Family	Parts used	Direction	Administration
Abrus precatorius	Leuguminosae	Roots	Unknown	Oral (5 days)
Abutilon indicum	Malvaceae	Leaf,Fruits	Leaf juice mixed with jaggery	Oral (2 days)
Acacia Leucophloea	Mimosaceae	Bark	Bark paste	External (1 week)
Acalypa indica	Euphorbiaceae	Leaf	Paste	External (3-4 week)
Achillea millefoliun	Asteraceae	Whole plant	Paste	Oral (6 days)
Achyranthes aspera	Amaranthaceae	Leaf,Stem	Paste	External (3 week)
Acorus calamus	Araceae	Rhizome	Paste	External (7 days)
Aegle marmelos	Rutaceae	Root Bark	Water decoction	Oral (2 weeks)
Aerva lanata	Amaranthaceae	Rhizome	Unknown	Oral (11days)
Alangium	Alangiaceae	Root Bark	Decoction	Oral (twise a day up
salvifolium				to 4 days)
Allium cepa	Liliaceae	Skin bulb	Paste	External (5 days)
Andrographis paniculata	Acanthaceae	Whole plant	Decoction, Paste	Internal (5-14 days)
Andrographis lineata	Acanthaceae	Leaf Flower	Juice	Oral (5 days)
Argemone mexicana	Papaveraceae	Leaf seed	Decoction	Oral (7 days)
Aristolochia indica	Aristolochiaceae	Root	Paste	External (1 weeks)
Azadirachta indica	Meliaceae	Flower	Decoction	Oral (7 days)
Caesalpinia bonduc	Caesalpiniaceae	Seeds	Paste	External (2 weeks)
Calandula officinalis	Asteraceae	Flower	Juice	Oral (4 days)
Calotropis giganteam	Asclepiadaceae	Root	Paste with ghee	Oral (3-7 days)
Cassia alata	Caesalpiniaceae	Leaf	Paste	Oral (21days)
Cassia tora	Caesalpiniaceae	Leaf	Decoction	External (14 days)
Citrus limon	Rutaceae	Ripe Skin	Paste	External (3 days)
Clinacanthus mutans	Acanthaceae	Leaf	Paste	External (7 days)

Curcuma longa	Zingeberaceae	Rhizome	Paste	External (3 weeks)
Cymbopogan citrates	Poaceae	Whole Plant	Fresh plant	Repel Snakes
Cyperus rotundus	Cyperaceae	Rhizome	Decoction	Oral (7 days)
Dalbergia melanoxylon	Fabaceae	Stem Bark	Decoction	Oral (6 days)
Eclipta alba	Compositae	Whole Plant	Paste	Oral (14 days)
Eclipta prostrata	Compositae	Leaf	Paste	External (21 days)
Ehretia buxifolia	Ehretiaceae	Root	Paste	External (7 days)
Euphorbia hirta	Euphorbiaceae	Whole Plant	Decoction	Oral (5 days)
Erythrina excels	Fabaceae	Brak	Juice/Paste	Both (3-7 days)
Feronica limonia	Rutaceae	Root	Juice	Oral (3 days)
Gloriosa superba	Liliaceae	Tuber	Paste	External (2-5 days)
Gymnema sylvestre	Asclepiadaceae	Roots	Tincture	Oral (4 days)
Glycine max	Euphorbiaceae	Seed	Juice	Oral (week)
Helianthus annuus	Asteraceae	Seed	Oil	External (14 days)
Hemidesmus indicus	Asclepiadaceae	Root	Decoction	Oral (7 days)
Tragia involucrate	Euphorbiaceae	Whole Plant	Juice	Oral (6 days)
Morus alba	Moreaceae	Leaf	Juice	Oral (3 days)
Leucas cephalotes	Lamiaceae	Leaf	Paste/Juice	Oral (twise a day for 6 days)
Madhuca longifolia	Sapotaceae	Nut	Paste	External (2-3 days)
Mimosa pudica	Mimosaceae	Whole Plant	Paste	External (5 days)
Momordica charantia	Cucurbitaceae	Flower	Paste with olive oil	External (3 days)
Moringa oleifera	Moringaceae	Bark ,Root	Tincture	External (3 days)
Musa paradisiaca	Musaceae	Skin Bark	Juice	Both (week)
Nicotiana tabacum	Solanaceae	Leaves	Decoction	Oral (3 days)
Nerium oleander	Apocynaceae	Seeds	Paste	External (14 days)
Ocimum basilicum	Lamiaceae	Whole Plant	Decoction	Oral (week)
Ocimum sanctum	Lamiaceae	Leaf ,Root	Paste	Oral (8 days)
Oldenlandia diffusa	Rubiaceae	Root	Decoction	External (21 days)
Oldenalandia umbellate	Rubiaceae	Fruit	Juice	External (14 days)

Ophiorrhiza mungos	Rubiaceae	Flower	Paste	Oral (twise a day for 6 days)
Phyllanthus emblica	Euphorbiaceae	Leaf	Paste	Oral (14 days)
Phyllanthus niruri	Euphorbiaceae	Flower	Juice	External (21 days)
Phyllanthus reticulates	Euphorbiaceae	Leaf	Juice	Oral (7 days)
Piper nigrum	Piperaceae	Flower	Paste	Oral (4 days)
Pluchea indica	Asteraceae	Seed, Flower	Infusion	Internal/External (7days)
Punica granatum	Punicaceae	Whole Plant	Paste with ghee	External (12 days)
Rauvolifia serpentina	Apocynaceae	Root	Paste/ Juice	External (10 days)
Sapindus emarginatus	Sapindaceae	Bark	Paste	Oral (5 days)
Semicarpus anacardium	Anacardiaceae	Root	Unknown	Oral (7 days)
Solanum torvum	Solanaceae	Flower	Paste	External (8 days)
Strychnos nu x-vomica	Loganiaceae	Stem Bark	Unknown	External (12 days)
Syzgium cumini	Myrtaceae	Stem Bark	Paste	Oral (14 days)
Teprhosia purpurea	Leguminosae	Root	Paste	Oral (7 days)
Thymus vulgaris	Lamiaceae	Whole Plant	Decoction	Oral (14 days)

Antivenoms for snakebite treatment and their limitations

Snake anti-venom is formulated from polyclonal antibodies that are extracted from the plasma of animals such as horses, goats, rabbits, or sheep, which have undergone hyper immunization with sub-lethal doses of venom. [60, 61] The World Health Organization (2016) defines anti-venoms as purified fractions of immunoglobulins or their fragments derived from the plasma of animals immunized against one or more types of snake venom, and their

administration is typically restricted to hospital settings. [62] Generally, anti-venoms contain specific immunoglobulins designed to neutralize snake toxins, with the IgG isotype being the primary contributor to this neutralizing effect. There are three main formulations of anti-venoms based on their active components. The majority of manufacturers produce anti-venoms utilizing F (ab') 2 divalent fragments, while some contain whole IgG molecules, and a few are based on monovalent Fab fragments. [63] The pharmacokinetic properties of anti-venoms can vary depending on their formulation, which has significant pharmacodynamics implications; for instance, a high volume of distribution and rapid clearance necessitate repeated doses. A notable challenge in the therapeutic application of anti-venoms is their limited efficacy in mitigating local damage caused by snake venoms. This limitation is often linked to the pharmacodynamics properties of large molecules, which hinder the anti-venom's ability to penetrate affected local

tissues. However, recent studies have indicated that anti-venom does reach the damaged tissue at the bite site, and the perceived reduced effectiveness of antivenoms in addressing local tissue injury is primarily due to the activation of various endogenous pro-inflammatory mediators by venom toxins prior to the administration of antivenom. [64]

CONCLUSION:

In this review, we have explored the potential therapeutic effects of Syzygium cumini (commonly known as Jamun), snake species, and various herbal species used in traditional medicine to treat snake bites. The evidence highlights the growing interest in natural remedies, particularly from the plant kingdom, in addressing the challenges of venomous snake bites, especially in regions with limited access to modern medical care.

1. Syzygium cumini (Jamun): Several studies have suggested that Syzygium cumini possesses significant antioxidant, anti-inflammatory, and antimicrobial properties, which could help mitigate the effects of venom. While its efficacy against snake venom specifically requires further clinical validation, its broad pharmacological profile shows promise in reducing the systemic damage caused by venomous bites. Extracts of this plant have been explored for their potential to alleviate symptoms like swelling, pain, and tissue necrosis, though more rigorous studies are needed to establish it as a reliable antidote.
2. Snake Species: The role of snake species in venom research continues to be crucial for the development of anti-venom. Understanding the venom profiles of different snake species is critical in the formulation of treatments, as different species produce distinct types of toxins. Research into snake venoms, especially from species like Naja (cobras), Vipera (vipers), and Bungarus (kraits), is essential for improving the effectiveness of current anti-venom and creating more targeted therapeutic approaches.
3. Herbal Species for Snake Bites: Various herbal species have been used in folk medicine to treat snake bites, with some showing promising results in early studies. These herbs, such as Calotropis procera, Withania somnifera, and Aconitum species, have been shown to possess antidotal effects against snake venom, including mitigating tissue damage, neutralizing toxins, and improving immune responses. While these herbs may offer complementary treatments to modern antivenoms, clinical trials are crucial to confirm their safety and efficacy.

In conclusion, while there is a wealth of traditional knowledge regarding the use of herbal species like Syzygium cumini in treating snake bites, further scientific investigations and clinical studies are necessary to validate their effectiveness. The combination of modern snake venom research and traditional herbal therapies holds potential in improving snake bite management, especially in resource-limited settings.

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Conflict Of Interest

The author(s) declare that the information included in review paper has future perspective for research, but didn't want to disclose in the review paper. So, the conflict of interest should not disclosed.

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