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Original Article

Natural Antidotes Against Snake Venom: A Review Of Medicinal Plant-Based Approaches

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ABSTRACT

Snake envenomation remains a major public health concern, particularly in developing countries such as India, where thousands of deaths and disabilities occur annually. For many decades, antivenom serum has been the primary and most effective specific treatment for snakebite poisoning. Despite its clinical importance, antivenom therapy has certain limitations, including inadequate protection against venom-induced tissue damage, hemorrhage, kidney injury, and local necrosis. In addition, some patients may experience allergic or hypersensitivity reactions following antivenom administration. India possesses a long history of traditional medicine, with numerous medicinal plants being used by local communities and traditional healers for the management of snakebites. Ethnobotanical records describe a wide range of plant species believed to possess antivenom properties. Although many of these plants are traditionally valued, only a limited number have undergone scientific evaluation, and even fewer have had their bioactive constituents isolated and characterized. Recent pharmacological investigations have demonstrated that several medicinal plants exhibit the ability to neutralize different toxic effects of snake venoms. This review highlights medicinal plants with experimentally validated anti-snake venom activity and discusses their relevance in relation to traditional ethnopharmacological knowledge. Plant-derived therapies may offer a promising complementary or alternative approach to conventional antivenom treatment and warrant further scientific exploration.

Keywords: Snake Bite; Anti-snake venom; Medicinal plants; Poisoning; Venomous.

INTRODUCTION

Snake envenomation remains a major public health concern, particularly in developing countries such as India, where thousands of deaths and disabilities occur annually. [1]For many decades, antivenom serum has been the primary and most effective specific treatment for snakebite poisoning. [2]Despite its clinical importance, antivenom therapy has certain limitations, including inadequate protection against venom-induced tissue damage, hemorrhage, kidney injury, and local necrosis. In addition, some patients may experience allergic or hypersensitivity reactions following antivenom administration.[3]

India possesses a long history of traditional medicine, with numerous medicinal plants being used by local communities and traditional healers for the management of snakebites. Ethnobotanical records describe a wide range of plant species believed to possess antivenom properties. Although many of these plants are traditionally valued, only a limited number have undergone scientific evaluation, and even fewer have had their bioactive constituents isolated and characterized.[4]

Recent pharmacological investigations have demonstrated that several medicinal plants exhibit the ability to neutralize different toxic effects of snake venoms.[5]This review highlights medicinal plants with experimentally validated anti-snake venom activity and discusses their relevance in relation to traditional ethnopharmacological knowledge.[6] Plant-derived Snake Venom Components and Herbal Approaches to Snakebite Management

Snake venom is a complex mixture of biologically active proteins and enzymes that contribute to various toxic effects in the victim. Major venom constituents include phospholipase A_2 (PLA_2), metalloproteinases,

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myotoxins, neurotoxins, cardiotoxins, cytotoxins, coagulant factors, and several proteolytic enzymes.[7-8] These components act on different physiological systems, leading to local tissue destruction, disturbances in blood coagulation, neuromuscular dysfunction, and systemic toxicity.

In many rural regions of India and other developing countries, medicinal plants continue to play an important role in the management of snakebite.[9] Traditional healers employ various plant species either individually or in polyherbal formulations to counteract venom-induced effects. Numerous plants have been reported in ethnomedicinal literature as possessing antivenom properties. Therefore, investigation of plant-based remedies has gained considerable attention as a potential complementary approach to conventional antivenom therapy. This review highlights ethnopharmacological evidence and experimental studies related to the use of medicinal plants against snake envenomation.[10]

TYPES OF VENOMOUS SNAKES

The clinical condition resulting from venom injection following a snakebite is known as ophitoxaemia. Globally, approximately 2,500–3,000 snake species have been identified, of which nearly 500 are considered venomous. Classification of snakes is based on several anatomical and biological characteristics, including scale arrangement, dentition, skeletal structure, sensory organs, and other morphological features.[11]

The principal families of venomous snakes include Atractaspididae, Elapidae, Hydrophidae, and Viperidae. In the Indian subcontinent, medically important venomous snakes mainly belong to the families Elapidae, Viperidae, and Hydrophidae. The Elapidae family includes cobras and kraits, whereas the Viperidae family comprises Russell's viper, pit vipers, and saw-scaled vipers. Sea snakes belong to the Hydrophidae family.[12]

Among the venomous snake species found in India, a significant proportion of snakebite-related morbidity and mortality is associated with five medically important species: Ophiophagus hannah (King Cobra), Naja naja (Indian Cobra), Daboia russelii (Russell's Viper), Bungarus caeruleus (Common Krait), and Echis carinatus (Saw-scaled Viper). [13-14]These species are responsible for the majority of serious envenomation cases reported across the country. Therapies may offer a promising complementary or alternative approach to conventional antivenom treatment and warrant further scientific exploration.

CLINICAL MANIFESTATIONS OF SNAKE ENVENOMATION

Snakebite envenomation can result in a wide range of local and systemic complications depending on the species involved and the composition of the venom. Local effects commonly include pain, swelling, blister formation, hemorrhage, edema, and tissue necrosis. Certain viper venoms contain metalloproteinases and procoagulant enzymes that promote bleeding disorders and extensive tissue damage.[13-14]

Envenomation by cobra species may lead to severe local necrosis, hemorrhage, respiratory paralysis, and complement system depletion. These effects are largely attributed to venom components such as phospholipase A_2 and cardiotoxins.[15] Ocular complications, including corneal ulceration and anterior uveitis, have also been reported in some cases.

Venoms of the genus Bothrops are known to induce marked local tissue injury characterized by edema, hemorrhage, proteolysis, and myonecrosis. Muscle destruction is one of the most serious consequences of envenomation and may result in permanent disability or, in severe cases, limb amputation.[16] Myonecrosis may occur directly through the action of myotoxic PLA_2 molecules on muscle cell membranes or indirectly due to ischemia caused by vascular damage induced by hemorrhagic metalloproteinases.[17]

TRADITIONALLY USED PLANTS FOR SNAKEBITE MANAGEMENT

While some of the therapeutic herbs work by stimulating the immune system, the majority of them lessen the symptoms of envenomation. [18]Abutilon indicum leaf paste, Acorus calamus root paste, Adhota vesica bark decoction, Amaranthus viridis root paste, Citrus limon paste, Curcuma longa paste, Dalbergia melanoxylon decoction, Eucalyptus globules juice, Helianthus annuus oil, Mimosa pudica

rice water paste, Nerium oleander paste, Nicotiana tobaccum decoction, Piper nigrum paste with ghee, Rauvolfia serpentina paste, Solanum torvum paste, Thymus vulgaris juice, Wedelia calendulae juice, Woodfordia fruticosa paste, Asteraceae, Apocynaceae, Araceae, Fabaceae, Euphorbiaceae, Lamiaceae, Malvaceae, Rubiaceae, and Zingeberaceae were the most notable botanical families with notable anti-ophidic properties, according to a study by that elaborated the cross-cultural comparison of medicinal floras for snake venom.[19]

Chewing leaves or bark, swallowing or injecting plant extracts, and applying a topical therapy to affected areas are just a few of the ways that many plant species have historically been used to detoxify snake venoms. [20]Traditional healers now solely employ pure plant medicines to cure snake envenomation. Particularly, krait and snake bites are treated using extracts from the roots of Abrus precatorius and Azadirachta indica, respectively. The rhizomes of certain curcuma species work well against Thai cobras' neurotoxic effects. Extracts from the stem and bark of Brownea rosademonte and Tabebuia rosea show antihemorrhagic qualities against Bothrops atrox venom.[21]

IDENTIFICATION OF TOXINS AND VENOMS

To select the best course of treatment, it is crucial to identify the venom involved in envenomation as soon as possible. It is challenging and perhaps impracticable to rule out the snake species responsible for envenomation since numerous snake bites have similar clinical signs. Bioassays, immune diffusion, immune electrophoresis, immunofluorescence, hemagglutination, radioimmunoassay (RIA) and enzyme-linked immunosorbent assay (ELISA) are few analytical methods that are used to detect venom involved in the poisoning.[22] Affinity chromatography and hybridoma technologies have also been employed for diagnostic reasons. Polymerase chain reaction (PCR), surface plasmon resonance (SPR), optical immunoassay (OIA), and venom/antibody micro-array assay have all recently been used for venom detection .

Plant species	Family	Plant used	Direction	Administration
Alangium salvifolium	Alangiaceae	Root bark	Decoction	Oral(twice a day up to 4 days)
Cassia alata	Caesalpiniaceae	Leaf	Paste	Oral (21 days)
Euphorbia hirta	Euphorbiaceae	Whole plant	Decoction	Oral (5 days)
Gymnema sylvestre	Asclepiadaceae	Root	Tincture	Oral (4 days)
Nerium oleander	Apocynaceae	Seeds	Paste	External (14 days)
Rauvolfia serpentina	Apocynaceae	Root	Unknown	External (10 days)
Sapindus emarginatus	Sapindaceae	Bark	Paste	Oral (5 days)
Solanum torvum	Solanaceae	Flower	Paste	External (8 days)
Piper nigrum	Piperaceae	Flower	Paste with ghee	Oral (4 days)
Punica granatum	Punicaceae	Whole plant	Paste	External (12 days)
Momordica charantia	Cucurbitaceae	Flower	Paste with olive oil	External (3 days)
Glycine max	Leguminosae	Seeds	Juice	Oral (Week)

Dalbergia melanoxylon	Fabaceae	Stem bark	Decoction	Oral (6 days)
Eclipta prostrata	Compositae	Leaf	Paste	External (21 days)
Feronica limonia	Rutaceae	Root	Juice	Oral (3 days)
Hemidesmus indicus	Asclepiadaceae	Root	Decoction	Oral (7 days)
Tragia involucrate	Euphorbiaceae	Whole plant	Juice	Oral (6 days)
Aristolochia indica	Aristolochiaceae	Root	Paste	External (1 Week)
Achyranthes aspera	Amaranthaceae	Leaf, Stem	Paste	External (3 Weeks)

Table 1. Traditional plants used against snakebite (India)

LIMITATIONS OF CONVENTIONAL ANTIVENOM THERAPY

Antivenom remains the only specific and widely accepted treatment for snakebite envenomation. It is generally produced by immunizing horses or sheep with snake venom and subsequently purifying the resulting antibodies. Although antivenom is highly effective in neutralizing circulating venom and reducing systemic toxicity, its use is associated with several limitations.[23]

Adverse reactions such as anaphylaxis, pyrogenic responses, and serum sickness may occur following antivenom administration. These reactions are often attributed to residual non-immunoglobulin proteins and other impurities present in antivenom preparations. Furthermore, clinical evidence suggests that antivenom is less effective in reversing local tissue damage once it has been established. Local manifestations such as intense pain, swelling, hemorrhage, and tissue necrosis frequently progress despite treatment and may lead to permanent scarring, functional impairment, or deformity.[24-25]

Consequently, there is growing interest in identifying alternative or adjunctive therapies, particularly plant-derived compounds, that may help reduce local tissue damage and improve outcomes in snakebite victims.[26]

CONCLUSION

The shortcomings of the biological health system, as well as the affordability and cultural acceptability of natural medicine, have all contributed to its use. The majority of snake envenomation cases in India occur in rural regions, and medicinal herbs are frequently utilized to treat snakebite.The established treatment in these areas is the use of herbal treatments by ethnic groups to prevent envenomation without administering antivenom.

Plant extracts have multiple biochemical and pharmacological properties and are a very rich source of pharmacologically active chemicals. When these substances interact with toxins or enzymes, their actions are neutralized or inhibited. Therefore, plant treatments might be helpful in treating snakebite and could serve as a substitute for antivenom serum.

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