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The Emerging Role of Snake Venom: A Review

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Abstract : The poisonous qualities of snake venom, a complex mixture of bioactive chemicals, have long been known. The potential of venom as a rich source of medicinal compounds has been revealed by recent developments in the field. Demonstrating the growing significance of substances derived from snake venom in the creation of innovative therapies for a range of illnesses, such as cancer, heart problems, and neurological disorders. the variety of venom-derived compounds' structures and functions, their modes of action, and the stage at which their clinical translation is currently at. Additionally, the difficulties and possibilities involved in creating venom-based treatments, such as the requirement for uniform procedures for venom collection, purification, and characterization. Finally, a thorough analysis of the medicinal benefits of snake venom and its bright future in the medical world.

Keywords -Venom, Venom peptides, Pharmacological tools, Drug discovery, Therapeutics, Insecticides**.**

INTRODUCTION

Snake venom, a complex concoction of biologically active molecules, has captivated human interest for millennia, not only for its lethal potential but also for its surprising therapeutic properties. One of the key enzymes causing snake venom toxicity is snake venom metalloproteinase (SVMP), which is present in the majority of viperid venoms[13]. This intricate mixture, primarily composed of proteins, peptides, and enzymes, has been a source of both fear and fascination, leading to its exploration in traditional medicine across diverse cultures. This duality—the power to harm and the potential to heal—forms the crux of ongoing research into the medical applications of snake venom. The venoms of poisonous snakes are the most sophisticated and intricate of all natural venoms, and they are well known for being abundant sources of poisons among other venomous species[39]. Nucleosides, metallic cations, carbohydrates, and very little amounts of free amino acids and lipids with reduced biological activity are additional substances found in snake venom. Although sodium is the most prevalent cation in snake venom, its function remains unclear. Calcium is necessary for phospholipase activity, whereas zinc is necessary for anticholinesterase (acetylcholinesterase inhibitor) activation[40,41]. We will then delve into the scientific underpinnings of these traditional uses, dissecting the complex composition of snake venom and identifying the specific components responsible for its therapeutic effects. This includes examining the diverse array of toxins, such as neurotoxins , hemotoxins, and cytotoxins, and how they interact with physiological systems. Venom poisoning is typically associated with a small number of venomous poisons[38]. Actively target and destroy cancer cells. The composition of snake venom varies throughout species, subspecies, and even within a single snake individual [42]. Numerous characteristics, such as phylogeny [43], geographic distribution [44], age [45], sex [46], and food [47], are linked to variations in snake venom.

While the potential benefits of snake venom in medicine are significant, challenges remain. Finally, offer a perspective on the future directions of this exciting field, highlighting the ongoing research efforts and the potential for further breakthroughs in the therapeutic use of snake venom. From pain management to cancer treatment, snake venom has shown promise in various medical applications. This review aims to provide a comprehensive overview of the current research, highlighting both the potential benefits and the challenges associated with the use of snake venom in medicine.

History of Snake Venom Use in Medicine:_ The use of snake venom in medicine dates back thousands of years, with ancient civilizations such as the Egyptians, Greeks, and Chinese utilizing venom to treat a range of ailments. In traditional medicine, snake venom was often used to treat pain, inflammation, and cardiovascular disease, among other conditions. However, it was not until the 20th century that modern medicine began to appreciate the full potential of snake venom as a source of novel therapeutics. Venom was first used in medicine in ancient Greece around 380 B.C.Aristotle's "*Historia Animalium*" explains how venom can be utilized to create venom antidotes[25].

Bioactive Compounds in Snake Venom:_ Snake venom is a complex mixture of bioactive compounds, including peptides, proteins, enzymes, and small molecules. These compounds have evolved to target specific biological pathways, making them ideal for therapeutic applications. Some of the most promising bioactive compounds in snake venom include.The proteins are Phospholipases A_2 (PLA_2): phospholipid-degrading enzymes[1]. Enzymes called hyaluronidases degrade hyaluronic acid. Enzymes that catalyze the oxidation of L-amino acids are known as L-amino acid oxidases (LAAO)An enzyme found in LAAO, a flavin adenine dinucleotide, transforms l-amino acid stereospecifically into the matching α-keto acid, producing ammonia and hydrogen peroxide as byproducts[12]. The enzymes known as acetylcholinesterase (AChE) degrade acetylcholine. Enzymes that eliminate phosphate groups are known as alkaline phosphatases.

Snake Venom Based Therapeutics :

Snake venom exhibits antineoplastic action

In order to promote the activation of programmed cell death pathways in cancer cells, snake venom toxins, a peptide isolated from the venom of Viper alebetina turanica, SVT, negatively regulated the expression of the antiapoptotic gene BCL-2 and increased the expression of proapoptotic genes like Bax, Caspase 3, Caspase 9, and p53.Additionally, SVT inhibited cell development by causing cell cycle arrest in PC-3 cells during the G0–G1 and G2–M phases[3].Hirudin (5 UIml) totally reduced PC-3 tumor cell-induced platelet aggregation (TCIPA), but increasing apyrase concentrations decreased the effect.The disintegrinobtustatin, which was extracted from the venom of *Viperalebetinaobtusa*, lacks a typical RGD sequence. Obtustatin demonstrated 84% suppression of angiogenesis activities in the chick Chorioallantoic Membrane (CAM) assay and decreased tumor size in the Lewis lung syngeneic mouse model[14,15]. Snake venom disintegrins are a library of compounds with varying structures, potencies, and specificities that make them suitable starting points for creating antiangiogenesis therapies. One of the most extensively researched cancer treatment approaches is the inhibition of angiogenesis[48-50]. The venom of Bothrops jararaca (BjV) increases polymorphonuclear leukocytes in the early phases of tumor formation and has an antitumoral effect on Ehrlich ascites tumor (EAT) cells[51].

Snake Venom's Anti-Arthritic Properties :

Ayurveda employed cobra venom to cure arthritis, inflammation, and joint discomfort [17].Ayurvedic medicine's *Visachikitsha* branch focuses on using venoms to treat illnesses using a method called Numerous chronic illnesses could be cured with ikavoron (venom at the point of a needle) and shodhono (venom detoxification)[17].Cobra venom was utilized in Ayurveda to cure arthritis, inflammation, and joint pain. The Visachikitsha branch of Ayurveda focuses on using venoms to treat illnesses using a method called *suchikavoron*[16].

Snake venom's antiplatelet action :

A number of enzymatic proteins, including PLA_2 and proteinases, prevent blood coagulation.PLA_2 enzymes are esterolytic enzymes that hydrolyze glycerophospholipids at the glycerol backbone's sn−2 position, producing fatty acids and lyso-phospholipids in the process. PLA_2 enzymes are abundant in snake venom. The PLA_2 enzymes found in several hundred snake venoms have been identified and refined. More than 280 PLA_2 enzymes' amino acid sequences have been identified[19,20].Certain PLA_2 enzymes found in snake venom prevent blood coagulation[21-24].The anticoagulant characteristics of certain PLA_2 enzymes were categorized as strongly, mildly, and non-anticoagulant. At quantities less than 2 µg/ml, PLA_2 enzymes, which are strongly anticoagulant, prevent blood coagulation. The effects of weakly anticoagulant PLA_2 enzymes range from 3 to 10 µg/ml. Even at 15 µg/ml, some venom PLA_2 enzymes do not considerably lengthen clotting times. As a result, the anticoagulant properties of various PLA_2 enzymes varied greatly[21,22]. Russell's viper (*Daboia russelli*) and Eastern Russell's viper (*Daboia siamensis*) snake venom is the source of RVV-X, a metalloprotease that is the most powerful and extensively researched FX activator[26,27].

Snake venom's fibrinogenolytic and fibrinolytic activities :

Enzymes found in snake venom eliminate fibrinogen from the bloodstream without turning it into fibrin. Venoms having anticoagulant properties are being explored for possible medical applications. Aggrastat (tirobifan), an antiplatelet medication (glycoprotein IIb/IIIa inhibitors), was created from a substance found in the venom of the saw-scaled viper (*Echiscarinatus*)[28].

Antihypertensive activity of snake venom:

The structure of a bradykinin-potentiating peptide that was extracted from the venom of the Brazilian pit viper, *Bothrops jararaca*, served as the basis for the development of captopril, the first angiotensin-converting enzyme inhibitor authorized for human use[29]. Bradykinin alters the intracellular Ca^{2+} concentration, interacts with G-protein coupled B2 receptors, and works via PLC, PLA2, prostaglandins, and protein kinases [34]. Bradykinin receptor B2 stimulation results in the production of prostacyclin and NO, both of which encourage vasodilation [35]. BPPs have been demonstrated to have ACE-independent mechanisms for causing hypotension, including AsS activation, gamma-aminobutyric acid (GABA), and glutamate release in the central nervous system (CNS), in addition to the ACE and BK pathways [37,36]

Table 1.1: Table showing Snake venom proteins and peptides expressing hypotensive effects through various mechanisms of action.

Protein	*Source*	The Hypotensive Effect Mechanism
Bj-PRO-5a	*Bothrops jararaca*	Increases urinary flow rate and sodium excretion. Vasodilation is achieved through the inhibition of the angiotensin-converting enzyme (ACE), along with the activation of bradykinin B_2 and muscarinic M_1 receptors. Lowers cardiac output by inducing bradycardia[30,31].
Bj-PRO-7a	*Bothrops jararaca*	Acts as an M_1 muscarinic receptor agonist, thus mobilizes intracellular Ca^{2+} in various cell types and induces vasodilation through vascular endothelial cells[32].

Conclusion:

Snake venom is proven to be a useful source for creating novel medical treatments since it contains a wide range of bioactive chemicals. According to research, compounds obtained from venom may be used to treat a variety of illnesses, such as cancer, heart problems, and neurological disorders. The many substances included in snake venom serve a variety of purposes, including lowering inflammation in arthritis, preventing cancer, and influencing blood coagulation through fibrino genolytic and fibrinolytic effects. Venom's potential to treat heart issues is further enhanced by its ability to reduce blood pressure and its antiplatelet properties, which may help avoid blood clots. Venom-based therapeutics have a lot of potential, despite several obstacles, such as the requirement for standardized procedures for its collection, purification, and analysis. Snake venom may play a significant role in the creation of novel therapies as research progresses, changing the way we treat a number of severe medical illnesses.

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