http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 16 (5): 201-207, 2013
ISSN 1028-8880 / DOI: 10.3923/pjbs.2013.201.207

Scorpion Anti-Venom Activity of Botanicals: A Pharmacological Approach

[1]Abhijit Dey, [2]Amrita Dey and [3]Jitendra Nath De
[1]Department of Botany, Presidency University (Formerly Presidency College),
86/1, College Street, Kolkata-700073, West Bengal, India
[2]Department of Museology, University of Calcutta, India
[3]Department of Botany, Charuchandra College, 22, Lake Road,
Kolkata-700029. West Bengal, India

Abstract: Scorpion bite is considered as one of the common and dangerous phenomenon throughout the world. The clinical manifestations include pulmonary edema, myocardial damage, intracerebral haemorrhage, brachial plexopathy, renal failure etc. which sometimes leads to mortality. The common antivenin therapy includes anti-scorpion venom serum or prazosin. In the vast rural areas of the third world countries phytotherapy is considered as an alternative system of medicine and scorpion sting is treated with the help of medicinal botanicals. As the safety and efficacy are considered as important aspects of anti venin therapy, conventional treatment can be supported by the herbal remedy. The present review compiles a number of medicinal plants pharmacologically evaluated *in vitro* and/or *in vivo* for scorpion antivenin properties. Considering the aspects like cost effectiveness, availability, lesser side effects and development of drug resistance, plant based anti venin therapy may be considered as a possible remedy against scorpion envenomation.

Key words: Scorpion sting, anti-scorpion venom serum, envenomation, antivenin, myocarditis

INTRODUCTION

Scorpions are widely distributed throughout the world (Uawonggul *et al*., 2005). Around 700 people/year die in Mexico due to scorpion bite (Calderon-Aranda *et al*., 1993). Scorpion antivenin serotherapy, considered as the most popular treatment in scorpion sting, has been questioned for effectiveness in clinical trials, especially in cases of severe envenomations (Abroug *et al*., 1999; Belghith *et al*., 1999). Although human death due to scorpion sting is not a very common phenomenon, severe pain and inflammatory reactions are common associated symptoms (Uawonggul *et al*., 2005). Traditional use of medicinal plants are popular in the treatment of various diseases such as gastrointestinal disorders (Dey and De, 2012a), snakebite (Dey and De, 2011a, 2012b), ailments of mother and child (Dey and De, 2011b) and livestock (Dey and De, 2010) etc. Medicinal plants are reported for antibacterial (Dey *et al*., 2011, Mukherjee *et al*., 2012), antifungal (Dey and De, 2011c), anti mycobacterial (Dey and De, 2012c), cytotoxic (Dey and De, 2012d), antioxidative (Dey and De, 2012e), antiohidian (Dey and De, 2012f) properties.

Plants are used against scorpion sting in the traditional medicinal systems throughout the world (Hutt and Houghton, 1998). Reports on traditional phytotherapy against scorpion envenomation are available from the countries like India, Mexico, Trinidad, Thailand (Brahmane *et al*., 2011; Izquierdo *et al*., 2010; Uawonggul *et al*., 2005; Lans *et al*., 2001) and many others. Earlier, Hutt and Houghton (1998) have provided a list of ethnobotanicals used against scorpion bite. In the present review, the authors present a pioneer effort to document the pharmacological investigations of medicinal plants used for the purpose.

Scorpion sting is known to cause a number of physiological disturbances and clinical manifestations such as pulmonary edema (Goncalves *et al*., 2012), myocardial damage (Maheshwari and Tanwar, 2012), intracerebral haemorrhage (Dube *et al*., 2011), brachial plexopathy (Rubin and Vavra, 2011), renal failure (Malhotra *et al*., 1978; Naqvi *et al*., 1998) etc. Prolific release of neurotransmitters especially acetylcholine and catecholamines is associated with scorpion envenomation (Ismail, 1995; Natu *et al*., 2010). Children are also severely affected by scorpion venom (Bahloul *et al*., 2010).

Corresponding Author: Jitendra Nath De, Flat No. C-103, Sunrise Estate, 14C Radhanath Chaudhuri Road, Kolkata-700015 India Tel: +9191630291726

Acidosis, tachypnea and myocarditis are the symptoms associated with children affected by scorpion bite (Prasad *et al*., 2011). Experimental envenomation in dogs and rabbits was also found to induce acute myocarditis in the animals (Murthy and Zare, 1998). Although, it was found that the certain scorpion venom toxicity depends on the age and mammalian species (Tiwari and Deshpande, 1993), acute myocarditis, caused by scorpion can be fatal in children as well as in adults (Kari and Zolfaghrian, 1986). Srinivasan *et al.* (2002) have prepared a molecular database named "SCORPION" involving scorpion toxins.

Scorpion envenomation is a common global phenomenon and regarding the effectiveness, the use of antivenin is some sort of controversial (Tuuri and Reynolds, 2011) requiring a protocol for standard antivenom treatment (Karnad, 2009). Anti-Scorpion Venom Serum (AScVS) or prazosin is commonly used in the treatment of scorpion venom toxicity associated clinical symtoms (Natu *et al*., 2010) and some have noted the efficacy of AscVS over other treatments (Deshpande, 2010). Several researches have been performed regarding the use, safety, utility and efficacy of AScVS or prazosin (Bawaskar and Bawaskar, 2007, 2011; Thirunavukkarasu and Chandrasekaran, 2011; Mills and Ford, 2011). Dobutamine has also been experimented as a possible antidote to scorpion sting (Gupta *et al*., 2010). Cost effectiveness of such anti venin therapy (Brown and Landon, 2010) has to be another primary concern especially for the developing and under developed countries. The venom protein was found to be neutralized *in vitro* by heat and chemical treatments such as hydrochloric acid and acetic acid which were also effective *in vivo*. The chemicals were found to decrease the total protein, free amino acids and protease activity of the venom and also reduced the mortality in experimental animals (Venkateswarlu *et al*., 1988). A sodium channel blocker was successfully used to neutralize the *Leiurus quinquestriatus* venom induced effects *in vitro* and *in vivo* (Fatani *et al*., 2000).

Keeping aside the dangerous and fatal aspects of the venom, it is found to be effective against cancer (Zhang *et al*., 2009) and HIV (Chen *et al*., 2012) and has shown antibacterial (Perumal Samy *et al*., 2007; Diaz *et al*., 2009), virucidal (Li *et al*., 2011), antiosteoporosis (Haldar *et al*., 2010), antiproliferative and apoptogenic (Gupta *et al*., 2007) properties. Therapeutic ability of animal venoms is considered as one of the prime aspects of research and scorpion venom along with snake, bee and other insects may serve as potential candidates against different human ailments. The objective of the study is to document the pharmacologically active botanicals against scorpion venom *in vitro* and/or *in vivo*.

Enumeration: The present review compiles a total number of nine medicinal plants tested for scorpion antivenin ability. Most of the reports come from Mexico followed by Egypt, Thailand, Jordon, India, Saudi Arabia and USA. Considering the traditional aspects of such therapy, most of the investigated plants were actually reported from the ethnic use as antivenin. Various scorpions have been used as source of the venom such as *Mesobuthus tumulus*, *Heterometrus laoticus*, *Centruroides limpidus limpidus* and *Leiurus quinquestriatus*. The plant names are mentioned along with the plant part(s), solvent system(s) used for extraction and isolated active principle(s) (if any). Studies were performed either *in vitro* or *in vivo* or both. For *in vitro* investigations isolated guinea-pig ileum, rabbit and guinea-pig jejunum and trachea or chick embryonic fibroblast cell have been used for the assay of antitoxin and anti fibroblast cell lytic activity of the venom respectively. For *in vivo* experimentation mice/rat model has been used. The following table (Table 1) alphabetically lists the botanicals pharmacologically tested for scorpion anti venin properties.

DISCUSSION

Andrographis paniculata has also been reported for snake venom neutralization capacity (Nazimuddin *et al*., 1978). Species of *Aristolochia* and *Vitex* are also reported for the same (Alam and Gomes, 2003; Dey and De, 2012g). Pharmacologically active cyclic hexapeptides bouvardin and deoxybouvardin were isolated from *Bouvardia ternifolia* (Jolad *et al*., 1977). *Aristolochia elegans*, on the other hand, is reported for antiprotozoal and anti mycobacterial activities due to the compounds fargesin and cubebin (Jimenez-Arellanes *et al*., 2012). *A. elegans* has been investigated extensively for phyto-constituents (Hussein and El-Sebakhy, 1974; Wu *et al*., 2000, 2002; Shi *et al*., 2004) many of which may contribute to its antivenin ability. Monodesmosidic saponins acutangulosides A-F and other related compounds were isolated from *Barringtonia acutangula* (Barua *et al*., 1961; Pal *et al*., 1994; Mills *et al*., 2005). Akbar (2011) has reviewed *Andrographis paniculata* for an array of biomolecules present in the plant with diverse phannacological efficacy. Aristolochic acid (8-methoxy-6-nitrophenanthro [3,4-d] [1,3] dioxole-5-carboxylic acid)

Table 1: A list of plants investigated pharmacologically as scorpion antivenin

Species name	Plant parts used/ solvent/compound	Scorpion used	Proposed mechanism of action/comment	*In vitro* studies	*In vivo* studies	Traditional relevance/ country of research	References
Ambrosia maritima	Plant/methanol	Leiurus quinquesteiartus	Hepatoprotective	No	Male albino rats	Egypt	Mansour *et al.* (2007a)
Ambrosia maritima	Plant/methanol	*Leiurus quinquesteiartus*	Renal tissue protective	No	Rats	Egypt	Mansour *et al.* (2007b)
Ambrosia maritima	Plant/methanol	*Leiurus quinquesteiartus*	no Skeletal muscles and intestinal tissue protective	No	Rats	Egypt	Mansour *et al.* (2011)
Andrographis paniculata	Plant/ethanol	*Mesobnthus tamulus*	Partial venom neutralization activity/no survival benefit	Yes	Mice	India	Brahmane *et al.* (2011)
Andrographis paniculata	Plant/water	*Heterometrus laoticus*	Anti fibroblast cell lytic activity/ anti venom activity with low cytotoxicity	Chick embryonic fibroblast cell	No	Thailand	Uawonggul *et al.* (2005)
Aristolochia elegans	Roots and aerial parts/ hexane and methanol	*Centruroides limpidus*	Antitoxin activity	Isolated guinea-pig ileum	No	Mexico	Izquierdo *et al.* (2010)
Aristolochia elegans	Roots/hexane and methanol	*Centruroides limpidus*	Significant *in vitro* antitoxin activity, lower *in vivo* protection	Guinea pig ileum	Mice	Mexico	Jimenez-Ferrer *et al.* (2005b)
Barringtonia acntangula	Plant/water	*Heterometrus laoticus*	Anti fibroblast cell lytic activity/anti venom activity with low cytotoxicity	Chick embryonic fibroblast cell	No	Thailand	Uawonggul *et al.* (2005)
Bouvardia ternifolia	Roots/hexane and methanol	*Centruroides limpidus*	Antagonistic to secretagogue e ffect of poison on pancreas	No	Mice	Mexico	Jimenez-Ferrer *et al.* (2005a)
Bouvardia ternifolia	Roots/hexane and methanol	*Centruroides limpidus*	Significant *in vitro* and *in vivo*	Guinea pig ileum antitoxin activity	Mice	Mexico	Jimenez-Ferrer *et al.* (2005b)
Eryngium creticum	Leaves and roots/ water and ethanol	*Leiurus quinquesteiartus*	Inhibitory effect to haemolytic activity of the venom/ethanol extract enhanced haemolysis	Sheep red blood cells	No	Jordan	Alkofahi *et al.* (1997)
Eryngium creticum	Roots/water	*Leiurus quinquestriatus*	Inhibitory effect on tracheal and jejunal contractions caused by the venom	Isolated rabbit and Guinea-pig jejunum and trachea	No	Jordan	Afifi *et al.* (1990)
Ginkgo biloba	Leaves	*Leiurus quinquestriatus*	Protease inhibitory and antioxi dative effect/plant extract in combination with aprotinin	No	Male wistar rats	Saudi Arabia	Fatani *et al.* (2006)
Vitex mollis	Leaves/hexane and methanol	*Centruroides limpidus*	Lower *in vitro* antitoxin, activity no *in vivo* protection	Guinea pig ileum	Mice	Mexico	Jimenez-Ferrer *et al.* (2005b)
Red grape	Seeds/proanthocyanidins	*Leiurus quinquestriatus*	Possibly by enhancing antioxidative system and cardioprotective effect by isolated proanthocyanidins	No	Mice	USA	El-Alfy *et al.* (2008)

isolated from species of *Aristolochia*, has also been reported for antiophidian properties (Girish and Kemparaju, 2005).

CONCLUSION

Several compounds present in the reported plants are known to possess protein binding and enzyme inhibitory principles which may be directly or indirectly related to the pharmacological activity of the crude extracts of the plants against scorpion venom. However, further research is needed to potentiate this speculation. Antiophidian claims of certain botanicals is encouraging since snake venom neutralizing ability of some plant extracts and isolated compounds can be correlated with their scorpion antivenin ability. Further investigation in this regard may lead to the discovery of certain common antidote which can be applied against snake, scorpion and other insect venoms effectively. Most of the experiments conducted in this area primarily concentrate on *in vitro* and *in vivo* assays. To elevate the potential of herbal remedy to the next level of drug discovery programs, extensive clinical trials are required considering the toxicological considerations of certain herbal preparations. Thus, the ethnic claims of anti venin therapy can be considered as the starting point of any potential drug discovery venture. In the present scenario of poverty and remoteness of medicine centers especially in the third world countries the safety, efficacy and cost effectiveness of the antivenins are of prime importance. Less development of side effects and occurrence of drug resistance are the other two aspects of phytotherapy, which are to be considered while developing plant based antivenin as an alternative and complementary therapy to the conventional antivenin treatment.

REFERENCES

Abroug, F., S. ElAtrous, S. Nouira, H. Haguiga, N. Touzi and S. Bouchoucha, 1999. Serotherapy in scorpion envenomation: A randomised controlled trial. Lancet, 354: 906-909.

Afifi, F.U., S. Al-Khalil, M. Aqel, M.H. Al-Muhteseb, M. Jaghabir, M. Saket and A. Muheid, 1990. Antagonistic effect of *Eryngium creticum* extract on scorpion venom in vitro. J. Ethnopharmacol., 29: 43-49.

Akbar, S., 2011. *Andrographis paniculata*: A review of pharmacological activities and clinical effects. Altern. Med. Rev., 16: 66-77.

Alam, M.I. and A. Gomes, 2003. Snake venom neutralization by Indian medicinal plants (*Vitex negundo* and *Emblica officinalis*) root extracts. J. Ethnopharmacol., 86: 75-80.

Alkofahi, A., A.J. Sallal, and A.M. Disi, 1997. Effect of Eryngium creticum on the haemolytic activities of snake and scorpion venoms. Phytother. Res., 11: 540-542.

Bahloul, M., I. Chabchoub, A. Chaari, K. Chtara and H. Kallel *et al*., 2010. Scorpion envenomation among children: Clinical manifestations and outcome (analysis of 685 cases). Am. J. Trop. Med. Hyg., 83: 1084-1092.

Barua, A.K., P.C. Maiti and S.K. Chakraborti, 1961. Triterpenoids XI. New triterpenoid sapogenins from the fruits of *Barringtonia acutangula*. J. Pharm. Sci., 50: 937-940.

Bawaskar, H.S. and P.H. Bawaskar, 2007. Utility of scorpion antivenin vs prazosin in the management of severe *Mesobuthus tumulus* (Indian red scorpion) envenoming at rural setting. J. Assoc. Physicians India, 55: 14-21.

Bawaskar, H.S. and P.H. Bawaskar, 2011. Efficacy and safety of scorpion antivenom plus prazosin compared with prazosin alone for venomous scorpion (*Mesobuthus tumulus*) sting: Randomised open label clinical trial. Br. Med. J., Vol. 342. 10.1136/bmj.c7136

Belghith, M., M. Boussarsar, H. Haguiga, L. Besbes and S. Elatrous *et al*., 1999. Efficacy of serotherapy in scorpion sting: a matched-pair study. J. Toxicol. Clin. Toxicol., 37: 51-57.

Brahmane, R.I., S.S. Pathak, V.V. Wanmali, K.J. Salwe, S.J. Premendran, and B.B. Shinde, 2011. Partial *in vitro* and *in vivo* red scorpion venom neutralization activity of *Andrographis paniculata*. Pharmacogn. Res., 3: 44-48.

Brown, N. and J. Landon, 2010. Antivenom: The most cost-effective treatment in the world? Toxicon, 55: 1405-1407.

Calderon-Aranda, E.S., D. Hozbor and L.D. Possani, 1993. Neutralizing capacity of murine sera induced by different antigens of scorpion venom. Toxicon, 31: 327-337.

Chen, Y., L. Cao, M. Zhong, Y. Zhang and C. Han *et al*., 2012. Anti-HIV-1 activity of a new scorpion venom peptide derivative Kn2-7. PLoS One, Vol. 7. 10.1371/journal.pone.0034947

Deshpande, S.B., 2010. Antiscorpion venom scores over other strategies in the treatment of scorpion envenomation. J. Postgrad. Med., 56: 253-254.

Dey, A. and J.N. De, 2010. Ethnoveterinary uses of medicinal plants by the aboriginals of purulia district, West Bengal, India. Int. J. Bot., 6: 433-440.

Dey, A. and J.N. De, 2011a. A survey of potential antiophidian botanicals from the Baruipur sub-division of the district South 24 Parganas, West Bengal, India. Int. J. Med. Arom. Plants, 1: 219-227.

Dey, A. and J.N. De, 2011b. Antifungal bryophytes: A possible role against human pathogens and in plant protection. Res. J. Bot., 6: 129-140.

Dey, A. and J.N. De, 2011c. Traditional use of medicinal plants in pediatric and maternal care practiced by the ethnic groups of Purulia district, West Bengal, India. Int. J. Med. Aromatic Plants, 1: 189-194.

Dey, A., T. Das and S. Mukherjee, 2011. In vitro Antibacterial activity of n-hexane fraction of methanolic extract of *Plumeria rubra* L. (Apocynaceae) Stem Bark. J. Plant Sci., 6: 135-142.

Dey, A. and J.N. De, 2012a. Antioxidative potential of Bryophytes: Stress tolerance and commercial perspectives: A review. Pharmacologia, 3: 151-159.

Dey, A. and J.N. De, 2012b. Anti snake venom botanicals used by the ethnic groups of Purulia District, West Bengal, India. J. Herbs, Spices Med. Plants, 18: 152-165.

Dey, A. and J.N. De, 2012c. Cytotoxic bryophytes: Present status and therapeutic potential: A review. Asian J. Trad. Med.,

Dey, A. and J.N. De, 2012d. Ethnomedicinal plants used by the tribals of Purulia district, West Bengal, India against gastrointestinal disorders. J. Ethnopharmacol., 143: 68-80.

Dey, A. and J.N. De, 2012e. Pharmacology and medicobotany of anti leprotic plants: A Review. Pharmacologia, 3: 291-298.

Dey, A. and J.N. De, 2012f. Phytoharmacology of antiophidian botanicals: A review. Int. J. Pharmacol., 8: 62-79.

Dey, A. and J.N. De, 2012g. Traditional use of plants against snakebite in Indian subcontinent: A Review of the recent literature. African J. Trad. Compl. Alternat. Med., 9: 153-174.

Diaz, P., G. D'Suze, V. Salazar, C. Sevcik, J.D. Shannon, N.E. Sherman and J.W. Fox, 2009. Antibacterial activity of six novel peptides from Tityus discrepans scorpion venom. A fluorescent probe study of microbial membrane Na+ permeability changes. Toxicon, 54: 802-817.

Dube, S., V.K.Sharma, T.N. Dubey, N.B. Gouda and V. Shrivastava, 2011. Fatal intracerebral haemorrhage following scorpion sting. J. Indian Med. Assoc., 109: 194-195.

El-Alfy, A.T., A.A.E. Ahmed, A.J. Fatani and F. Kader, 2008. Amelioration of the cardiovascular manifestations of the yellow scorpion *Leiurus quinquestriatus* envenomation in rats by red grape seeds proanthocyanidins. Toxicon, 51: 321-333.

Fatani, A.J., A.L. Harvey, B.L. Furman and E.G. Rowan, 2000. The effects of lignocaine on actions of the venom from the yellow scorpion? *Leiurus quinquestriatus*? *in vivo* and *in vitro*. Toxicon, 38: 1787-1801.

Fatani, A.J., H.A. Al-Zuhair, H.I. Yaquob, A.A. Abdel-Fattah, M.I. El-Sayed and F.A. El-Sayed, 2006. Protective effects of the antioxidant *Ginkgo biloba* extract and the protease inhibitor aprotinin against Leiurus quinquestriatus venom-induced tissue damage in rats. J. Venom. Anim. Toxins incl. Trop. Dis., 12: 255-275.

Girish, K.S. and K. Kemparaju, 2005. Inhibition of Naja naja venom Hyaluronidase by plant derived bioactive components and polysaccharides. Biochemistry, 70: 948-952.

Goncalves, E., B.T. Maia and H.M. Junior, 2012. Scorpion sting-induced unilateral pulmonary edema. Rev. Soc. Bras. Med. Trop., Vol. 45. 10.1590/S0037-86822012000300032

Gupta, B.D., M. Parakh and A. Purohit, 2010. Management of scorpion sting: Prazosin or dobutamine. J. Trop. Pediatr., 56: 115-118.

Gupta, S.D., A. Debnath, A. Saha, B. Giri and G. Tripathi *et al*., 2007. Indian black scorpion (*Heterometrus bengalensis* Koch) venom induced antiproliferative and apoptogenic activity against human leukemic cell lines U937 and K562. Leuk. Res., 31: 817-825.

Haldar, S., S. Das Gupta, A. Gomes, B. Giri and S.C. Dasgupta *et al*., 2010. A high molecular weight protein Bengalin from the Indian black scorpion (*Heterometrus bengalensis* C.L. Koch) venom having antiosteoporosis activity in female albino rats. Toxicon, 55: 455-461.

Hussein, F.T. and N.A. El-Sebakhy, 1974. A phytochemical investigation of the leaves of Aristolochia elegans. Planta Med., 25: 310-314.

Hutt, M.J. and P.J. Houghton, 1998. A survey from the literature of plants used to treat scorpion stings. J. Ethnopharmacol., 60: 97-110.

Ismail, M., 1995. The scorpion envenoming syndrome. Toxicon, 33: 825-858.

Izquierdo, A.M., E.V. Zapata, J.E. Jimenez-Ferrer, C.B. Munoz, A.J. Aparicio, K.B. Torres and L.O. Torres, 2010. Scorpion antivenom effect of micropropagated *Aristolochia elegans*. Pharm. Biol., 48: 891-896.

Jimenez-Arellanes, A., R. Leon-Diaz, M. Meckes, A. Tapia, G.M. Molina-Salinas, J. Luna-Herrera and L. Yepez-Mulia, 2012. Antiprotozoal and antimycobacterial activities of pure compounds from *Aristolochia elegans* rhizomes. Evid. Based Complement. Alternat. Med., 10.1155/2012/593403

Jimenez-Ferrer, E., I. Reynosa-Zapata, Y. Perez-Torres and J. Tortoriello, 2005a. The secretagogue effect of the poison from *Centruroides limpidus limpidus* on the pancreas of mice and the antagonistic action of the *Bouvardia ternifolia* extract. Phytomedicine, 12: 65-71.

Jimenez-Ferrer, J.E., Y.Y. Perez-Teran, R. Roman-Ramos and J. Tortoriello, 2005b. Antitoxin activity of plants used in Mexican traditional medicine against scorpion poisoning. Phytomedicine, 12: 116-122.

Jolad, S.D., J.J. Hoffman, S.J. Torrance, R.M. Wiedhopf, J.R. Cole *et al*., 1977. Bouvardin and deoxybouvardin, antitumor cyclic hexapeptides from *Bouvardia ternifolia* (Rubiaceae). J. Am. Chem. Soc., 99: 8040-8044.

Kari, R.K. and H. Zolfaghrian, 1986. Increased osmotic fragility of red cells in dogs with acute myocarditis Produced by scorpion (*Buthus tamulus*) venom. Indian J. Physiol. Pharmacol., 30: 215-222.

Karnad, D.R., 2009. Management of scorpion envenomation: Need for a standard treatment protocol using drugs and antivenom. J. Assoc. Physicians India, 57: 299-300.

Lans, C., T. Harper, K. Georges and E. Bridgewater, 2001. Medicinal and ethnoveterinary remedies of hunters in Trinidad. Complement. Altern. Med., Vol. 1. 10.1186/1472-6882-1-10

Li, Q., Z. Zhao, D. Zhou, Y. Chen and W. Hong *et al*., 2011. Virucidal activity of a scorpion venom peptide variant mucroporin-M1 against measles, SARS-CoV and influenza H5N1 viruses. Peptides, 32: 1518-1525.

Maheshwari, M. and C.P. Tanwar, 2012. Scorpion bite induced myocardial damage and pulmonary edema. Heart Views, 13: 16-18.

Malhotra, K.K., C.M. Mirdehghan and H.D. Tandon, 1978. Acute renal failure following scorpion sting. Am. J. Trop. Med. Hyg., 27: 623-626.

Mansour, N.M., M.N. Tawfik, A.E. Yaseen and T.R. Rahmy, 2007a. Prophylactic effect of Ambrosia maritima plant extract on hepatic tissues of rats envenomed with *Leiurus quinquestriatus* scorpion. Egy. J. Nat. Tox., 4: 69-100.

Mansour, N.M., M.N. Tawfik, T.R. Rahmy and A.E. Yaseen, 2007b. Prophylactic effect of Ambrosia maritima plant extract on renal tissues of rats envenomed with *Leiurus quinquestriatus* scorpion. Egy. J. Nat. Tox., 4: 101-130.

Mansour, N.M., M.N. Tawfik, A.E. Yaseen and T.R. Rahmy, 2011. Protective role of Ambrosia maritima plant extract against alterations induced by *Leiurus quinquestriatus* scorpion venom on skeletal muscles and intestinal tissues of rats. Egy. J. Nat. Toxin, 8: 81-103.

Mills, C., A.R. Carroll and R.J. Quinn, 2005. Acutangulosides A-F, monodesmosidic saponins from the bark of *Barringtonia acutangula*. J. Nat. Prod., 68: 311-318.

Mills, E.J. and N. Ford, 2011. Research into scorpion tings. Br. Med. J., 10.1136/bmj.c7369

Murthy, K.R. and M.A. Zare, 1998. Effect of Indian red scorpion (Mesobuthus tamulus concanesis, Pocock) venom on thyroxine and triiodothyronine in experimental acute myocarditis and its reversal by species specific antivenom. Indian J. Exp. Biol., 36: 16-21.

Mukherjee, S., A. Dey and T. Das, 2012. *In vitro* antibacterial activity of n-hexane fraction of methanolic extract of Alstonia scholaris L. R.Br. stem bark against some multidrug resistant human pathogenic bacteria. Eur. J. Med. Plants, 2: 1-10.

Naqvi, R., A. Naqvi, F. Akhtar and A. Rizvi, 1998. Acute renal failure developing after a scorpion sting. Br. J. Urol., 82: 295-295.

Natu, V.S., S.B. Kamerkar, K. Geeta, K. Vidya and V. Natu *et al*., 2010. Efficacy of anti-scorpion venom serum over prazosin in the management of severe scorpion envenomation. J. Postgrad. Med., 56: 275-280.

Nazimuddin, S.K., S. Ramaswamy and L. Kameswaran, 1978. Effect of *Andrographis paniculata* on snake venom induced death and its mechanism. Indian J. Pharmaceut. Sci., 40: 132-133.

Pal, B.C., T. Chaudhuri, K. Yoshikawa and S. Arihara, 1994. Saponins from *Barringtonia acutangula*. Phytochemistry, 35: 1315-1318.

Perumal Samy, R., P. Gopalakrishnakone, M.M. Thwin, T.K. Chow, H. Bow, E.H. Yap and T.W. Thong, 2007. Antibacterial activity of snake, scorpion and bee venoms: A comparison with purified venom phospholipase A2 enzymes. J. Applied Microbiol., 102: 650-659.

Prasad, R., O.P. Mishra, N. Pandey and T.B. Singh, 2011. Scorpion sting envenomation in children: Factors affecting the outcome. Indian J. Pediatr., 78: 544-548.

Rubin, D.I. and M. Vavra, 2011. Brachial plexopathy as a rare presenting manifestation of scorpion envenomation. Muscle Nerve, 44: 131-135.

Shi, L.S., P.C. Kuo, Y.L. Tsai, A.G. Damu and T.S. Wu, 2004. The alkaloids and other constituents from the root and stem of *Aristolochia elegans*. Bioorg. Med. Chem., 12: 439-446.

Srinivasan, K.N., P.T. Gopalakrishnakone, K.C. Tan, B. Chew and R.M. Cheng *et al*., 2002. Scorpion, a molecular database of scorpion toxins. Toxicon, 40: 23-31.

Thirunavukkarasu, A.B. and V. Chandrasekaran, 2011. Efficacy of anti-scorpion venom serum over prazosin in severe scorpion envenomation: Is the current evidence enough? J. Postgrad. Med., 57: 83-84.

Tiwari, A.K. and S.B. Deshpande, 1993. Toxicity of scorpion (Buthus tamulus) venom in mammals is influenced by the age and species. Toxicon, 31: 1619-1622.

Tuuri, R.E. and S. Reynolds, 2011. Scorpion envenomation and antivenom therapy. Pediatr. Emerg. Care, 27: 667-672.

Uawonggul, N., A. Chaveerach, S. Thammasirirak, T. Arkaravichien, C. Chuachan and S. Daduang, 2005. Screening plants acting against Heterometrus laoticus scorpion venom activity on fibroblast cell lysis. Ethnol. Pharm., 103: 201-207.

Venkateswarlu, Y., B. Janakiram and G.R. Reddy, 1988. In vitro., neutralization of the scorpion, Buthus tamulus venom toxicity. Indian J. Physiol. Pharmacol., 32: 187-194.

Wu, T.S., Y.L. Tsai, P.L. Wu, Y.L. Leu, F.W. Lin and J.K. Lin, 2000. Constituents from the leaves of Aristolochia elegans. J. Nat. Prod., 63: 692-693.

Wu, T.S., Y.L. Tsai, A.G. Damu, P.C. Kuo and P.L. Wu, 2002. Constituents from the root and stem of Aristolochia elegans. J. Nat. Prod., 65: 1522-1525.

Zhang, Y.Y., L.C. Wu, Z.P. Wang, Z.X. Wang, Q. Jia, G.S. Jiang and W.D. Zhang, 2009. Anti-proliferation effect of polypeptide extracted from scorpion venom on human prostate cancer cells in vitro. J. Clin. Med. Res., 1: 24-31.