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REVIEW

Saudi medicinal plants for the treatment of scorpion sting envenomation

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Abstract Scorpion sting envenoming poses major public health problems. The treatment modalities include antivenoms, chemical antidotes and phytotherapy, with varying degrees of effectiveness and side effects. In this investigation, we reviewed the use of Saudi medicinal plants for the treatment of scorpion sting patients. The relevant literature was collected using the online search engines including Science Direct, Google and PubMed with the help of specific keywords. We also used the printed and online resources at our institutional library to gather the relevant information on the use of medicinal plants for the treatment of scorpion sting patients. A descriptive statistics was used for data compilation and presentation. The results of this survey showed the use of at least 92 medicinal plants with beneficial effects for treating victims of stings of different scorpion species. These commonly used herbs spanned to 37 families whilst different parts of these plants were employed therapeutically for alleviation of envenomation symptoms. The application of leaves (41%) was preferred followed by roots (19%), whole plant (14%) and seeds (9%). The use of latex (4%), stem (3%), flowers (3%) and bark (3%) was also reported. In some cases, tannin (2%), rhizome (1%) and shoot (1%) were also used. In conclusion, herbal medicines are effectively used for the treatment of patients with scorpion envenomation. This type of medication is free from side effects as observed with chemical antidotes or antivenom therapy. It is important to identify the active ingredients of herbal drugs for improving their therapeutic potential in traditional medicine.

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Contents

1. Introduction

Scorpions are widely distributed throughout the world and pose serious health hazard due to their poisonous venoms (Uawonggul et al., 2006; Al Asmari et al., 2012, 2015, 2016). The scorpion venom is a heterogeneous mixture of various neurotoxins, cardiotoxins, nephrotoxins and haemolytic that exert acute toxicological effects in humans (Bawaskar and Bawaskar, 2012). The degree of envenomation is associated with several factors including scorpion species, venom lethality, dose of venom injected at the time of sting and the victim's physiological response to venom (Karnad, 2009). The common symptoms in scorpion sting victims are severe pain and inflammatory reactions whereas mortality may happen in rare cases (Uawonggul et al., 2006). The synergistic impact of cardiac, respiratory, autonomic and metabolic abnormalities in scorpion sting patients may lead to multisystem failure and death (Murthy et al., 1991; Yugandhar et al., 1999; Bawaskar and Bawaskar, 2007).

The current therapeutic regimens for alleviation of scorpion venom-induced symptoms include prazosin, angiotensin-converting enzyme inhibitors, insulin and antivenoms (Murthy et al., 1991; Bagchi and Deshpande, 1998; Yugandhar et al., 1999; Bawaskar and Bawaskar, 2007; Krishnan et al., 2007; Deshpande et al., 2008). Sodium channel blockers (Fatani et al., 2000) and β1-adrenergic agonist dobutamine (Gupta et al., 2010) have also served as antidotes to neutralize the toxic effects of scorpion venom. The use of herbal sources in traditional medicine is not a new concept but was in practice for more than 5000 years (Sher and Hussain, 2009). It is important to note that more than 25% of drugs are of plant origin and more than 100 active compounds and synthetically produced drug analogues come from natural precursors (Shinwari, 2010).

Two thirds of the Arabian peninsula are occupied by the Kingdom of Saudi Arabia, covering a wide range of natural sites with great biodiversity and synergistic framework of associated ecosystems (Ahmad and Ghazanfar, 1991; Ghazanfar, 2007). Although there are many reports on barcoding of medicinal and wild plants of Saudi Arabia (Arif et al., 2010a,b; Bafeel et al., 2011, 2012a,b) a comprehensive survey of the use of medicinal plants for the treatment of scorpion sting victims is lacking. In the present study, efforts have been made to document importatn medicinal plants used for the treatment of scorpion sting patients as an alternative medicine.

2. Methods

This research survey was conducted using the electronic search engines pertaining to scientific research data including PubMed and Science Direct. We also approached the libraries of biological and chemical abstracts. The key words used for the literature search of this study were "Saudi Arabian medicinal plants, ethnobotanical evidences in scorpion sting and natural products". Selection of plants was focused on their therapeutic potentials as anti-venom in folklore remedies. Specific searches were also made to enlist already reported anti-venom constituents with possible mechanism to support the anti-venom characteristics of medicinal plants of Saudi Arabia. The outcome of the results were rechecked and compared with literature of current drugs that are employed in combating signs and symptoms of envenoming by scorpions.

3. Results

The findings of this survey identified 92 medicinal plants distributed at various places in Saudi Arabia, and have been enlisted in alphabetical order of family, scientific name and the plant portion used for the treatment of scorpion sting victims (Table 1). These species are distributed in 37 families among which Leguminosae and Apocynaceae have maximum representation with 11 and 10 plants. The families Amaranthaceae and Compositae represented 8 and 6 plants respectively whereas the families Euphorbiaceae, Poaceae and Solanaceae had 5 plants each. Three plants each were belonged to families Apiaceae and Convolvulaceae, whereas 2 plants each belonged to families Boraginaceae, Cucurbitaceae, Cyperaceae, Moraceae, Nyctaginaceae, Plantaginaceae, Portulacaceae and Rutaceae. The remaining families including Acanthaceae, Aizoaceae, Annonaceae, Araceae, Aristolochiaceae, Burseraceae, Capperdiceae, Ceratophyllaceae, Commelinaceae, Lauraceae, Lythraceae, Malvaceae, Myrtaceae, Oxalidaceae, Papaveraceae, Plumbaginaceae, Rhamnaceae, Salvadoraceae, Verbenaceae and Zygophyllaceae represented only single medicinal plant per family, with anti-venom potential (Table 1). All the plants mentioned in this study are distributed at various places throughout the Kingdom of Saudi Arabia (Flora of Saudi Arabia, 2014). The data showed that several parts of the medicinal plants were used for their anti-venom potentials. Of these, the use of leaves predominated (41%) followed by roots (19%), whole plant (14%) and seeds (9%) as shown in Fig. 1. Plant latex was used in 4% cases whereas stem, flower and bark were applied in 3% of the scorpion envenoming victims. Fewer cases were treated with tannin (2%), rhizome (1%) or shoot (1%) (Fig. 1).

4. Discussion

The ethnobotanical resources of Saudi Arabia can be broadly classified into fibre yielding plants, oil-producing plants,

Table 1 Medicinal plants used for the treatment of scorpion sting patients.

Family	Botanical name	Parts used	Reference
Acanthaceae	*Blepharis maderaspatensis* (L.) Heyne ex Roth	Leaf juice is taken orally	Alagesaboopathi (2011)
Aizoaceae	*Trianthema portulacastrum* L.	Leaf	Sharma et al. (2004), Ayyanar and Ignacimuthu (2005)
Amaranthaceae	*Achyranthes aspera* L.	Bark, shoot, leaf, roots and seeds are useful	Swamy et al. (2003), Ayyanar and Ignacimuthu (2005), Flatie et al. (2009), Riuz-Teran et al. (2008), Reddy et al. (2010)
	Aerva lanata (Linn) Juss. ex. Schult.	Plant extract	Ali-Shtayeh et al. (1998)
	Alternanthera pungens Kunth	Whole plant	Ayyanar and Ignacimuthu (2005)
	Alternanthera sessilis (L.) R.Br. ex DC.	Leaf	Bolyard (1981), Hernandez et al. (1999)
	Amaranthus graecizans L.	Leaf	Ghazanfar (1994)
	Amaranthus spinosus L.	Leaf, stem, root are taken orally	Lalfakzuala et al. (2007)
	Amaranthus viridis L.	Leaf used as emollient in scorpion sting	Ignacimuthu et al. (2008), Chotchoungchatchai et al. (2012)
	Chenopodium ambrosioides L.	Leaf	Samal et al. (2010)
Annonaceae	*Annona squamosa* L.	Leaf, root paste for external application. Root bark decoction orally.	Hammiche and Maiza (2006), Ghatapanadi et al. (2011)
Apiaceae	*Carum carvi* L.	Root	Larousse (1975)
	Conium maculatum L.	Flower, leaf	Duke and Wain (1981)
	Trachyspermum ammi (L.) Sprague	Stem	Rao et al. (2000), Shardong and Cervi (2000)
Apocynaceae	*Adenium obesum* (Forssk.) Roem. & Schult.	Leaf, latex	Rodriguez-Lopez et al. (2007)
	Calotropis procera (Aiton) Dryand.	Latex, leaf, whole plant, root	Abbiw (1990), Ghazanfar (1994), Meena and Yadav (2011)
	Carissa spinarum L.	Root, flower	Kunwar et al. (2009)
	Catharanthus roseus (L.) G. Don.	Leaf	Kerharo and Bouquet (1950)
	Ceropegia bulbosa Roxb.	Stem, tannin	Samy et al. (2008)
	Glossonema boveanum (Decne.) Decne.	Stem, leaf	Ayyanar and Ignacimuthu (2005)
	Gymnema sylvestre (Retz.) Schult	Leaf, root	Girish et al. (2004), Riuz-Teran et al. (2008)
	Nerium oleander L.		Chotchoungchatchai et al. (2012)
	Pergularia daemia (Forssk.) Chiov.	Leaf	Ragunathan and Abay (2009)
	Pergularia tomentosa L.	Leaf	Duke and Wain (1981)
Araceae	*Arisaemaflavum*	Rhizome	Bibi et al. (2011)
Aristolochiaceae	*Aristolochia bracteolata* Lam.	Paste of leaf for local application	Thirumal et al. (2012)
Boraginaceae	*Heliotropium aegyptiacum* Lehm	Root	Abroug et al. (1999)
	Heliotropium strigosum Willd.	Whole plant	Abbiw (1990)
Burseraceae	*Commiphora molmol* (Engl.) Engl. ex Tschirch	Bark	Ross (2003)
Capperdiceae	*Cleome gynandra*	Leaf, seed, root juice	Kori et al. (2009)
Ceratophyllaceae	*Ceratophyllum demersum* L.	Whole plant	Van Wyk (2008)
Commelinaceae	*Commelina benghalensis* L.		Mahishi et al. (2005)
Compositae	*Artemisia scoparia* Waldst. & Kitam.	Whole plant	Gangwar et al. (2010)
	Centaurea iberica Trevir.	Leaf	Meena and Rao (2010)
	Cnicus benedictus L.		Larousse (1975)
	Eclipta prostrata (L.) L.	Leaf, whole plant	Ayyanar and Ignacimuthu (2005), Jalalia et al. (2006)
	Lactuca serriola L.	Latex	Zakaria and Mohammed (1994), Duke and wain (1981)
	Sonchus oleraceus (L.) L.		Suryanarayana (2014)
Convolvulaceae	*Evolvulus alsinoides* (L.) L.	Whole plant	Abbiw (1990)
	Ipomoea aquatica Forssk.	Leaf	Singh and Pandey (1998)
	Ipomoea eriocarpa R. Br.	Leaf	Ayyanar and Ignacimuthu (2005)
Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	Flower, root, stem, whole plant	Kapoor (2000), Navarro Garcia et al. (2003), Khalid et al. (2012)
	Coccinia grandis (L.) Voigt	Root, leaf	Kerharo and Bouquet (1950), Singh and Pandey (1998)

Table 1 (*continued*)

Family	Botanical name	Parts used	Reference
Cyperaceae	*Cyperus longus L.*		Hebbar et al. (2002)
	Cyperus rotundus L.	Tannin	Kapoor (2000), Zakaria and Mohammed (1994), Riuz-Teran et al. (2008)
Euphorbiaceae	*Acalypha indica L.*	Leaf	Sudhakar and Madhava Chetty (1998)
	Croton lobatus L	Leaf	Abrough et al. (1999)
	Euphobia cuneata Vahl		Soudahmini et al. (2005)
	Euphorbia granulata Forssk.	Whole plant, latex	Thirumal et al. (2012); http://www.vanilla.com/html/globe-enchanting-tahiti.html
	Ricinus communis L.	Seeds, leaf	Zakaria and Mohammed (1994), Singh and Pandey (1998)
Lauraceae	*Cassytha filiformis* L.	Root	Riuz-Teran et al. (2008)
Leguminosae	*Abrus precatorius L.*	Root	Riuz-Teran et al. (2008)
	Acacia oerfota (Forssk.) Schweinf.		Khalid et al. (2012)
	Astragalus mareoticus Delile	Leaf	Al-Kindi (1966)
	Clitoria ternatea L.	Leaf, root, stem	Singh and Pandey (1998), Singh and Singh (2008)
	Crotalaria retusa L.	Stem	Savonnet (1973); http://www.more-lostravel.com/Catalogosardin.Etnob-otanico.pdf
	Desmodium gangeticum (L.) DC.	Root	Medicinal plants of Nepal (1976)
	Dichrostachys cinerea (L.) Wight & Arn.	Root, leaf	Ross (2003)
	Glycyrrhiza glabra L.	Root	Medicinal plants of Nepal (1976)
	Indigofera tinctoria L.	Whole plant	Jayaweera (1981), Ayyanar and Ignacimuthu (2005)
	Prosopis cineraria (L.) Druce		Ghazanfar (1994)
	Tamarindus indica L.	Stem, leaf, whole plant	Kapoor (2000), Nacoulma-Ouadraogo et al. (1997–1998), Singh and Pandey (1998)
Lythraceae	*Lawsonia inermis* L.		Seaforth (1988)
Malvaceae	*Malva parviflora* L.	Leaf	Ali-Shtayeh et al. (1998)
Moraceae	*Ficus carica* L.	Latex, leaf	Yesilada and Coll (1995), Siromoney et al. (1973)
	Ficus cordata salicifolia (Vahl) C.C. Berg	Leaf	David Samuel (2004)
Myrtaceae	*Myrtus communis* L.	Leaf	Ghazanfar (1994)
Nyctaginaceae	*Boerhavia diffusa* L.	Root, leaf	Sharma et al. (2004)
	Mirabilis jalapa L.		Mukherjea et al. (2008)
Oxalidaceae	*Oxalis corniculata* L.	Leaf	Honda and Coll (1996), Chotchoungchatchai et al. (2012), Riuz-Teran et al. (2008)
Papaveraceae	*Argemone mexicana* L.	Root, leaf	Jayaweera (1981)
Plantaginaceae	*Plantago major* L.	Whole plant	Singh and Pandey (1998)
	Scoparia dulcis L.	Leaf	Meena and Yadav (2010)
Plumbaginaceae	*Plumbago zeylanica* L.	Whole plant, root	Girish et al. (2004)
Poaceae	*Cymbopogon schoenanthus* (L.) Spreng.	Leaf	Ayyanar and Ignacimuthu (2005)
	Echinochloa colona (L.) Link		Kallawaya (1984)
	Heteropogon contortus (L.) P. Beauv. ex Roem & Schult.	Whole plant	Dash et al. (2008)
	Imperata cylindrica (L.) Raeusch.	Root	Lasry (1937); http://himalayahealth-care.com/pages/Ayuravedi cherbuses.htm
	Setaria verticillata (L.) P. Beauv.	Leaf	Dalziel (1937)
Portulacaceae	*Portula oleracea* L.	Whole plant	Ayyanar and Ignacimuthu (2005)
	Portula quadrifida L.	Tannin, stem	Ayyanar and Ignacimuthu (2005)
Rhamnaceae	*Ziziphus nummularia* (Burm.f.) Wight & Am.	Leaf	Nacoulma-Ouadraogo et al. (1997–1998)

(*continued on next page*)

Table 1 (*continued*)

Family	Botanical name	Parts used	Reference
Rutaceae	*Haplophyllum tuberculatum* Juss.	Leaf	Zakaria and Mohammed, 1994
	Ruta chalepensis L.	Whole plant	Ghazanfar (1994), Zakaria and Mohammed (1994), Duke and Wain (1981)
Salvadoraceae	*Salvadora persica* L.	Leaf, flower	Ghazanfar (1994)
Solanaceae	*Datura stramonium* L.	Leaf, stem, root	Abbiw (1990); http://www.ncl.ac/uk/medplant
	Hyoscyamus albus L.		Zakaria and Mohammed (1994)
	Nicotiana tabacum L.	Leaf	Medicinal plants of Nepal (1976), Kerharo and bouquet (1950), Singh and Pandey (1998)
	Solanum anguivi Lam.	Stem	Ur-Rehman (2006)
	Withania somnifera (L.) Dunal	Leaf, root	Ghazanfar (1994)
Verbenaceae	*Phyla odiflora* L.	Leaf	Nasim et al. (2013)
Zygophyllaceae	*Balanites aegyptiaca* (L.) Delile	Leaf, stem	Riuz-Teran et al. (2008)

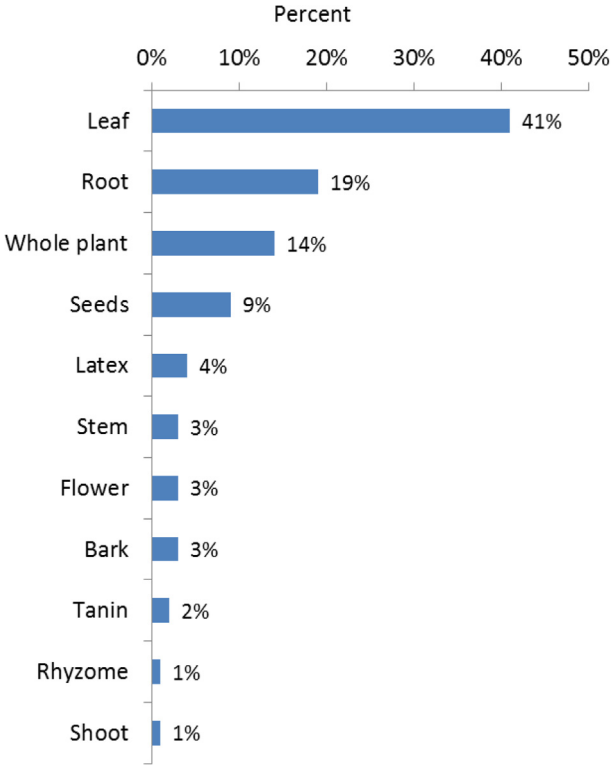

Figure 1 Use of different plant parts for the treatment of scorpion sting victims.

timber plants, edible plants and medicinal plants. *Juniperus*, *Prosopis*, *Tamarix*, *Ziziphus*, etc. were a good source of timber for construction. The use of *Salvadora persica* roots as toothbrush, Myrrh from *Commiphora*, Henna from *Lawsonia inermis*, etc. is common even in these days. Reeds such as *Phragmites*, *Typha*, *Scirpus* are still being used more making baskets, mats, etc., although to keep the tradition alive. Pillows have been made from the inflorescence of *Typha*, *Sacharum*, *Aerva javanica* and mats from the fibres of *Sansevieria*, *Dracaena*, etc. As many as 319 species have been identified in the past decades which have been widely used in Saudi folk medicine (Flora of Saudi Arabia, 2014). Various essential oils were extracted from species belonging to the Lamiaceae family. Species such as *Anastatica hierochuntica*, *Matricaria aurea*, *L. inermis*, *Mentha* spp. *Calligonum comosum*, *Teucrium polium*, *Withania somnifera*, *Anagyris foetida*, *Senna alexandrina*, etc. are good sources of medicines for treating various ailments (Flora of Saudi Arabia, 2014).

The findings of this study showed that there are numerous plants of medicinal importance that have shown anti-venom properties against scorpion stings (Table 1). History of the use of natural products started from very beginning of the human civilization. From the ancient time plant products were the most successful remedies because of better compatibility with the human body and enhanced acceptability in human societies. Most frequent manifestations of scorpion envenomation are pulmonary oedema (Goncalves et al., 2012), myocardial damage (Maheshwari and Tanwar, 2012), intracerebral haemorrhage (Dube et al., 2011), brachial plexopathy (Rubin and Vavra, 2011) and renal failure (Naqvi et al., 1998), induced by the prolific release of neurotransmitters (Ismail, 1995; Natu et al., 2010). Prazosin is a common supportive therapy for scorpion envenomation (Natu et al., 2010). Other investigators have reported the benefits of scorpion antivenom treatment for the management of scorpion sting victims (Deshpande, 2010). However, clinical trials provided questionable and controversial data about the effectiveness of scorpion antivenom serotherapy (Tuuri and Reynolds, 2011), especially in severe envenoming cases (Abroug et al., 1999; Belghith et al., 1999), such as children who are severely affected (Bahloul et al., 2010).

The efficacy of plants against scorpion sting may be associated with the presence of various phytochemicals, whilst symptomatic relief may be due to anti-inflammatory, anti-pruritic and analgesic effects of medicinal plants (Dupre, 2013). The mechanism may involve quick antagonism or metabolism of catecholamines released as a result of interaction of venom with receptors. The intensity of envenoming effects can also be reduced by non-specific stimulation of the immune system that would result in neutralization or phagocytosis of the venom peptides. Phospholipase enzymes play significant role in the cascade which leads to pain and inflammatory responses, whilst, inhibition of these enzymes may relieve scorpion envenoming (Abbasi et al., 2010). The folklore medicinal

plants contain various types of flavonoids, steroids, terpenoids, alkaloids, tannins and coumarins that may account for their antivenom potentials (Khalil et al., 1981; Picman, 1986; Ammar et al., 1993; Bin Asad et al., 2011; Mansour et al., 2011). The antivenom activity of a plant cannot be attributed to a single active ingredient however the overall activity results from the synergistic effect of various constituents on various target structures such as enzymes and receptors (Uawonggul et al., 2006; Mansour et al., 2007, 2011). Fatani et al. (2006) showed that extracts of *Gingko biloba* associated with aprotinin, a protease inhibitor, protected rats against cardiovascular damage induced by the venom of *Leiurus quinquestriatus*. Mansour et al. (2011) showed that extracts of *Ambrosia maritima* protect against the adverse effects of *L. quinquestriatus* scorpion venom on muscular and intestinal tissue in rats. Treatment with red grape seed against *L. quinquestriatus quinquestriatus* venom significantly reduced mortality and improved mean arterial blood pressure, signs of conduction defects, myocardial ischaemia, and infarction in rats (El-Alfy et al., 2008).

In conclusion, the data mentioned in this study clearly showed that herbal medications possess potential antivenom properties that can be utilised for the treatment of scorpion sting victims. The information reported above could be helpful for scientists, drug designers, medicinal plant boards and other scientific bodies related to herbal research in scorpion sting treatment. Further studies are required to identify the phytochemicals responsible for anti-scorpion venom activity of these medicinal plants. Moreover, well-designed pharmacological and clinical trials will help in confirmation of the efficacy of the reported herbs. There is also a need to create more public awareness about growing the medicinal plants in the residential vicinity so that they can be used for providing first aids to alleviate the symptoms of scorpion envenomation.

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