Chapter 21

Halophytes as Medicinal Plants

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ABSTRACT

Halophytes are plants of significant economic potential which can contribute tremendously toward the environmental restoration besides a potential source of medicine. This paper reviews available literature about the status of 45 coastal and near-coastal species traditionally used as medicine for 7 different types of disease conditions. Local inhabitants have a long history of traditional plant use as medicine to cure almost all types of ailments. Many of these plants are perennial halophytic herbs and shrubs including a few herbaceous annuals. The aim is to highlight the importance of halophytes as medicinal plants and indicate their potential utilization at industrial scale.

INTRODUCTION

Review of literature indicates that an increase in research interest on halophytes which reflects recognition of their immense potential as a valuable resource and cash crop (Khan et al., 2009; Hussain et al., 2003). Use of saline and brackish water resources has been recommended for growing cash crop as food, fuel, fiber, fodder and medicine for the ever increasing human population (Rozema and Flowers, 2008). Recently, a salt tolerant plant *Panicum turgidum* has been shown to be useful as alternative cattle feed for maize when irrigated with brackish water on saline soils (Khan et al., 2009). The *Panicum – Suaeda* intercropping system helped maintain soil salinity at low levels and *Panicum turgidum* was reported to produces more than 50 tons/ha biomass annually as fodder for cattle (Khan et al., 2009).

Fatty acid profile of some halophytic species holds great promise for production of commercial vegetable oil with high poly-unsaturation equivalent to conventional oil seed crops such as canola and sunflower (Khan and Qaiser, 2006). Seeds of

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various halophytes, such as *Suaeda fruticosa, Arthrocnemum macrostachyum, Salicornia bigelovii, S. brachiata, Halogeton glomeratus, Kochia scoparia,* and *Haloxylon stocksii* possess a sufficient quantity of high quality edible oil with unsaturation ranging from 70-80 % (Weber et al., 2001). Shoots of *Salicornia bigellovi, Sesuvium portulacastrum, Chenopodium album, Portulaca oleracea,* and *Suaeda maritima* are used for vegetables, salads and pickles in various parts of the country. Fuel wood is also traditionally obtained from salt tolerant perennials such as *Prosopis, Tamarix, Salsola, Acacia, Suaeda, Kochia, Capparis* and *Salvadora* (Dagar, 1995).

Khan and Qaiser (2006) reported more than 400 species of halophytes in Pakistan with almost 100 species or 1/4 of the total number from coastal areas. Most of the halophytes of arid areas are perennial shrubs or perennial herbs which can provide a sustainable supply of plant material from multiple harvests using non-conventional saline irrigation system on poor quality soil and brackish water irrigation. With appropriate management and monitoring, saline irrigation and cropping systems hold great promise for tapping the highly productive saline systems for meeting the basic needs of local communities and also for ensuring high economic returns in salt prone areas.

This paper is a brief review of the medicinal importance of coastal halophytic species along the Arabian Sea coast which are reported for their use in treating a number of ailments in local communities (Table 1). The information will help us to find patterns of plant use and their relationship with other human community attributes that binds man and nature together.

CURRENT SALINITY SCENARIO

Good quality land and fresh water need to be utilized primarily for growing food for the ever growing population. However, immense potential lies not only in reclamation of salinized lands by improving soil fertility but also in better utilization of these untapped resources for cultivating non-conventional salt tolerant cash crop plants – the Halophytes. About 6.5 million hectares of land are salt affected out of which approximately 2 million hectares are slightly to moderately affected but these can successfully be utilized to produce medicinal plants besides other uses.

The consumption of medicinal herbs in Pakistan was estimated at 631.5 tons worth about Rs. 1.5 billion annually (Hussain et al. 2003). However, 90% of these herbs are imported from countries like Sri Lanka, China and India which grow a variety of medicinal plants for local use as well as for export to neighboring countries and earn considerable foreign exchange. Pakistan lacks the basic infrastructure to efficiently exploit the full potential of naturally growing herbs even for domestic usages while there is a constant decrease in indigenous plant species biodiversity due to both urbanization as well as global climate changes (IUCN, 2004). Concerted research efforts are required to domesticate indigenous medicinal plants to be used as cash crops on an urgent basis.

Table 21.1: Traditional uses of halophytes reported as medicine

S #	Name of species (Family)	Habit	Life form	Part used	Preparation	Medicinal use	Reference
1	*Acacia nilotica* L. (Mimosaceae)	T	P	L,B,G	Decoction	Asthma, diarrhea, demulcent	Ilahi, 2008
2	*Achyranthes aspera* L. (Amaranthaceae)	H	P	R	Powder	Asthma, cough, pneumonia, joint pain, labor discomfort	Qureshi & Bhatti, 2008; Savithramma et al., 2007
3	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes (Amranthaceae)	Sh	P	L,F,WP	Paste/ Decoction	Wounds, Jaundice, Diabetes, cough, headaches	Qureshi & Bhatti, 2008, Hammiche & Maiza, 2006
4	*Alhagi maurorum* Medic. (Fabaceae)	Sh	P	WP	Decoction	Laxative, diuretic, eye infections	Ilahi, 2008; Goodman & Ghafoor, 1992
5	*Amaranthus virdis* L. (Amaranthaceae)	H	A	WP	Potherb	Constipation, gall bladder/kidney stones	Qureshi & Bhatti, 2008
6	*Arthrocnemum indicum* (Willd.) Moq (Chenopodiaceae)	Sh	P	WP	Ashes	Alexipharmic	Agoramoorthy, 2008
7	*Atriplex stocksii* Boiss (Chenopodiaceae)	Sh	P	L, WP	Infusion	Fever, jaundice, dropsy, liver disease	Qureshi et al., 2009
8	*Calotropis procera* (Ait.) Ait. f. (Asclepidaceae)	Sh	P	WP	Paste	Tooth & stomach aches	Ilahi, 2008
9	*Capparis decidua* Forssk. (Capparidaceae)	Sh	P	F, B	Decoction	Carminative, aphrodisiac, ulcer, cough, asthma, stomach aches	Ilahi, 2008; Goodman & Ghafoor, 1992
10	*Chenopodium album* L. (Chenopodiaceae)	H	A	WP	Potherb	Constipation	Qureshi & Bhatti, 2008
11	*Citrullus colocynthis* L. (Cucurbitaceae)	H	P	F, R	Toothache, Pills,	Toothache, Constipation, bleeding, piles, diabetes, leucorrhea, Asthma	Goodman & Ghafoor, 1992; Qureshi & Bhatti, 2008; Savithramma et al. 2007
12	*Cleome brachycarpa* Vahl. (Capparidaceae)	H	A	WP	With sesame oil	Itching, Joint pain, skin diseases, inflammation	Qureshi & Bhatti 2008;

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Table 21.1 – Contd…

S #	Name of species (Family)	Habit	Life form	Part used	Preparation	Medicinal use	Reference
							Shafi et al., 2001
13	*Cleome viscosa* L. (Capparidaceae)	H	A	WP	Juice	Ear infection, pain, deafness	Qureshi & Bhatti, 2008
14	*Corchorus depressus* (L.) Stocks (Tiliaceae)	Sh	P	WP	Infusion	Dysuria	Goodman & Ghafoor, 1992
15	*Cressa cretica* L. (Convolvulaceae)	H	p	L	Paste	Sores	Qureshi & Bhatti, 2008
16	*Cymbopogon jwarancusa* Boiss. (Poaceae)	G	P	WP	Decoction	Fever, catarrh, joint pain, inflammation	Qureshi & Bhatti, 2008; Goodman & Ghafoor, 1992
17	*Cynodon dactylon* (L.) Pers. (Poaceae)	G	P	WP	Paste	Cuts, wounds	Qureshi & Bhatti, 2008
18	*Cyperus rotundus* L. (Cyeraceae)	Se	P	R	Poultice	Acne, Carbuncle	Qureshi & Bhatti, 2008
19	*Desmostachya bipinnata* L. (Poaceae)	G	P	R	Potherb	Carbuncle	Qureshi & Bhatti, 2008
20	*Digera muricata* (L.) Mart (Amranthaceae)	H	A	WP	Powder	Constipation	Qureshi & Bhatti, 2008
21	*Euphorbia caducifolia* Haines (Euphorbiaceae)	Sh	P	La	Raw	Increase male sexual vigor	Goodman & Ghafoor, 1992
22	*Fagonia indica* Burm. f. (Zygophyllaceae)	Sh	P	WP	Decoction	Skin eruption, malarial fever	Qureshi & Bhatti, 2008; Goodman & Ghafoor, 1992
23	*Glinus lotoides* L.	H	A	WP	Powder	Blood purifier	Qureshi & Bhatti, 2008
24	*Gynandropsis gynandra* (L.) Briq. (Capparidaceae)	H	A	R, L	Decoction	Stomach ace and skin inflammation	Shafi et al., 2001
25	*Haloxylon stocksii* (Boiss.) Benth. & Hook. (Chenopodiaceae)	Sh	P	WP	Decoction	Tooth and stomach aches	Ilahi, 2008
26	*Heliotropium curassavicum* L.	H	P	R	Paste	Boils	Qureshi & Bhatti, 2008

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Table 21.1 – Contd…

S #	Name of species (Family)	Habit	Life form	Part used	Preparation	Medicinal use	Reference
	(Boraginaceae)						
27	*Heliotropium strigossum* Willd. (Boraginaceae)	Sh	P	WP	Paste	Boils, Ulcer, wounds	Shafi et al., 2001
28	*Heliotropium. eichwaldi* Steud. (Boraginaceae)	Sh	A	L	Raw	Earache	Shafi et al., 2001
29	*Ipomoea pes-caprae* (L.) Swt. (Convolvulaceae)	H	P	WP	Decoction	Diarrhea, pains, vomiting, inflammation of legs, piles	Agoramoorthy, 2008
30	*Leucas urticifolia* (Vahl) Rr. B. (Labiatae)	H	A	WP	Decoction	Cold, fever, gastrointestinal problems.	Shafi et al., 2001
31	*Peganum harmala* L. (Zygophyllaceae)	H	P	WP,S	Decoction	Anti-microbial, colic, lumbago/Rheumatisms, back pains	Ilahi 2008; Hammiche & Maiza, 2006
32	*Portulaca oleracea* L. (Portulacaceae)	H	A	L,F,S	Infusion	Stomach ache, gastric trouble	Husain et al., 2008
33	*Rhizophora mangle* L. (Rhizophoraceae)	Sh	P	F,R,W	Maceration, tea	Diarrhea, diabetes	Ferreira, 2009
34	*Suaeda monoica* Forsk. ex Gmel. (Chenopodiaceae)	Sh	P	WP	Paste	Ointment for wounds	Agoramoorthy, 2008
35	*Salvadora oleoides* Decne. (Salvadoraceae)	Sh	P	L,F,S	Decoction	Purgative, aphrodisiac, diarrhea	Shafi et al. 2001; Goodman & Ghafoor, 1992
36	*Salvadora persica* L. (Salvadoraceae)	Sh	P	L,F	Decoction	Asthma, cough	Shafi et al. 2001; Savithramma et al. 2007
37	*Salsola imbricata* Forssk. (Chenopodiaceae)	Sh	P	WP	Infusion	Insecticidal, Vascular hypertension	Hassan et al 2005, Hammiche & Maiza, 2006
38	*Solanum surattense* Burm.f. (Solanaceae)	Sh	P	F, WP	Pills	Bronchial, asthma, headache, cough, joint pain And chest pain, vomiting, burning feet	Qureshi and Bhatti 2008, Savithramma et al., 2007; Ilahi, 2008; Goodman &

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Table 21.1 – Contd…

S #	Name of species (Family)	Habit	Life form	Part used	Preparation	Medicinal use	Reference
							Ghafoor, 1992
39	*Suaeda fruticosa* Forssk. (Chenopodiaceae)	Sh	P	L	Water and Alcoholic extracts	Antibacterial	Rasheed et al., 2000
40	*Trianthema portulacastrum* L. (Aizoaceae)	H	A	L	Decoction	Asthma	Qureshi et al 2009; Savithramma et al., 2007
41	*Tribulus terrestris* L. (Zygophyllaceae)	H	A	R	Infusion	Urinary calculi, spermatorrhoea, general debility, Asthma, Kidney stones	Qureshi & Bhatti, 2008; Savithramma et al., 2007; Hammiche and Maiza 2006; Hussain et al 2008
42	*Withania somnifera* (L.) Dunal (Solanaceae)	Sh	P	F, L	Decoction	Anthelmintic, leucorrhoea, tuberculosis	Hussain et al., 2008
43	*Zaleya pentandra* (L.) Jeffrey in Kew Bull (Aizoaceae)	H	P	R	Powder	Influenza, phlegmatic cough	Qureshi & Bhatti, 2008
44	*Ziziphus nummularia* (Burm. f.) Wight & Arn. (Rhamnaceae)	Sh	P	L, F, B	Decoction	Digestive, blood purifier, sores, skin diseases	Ilahi, 2008
45	*Zygophyllum simplex* L. (Zygophyllaceae)	H	A	L	Decoction	Helminthiases	Hammiche & Maiza, 2006

Key: Sh- Shrub; H- Herb; T- Tree; G- Grass; Se- sedge; L- Leaves; WP- Whole plant; F- Fruit; R- Root; S- Seed; B- Bark; La- Latex; A- Annual; P- Perennial.

DISTRIBUTION

Halophytes are found in a range of environmental conditions depending on their ability to tolerate various combinations of salts in the substrate (Song et al., 2008) and may be grouped in various ways such as into coastal, near coastal and inland species depending on the proximity to the open sea or according to the type of habitat they occupy such as salt desert, salt flat or salt marsh plants.

RESULTS AND DISCUSSION

Halophytes are adapted to tolerate harsh saline and arid conditions by synthesizing a number of active chemicals to maximize their fitness, many of which are a source of potent medicine against a number of chronic ailments. Coastal environments were reported to be more stressful than inland due to higher soil salinity, greater light intensity and more frequent diurnal and seasonal climatic conditions (Gulzar and Khan, 1998). Numerous reports have documented the traditional uses of medicinal plants in rural and tribal areas all over the world as a successful home remedy against different ailments (Hamburger and Hostettmann, 1991; Hammiche and Maiza, 2006; Hussain et al., 2006).

TRADITIONAL USES

The ethnobotanical data collected from different sources covers 7 health related conditions i.e., digestive, skin, respiratory, pain, fever and toothache, genito-urinary and others. A summary of the different ethnobotanical uses of 45 documented species (Table 1) and their percent distribution with respect to type of disease condition (Table 2) is presented here. In almost all cases whole plants or plant parts are used as a cure for various illnesses which indicates the presence of beneficial chemicals.

DIGESTIVE CONDITIONS

Twenty four percent of the species reported here are used as purgatives, carminatives and as anti-helmintics in the treatment of digestive disorders like stomach pain, vomiting, diarrhea (Fig 1). *Acacia nilotica* L., *Citrullus colocynthis* L. and *Ipomoea pes-caprae* (L.) Swt. are the most frequently used species. *Chenopodium album* L. and *Digera muricata* (L.) Mart. are used to treat constipation and bowel movement. *Haloxylon stocksii* (Boiss.) Benth. & Hook. and *Portulaca oleracea* L. are used for the treatment of stomach ache (Ilahi 2008; Husain et al. 2008), for ulcer (Ilahi 2008; Shafi et al. 2001) and for vomiting and gastric trouble (Agoramoorthy 2008, Shafi et al. 2001, Qureshi and Bhatti 2008, Savithramma et al. 2007, Ilahi 2008). *Capparis decidua* Forssk. is a popular carminative (Ilahi 2008) while *Withania somnifera* (L.) Dunal and *Zygophyllum simplex* L. are used to cure helminthiases (Husain et al. 2008; Hammiche and Maiza 2006). *Salvadora oleoides* Decne. is also used as a purgative (Shafi et al. 2001) while *Rhizophora mangle* L. is used to treat diarrhoea (Coelho-Ferreira 2009).

SKIN CONDITIONS

Skin conditions account for 15% of plant species listed (Table 1; Fig 1). *Cleome brachycarpa* Vahl. and *Cynodon dactylon* (L.) Pers. are frequently cited for the treatment of wounds, itching and inflammations. *Fagonia indica* Burm. f. and *Heliotropium strigossum* Willd. are also used in the treatment of wounds (Shafi et al.

2001) and burns (Shafi et al. 2001) and leaves of *Suaeda monoica* Forsk. ex Gmel. to make an antiseptic ointment for skin eruptions (Agoramoorthy 2008). *Heliotropium curassavicum* L. is used for healing boils (Qureshi and Bhatti 2008); *Ziziphus nummularia* (Burm. f.) Wight & Arn. for skin infections (Ilahi 2008) while paste from *Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes leaves for treating skin diseases (Qureshi and Bhatti 2008; Hammiche and Maiza 2006). Roots of *Desmostachya bipinnata* L. and *Cyperus routundus* L. are applied externally on carbuncles and those of *C. rotundus* are also used to treat acne (Qureshi and Bhatti 2008).

RESPIRATORY CONDITIONS

Respiratory tract infections are treated by about 14% of the species in this study (Fig 1). *Solanum surattense* Burm.f. is commonly used for chronic coughs, asthma, bronchitis and sore throat (Qureshi and Bhatti 2008, Savithramma et al. 2007, Goodman & Ghafoor, 1992), roots of *Zaleya pentandra* (L.) Jeffrey have anti-phlegmatic activity and are also used against influenza (Qureshi and Bhatti 2008). *Acacia nilotica* L. is used as a demulcent (Ilahi 2008) and *Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes and *Capparis decidua* Forssk. are frequently used to relieve cough and chest complaints (Hammiche and Maiza 2006, Ilahi 2008). Decoctions of ground *Achyranthes aspera* L. roots are used to treat pneumonia (Qureshi and Bhatti 2008, Savithramma et al. 2007). Whole plants of *Leucas urticifolia* (Vahl) Rr. B. and leaves of *Salvadora persica* L. are used for cough and cold (Shafi et al. 2001, Savithramma et al. 2007).

Asthma is a common respiratory track disease in rural areas which is successfully cured using traditional medicine since generations. For instance *Tribulus terrestris* L. fruits (Hussain et al. 2008) are commonly used in parts of Pakistan whereas Savithramma et al. (2007) recorded about 80 indigenous species that are used to cure asthma in Natuvaidyulu India including the halophytes *Achyranthes aspera* L., *Citrullus colocynthis* L., *Salvadora persica* L., *Trianthema portulacastrum* L. and *Tribulus terrestris* L.

PAIN

Among the halophytes listed in this paper about 13 % of the species are used for pain alleviation (Fig 1). *Achyranthes aspera* L., *Cleome brachycarpa* Vahl., *Cymbopogon jwarancusa* Boiss. and *Solanum surattense* Burm.f. are used for treating joint pains (Ilahi 2008, Qureshi and Bhatti 2008). Whole plant decoctions of *Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes are used for headaches, while *Solanum surattense* Burm.f. fruits for the relief of chest pain (Hammiche and Maiza 2006, Qureshi and Bhatti 2008). Whole plant extracts of *Peganum harmala* L. are used to relieve back pain (Hammiche and Maiza 2006) and those of *Ipomoea pes-caprae* (L.) Swt. for pain with inflammation (Agoramoorthy 2008). Sap obtained from *Cleome viscosa* L. plants is ingested for treating ear infections, pain and deafness (Qureshi and Bhatti 2008). Similarly, *Heliotropium eichwaldi* Steud. leaves are a good remedy for ear aches (Shafi et al. 2001). In their monograph Goodman & Ghafoor (1992) reported that few drops of fresh leaves extract of *Alhagi maurorum* Medic can cure infections, pain and redness of eyes.

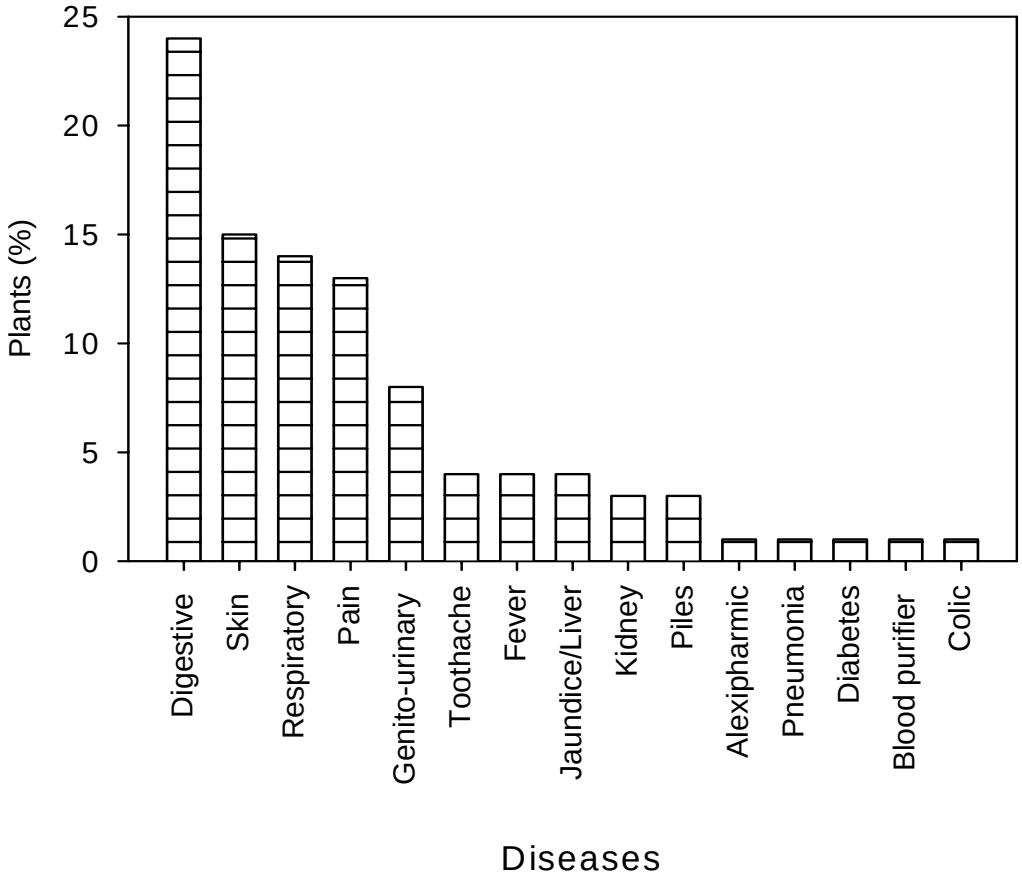

Figure 21.1: Major ailments treated by local healers using coastal medicinal plants

FEVER AND TOOTHACHE

About 8 % species are used to treat fevers and toothaches (Fig 1). Leaves of *Atriplex stocksii* Boiss. when crushed to make decoction or infusion in water are said to relieve any kind of fever (Qureshi et al., 2009). Tea extracted from leaves of *Cymbopogon jwarancusa* Boiss. can treat prolonged fever (Qureshi and Bhatti 2008; Goodman and Ghafoor 1992). *Leucas urticifolia* (Vahl) Rr. B. is also used to treat fever, cold as well as gastric problems (Shafi et al. 2001). Fresh plants of *Fagonia indica* Burm. f., are soaked overnight and the infusion is used to cure malarial fever (Goodman & Ghafoor, 1992). *Calotropis procera* (Ait.) Ait. f. latex generally considered to be poisonous, when applied with care by experienced practitioners relieves pain in teeth and gums (Ilahi, 2008). Fruits of *Citrullus colocynthis* L. and decoctions of *Haloxylon stocksii* (Boiss.) Benth. & Hook. are also reported for tooth and stomach aches (Ilahi 2008; Goodman & Ghafoor 1992).

GENITO-URINARY CONDITIONS

About 8 % of halophyte species are useful in the treatment of genito-urinary and kidney related problems (Fig 1) e.g., decoctions of *Citrullus colocynthis* L. and

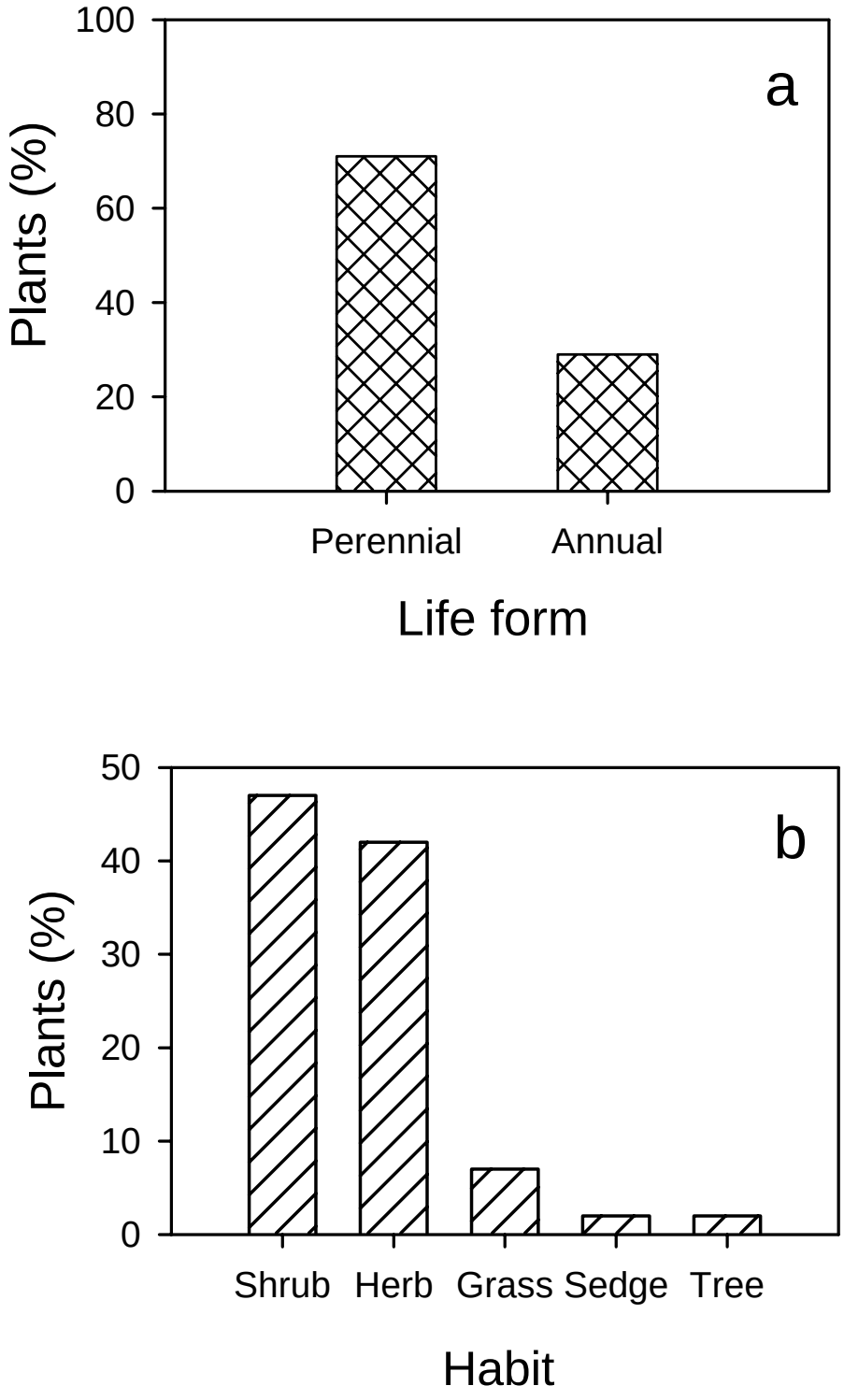

Figure 21.2: Distribution of medicinal plants with respect to their (a) Life form and (b) Habit

Withania somnifera (L.) Dunal are useful for treating leucorrhoea (Qureshi and Bhatti, 2008; Savithramma et al., 2007; Hammiche and Maiza, 2006; Hussain et al., 2008). Fruit decoctions of *Capparis decidua* Forssk. (Ilahi, 2008) and *Salvadora oleoides* Decne. (Shafi et al., 2001) are used as aphrodisiac.

The whole plant decoctions from *Tribulus terrestris* L. are used as a potent medicine to treat Spermatorrhoea (Hussain et al. 2008). A small quantity of *Euphorbia caducifolia* Haines latex taken orally by males before sexual intercourse is reputed to increase prowess (Goodman & Ghafoor, 1992). Ground roots of *Achyranthes aspera* L. are used traditionally to relieve labor discomfort and allow ease of delivery (Qureshi and Bhatti, 2008).

Aerial parts of *Amaranthus virdis* Linn. are frequently utilized in the treatment of urinary tract infections especially for kidney stones and painful urination (Qureshi and Bhatti, 2008). The plant is boiled in a pot until soft and eaten for dysuria. Oral decoctions of *Alhagi maurorum* Medic. are considered to have diuretic properties (Ilahi 2008). Infusion of *Corchorus depressus* (L.) Stocks are used to relieve irritation and pain during urination and provide relief from heat stroke in summer (Goodman & Ghafoor, 1992).

OTHER MEDICAL CONDITIONS

Leaf infusions of *Atriplex stocksii* Boiss. are used to treat jaundice and other liver disorders (Qureshi et al. 2009). Leaf decoctions of *Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes are also used against jaundice while oral administration also cures yellow fever (Qureshi and Bhatti 2008, Hammiche and Maiza 2006). Powdered plant material of *Glinus lotoides* L. is useful as a blood purifier (Qureshi and Bhatti 2008) and a major cure for pimples, boils, skin discoloration, jaundice, headaches, drowsiness, wrinkles and premature aging. *Citrullus colocynthis* L. is widely used to treat a variety of ailments using several recipes even for the same ailment such as the bitter fruits against diabetes (Qureshi and Bhatti 2008). Initially, patients do not feel the bitterness of the fruit and the treatment is continued until the bitterness is sensed. The roots of *Achyranthes aspera* L. are used in the treatment of pneumonia (Qureshi and Bhatti 2008) and *Arthrocnemum indicum* (Willd.) Moq. as an antidote against venom from bite of scorpions, snakes or poisonous insects. The plant is burnt to ash and applied directly to the affected area (Agoramoorthy 2008) as an alexipharmic. *Peganum harmala* L. infusions are used to treat colic in 2-5 week old infants (Ilahi 2008, Hammiche and Maiza 2006). *Citrullus colocynthis* L. and *Ipomoea pes-caprae* (L.) Swt. are reported for treatment of piles (Qureshi and Bhatti 2008; Agoramoorthy 2008).

CONCLUSIONS

Plants continue to be almost exclusive sources of drugs for the majority of the world's population (Hamburger and Hostettmann, 1991). A variety of plant chemicals have therapeutic importance such as low molecular weight proteins and peptides (Linthorst, 1991) or glycosides. These primary metabolites exhibit antifungal and/or antimicrobial (Robert and Seletrennikoff, 1986; Terras et al., 1992) activity probably due to their ability to bind to and degrade microbial surfaces. Secondary metabolites such as phytoalexins, phenolic acids, alkaloids, saponins, flavonoids, tannins, essential oils could also be part of the plant defense against microbes (Van Etten et al., 1989; Maher et al., 1994).

Plant drug discovery and development are processes of collaborative effort between field practitioners and laboratory scientists. A continuous flow of raw material from the field, a joint cooperation between practitioners and research institutes and a long-term assurance of sharing benefits of the discovery between the parties are essential at this stage. Ethno-medicinal studies typically involve thorough surveys of indigenous species, their local uses, mode of preparation, dosage and routes of administration. While chemical analyses include determination of biological (anti-bacterial, anti-fungal, anti-viral) activity, pharmacological investigations, identification of active ingredients using GC, GC-MS, LC-MS, NMR and clinical trials. However, the transformation of an active ingredient from a raw plant material to a commercial product is a long and tedious process. Flora of Pakistan accounts for 85% of terrestrial plants with more than 5700 species throughout the country while the remaining 15% are being documented from the remote northern areas of Pakistan (Ali and Qaiser, 1995-2005). So far, around 400 species of halophytes have been reported from Pakistan and 25% of these are from the Arabian Sea coast. It is speculated that many more new reports of halophytes will be forthcoming from pristine mountainous habitats (Ali, 2008).

Domestication of medicinal halophytes is no longer a myth but is still not being pursued on war footing in salt prone areas due to two possible reasons: firstly, since salinity has not so far threatened the availability of food for humans and secondly due to a lack of awareness, acceptance and confidence in the benefits of non-conventional resources by the masses. However, global climate changes and population increase are occurring at an alarming rate are predicted to decrease the per capita water availability within the next quarter of century leading to increasing realization of need to tap new avenues in providing food and health security.

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