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Full Length Research Paper

Overview on the ecological and geographical appraisal of important medicinal and aromatic plants: An endangered component in the flora of Saudi Arabia

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The geographical location of Saudi Arabia has provided an ideal environment for the growth and nourishment of various floristic elements including medicinal and aromatic plant (MAP) species. The country is gifted with diverse vegetation types occurring in the desert, semi-desert, and mountainous ecosystems. Furthermore, the country represents three phytogeographic regions: Saharo-Sindian, Somali-Masur and Afro-Montane with 24 different ecosystems having more than 2200 species of flowering plants. Out of this, 246 are endemic to the Kingdom and several species are believed to be threatened because of various reasons and need ecological assessment and survey. In addition, there is no shortage of places in Saudi Arabia with occasional glimpse of sub-alpine and alpine vegetation types. The Kingdom of Saudi Arabia is home to precious wide range of globally threatened species of plant resources with a number of progenitors of economically useful crops and a multitude of MAPs, having applications for the development of pharmaceutical industries and possesses agro-industrial potentialities. Presently this region faces serious threats to plant species and their habitats spurred by demographic, economic and technological changes, habitat degradation and injudiciously laid infrastructure schemes. In this context, we realize the importance of the biological heritage of the mountainous and arid ecosystem of the country, with the aim to take a number of substantive measures to protect its biological diversity with special reference to MAPs. The overall goal of the study was to provide baseline studies and useful suggestions to conserve globally significant MAP species and associated habitats in different ecologically important core area and hotspots (of biodiversity) of Saudi Arabia. The present study endeavours' to create people's awareness and involvement for the conservation of MAPs through ingraining their importance in their minds. Sensitization and realization of the plant scientists is required to focus on the sustainable use, conservation and management requirements of the valuable MAP species, so that their sustainable production and conservation with the development of balanced ecosystem may lead the country to sustainable income and other welfare.

Key words: Biodiversity, mankind survival, economic importance, local people, environmental hazards.

INTRODUCTION

Saudi Arabia as a whole has a desert climate characterized by extreme heat during the day, an abrupt drop in temperature at night, and slight, erratic rainfall. Thus, considerable variation occurs in the daily temperature and humidity. The two main extremes in climate are felt between the coastal lands and the interior. Along the coastal regions of Red Sea and Persian Gulf, the desert temperature is moderated by the proximity of these large bodies of water. Temperatures seldom rise above 38°C, but the relative humidity is

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usually more than 85% and frequently 100% for extended periods (Al-Yemeni and Zayed, 1999). This combination produces a hot mist during the day and a warm fog at night. Prevailing winds are from the north, and, when they blow, coastal areas become bearable in the summer and even pleasant in winter. A southerly wind is accompanied invariably by an increase in temperature and humidity and by a particular kind of storm known in the gulf area as *kauf*. In late spring and early summer, a strong northwesterly wind, the *shamal*, blows; it is particularly severe in eastern Arabia and continues for almost three months. The shamal produces sandstorms and dust storms that can decrease visibility to a few meters.

A uniform climate prevails in Najd, Al Qasim Province, and the great deserts. The average summer temperature is 45°C, but readings of up to 54°C are common. The heat becomes intense shortly after sunrise and lasts until sunset, followed by comparatively cool nights. In the winter, the temperature seldom drops below 0°C, but the almost total absence of humidity and the high wind-chill factor make a bitterly cold atmosphere. In the spring and autumn, temperatures average 29°C (Al-Yemeni, 2000). Asir province of Saudi Arabia is affected by Indian Ocean monsoons, usually occurring between October and March. For the rest of the country, rainfall is low and erratic. The entire year's rainfall may consist of one or two torrential outbursts that flood the *wadis* (Valley) and then rapidly disappear into the soil to be trapped above the layers of impervious rock.

VEGETATION AND FLORISTIC DIVERSITY

The flora of Saudi Arabia reflects the geographical position of the Arabian Peninsula between Africa, Asia and Europe. Consequently, the flora has many elements of two of the eight global terrestrial realms; namely the Palaearctic (Europe and Asia) and the Afro-tropical (Africa south of the Sahara) as well as a smaller complement of elements from the Indo-Malayan terrestrial realm. Saudi Arabia is generally an arid country with a few exceptional sub-humid regions on the south-western escarpments and is divided into three chorological units: the Saharo-Sindian, Somali-Masur, and Afro-Montane (Sher and Al-Yemeni, 2011). It is thus an area of ecological significance.

Vegetationally and climatically, Saudi Arabia can be classified into 24 different ecosystems. Most of these cover large areas and are widespread in the Kingdom (Ahmad and Ghazanfar, 1991).

Ecosystems range from those of the saline areas along the Gulf Coast and in the inland drainage basins through the systems of the dune seas of the Nafud and Rub al Khali to the complex and species-rich woodlands of the western highlands. Most of the ecosystems are comparatively simple in structure and species diversity, reflecting the aridity and high summer temperatures experienced by most of the physiographic regions.

The vegetation of most ecosystems of the Saharo-Sindian region is generally sparse and about 60% of the vegetation, mainly occurs in the low lying areas, is represented by annuals (Sher and Al-Yemeni, 2011). Population density of these annual species varies from year to year, depending on the amount of rainfall and the amount of seeds remaining from previous years. The western region is rich in vegetation when compared to the central and eastern region. The north-western mountains are rugged and floristically poorer than the south-western mountains, with affinities to the Mediterranean and North African floristic regions. The south-western region is the richest in terms of species diversity, with elements of all chorological units being found. The African element is especially noticeable, adding many species. The south-western area also contains the highest concentration of endemics, despite the fact that these high altitude areas are heavily populated with human settlements dating to ancient times.

The flora of Saudi Arabia is moderately well known at the taxonomic level. Species richness of the 15 Protected Areas administered by the National Commission for Wildlife Conservation and Development, as well as many of the areas under the administration of the Ministry of Agriculture, is well documented (NCWCD, 2006). Hence the relationships of the flora to surrounding areas, as well as the numbers of endemic taxa are well established. The 2,250 species of flowering plants in Saudi Arabia belong to 132 families and 837 genera. About 105 species inhabit sand dunes, 90 are halophytes, 75 are trees and 12 are aquatic plants. It is also reported that no families or genera of flowering plants are endemic, but there are some 246 species that are considered regionally endemic (James, 1990; Ahmad and Ghazanfar, 1991; Alyemeni and Sher, 2010). However, further study is required on the flora of Saudi Arabia to attain a better knowledge of some poorly known floristic elements that occur in the remote pockets of Asir Mountains (Figure 1).

Studies revealed that about 450 species of flowering plants (that is, 18% of the total flora) have direct benefit to man and 45 species (1.8%) are poisonous. Some 334 species (13.4%) are used in folk medicine or are known to have medicinal value. Thirty-eight species are important palatable fodder plants, 6 are important as fuel wood, 25 species are human food plants and 47 species are used as ornamentals or for other purposes (El-Sheikh, 1996; Sher and Al-Yemeni, 2011). Related to the modest numbers of species and levels of endemism, most families of flowering plants have only a very small proportion of their worldwide total numbers of species found in Saudi Arabia. Exceptions are two small families, the Ceratophyllaceae and Barbeyaceae, in which all known species occur in the Kingdom.

In contrast with the flowering plants, gymnosperms,

Figure 1. Location map of the study area (survey was mainly conducted in sites colored in green).

pteridophytes, bryophytes, fungi and algae are neither well known nor documented by the experts working in the country. Therefore, we suggest that further study is required to ecologically and taxonomically evaluate all phanerogames of the country, as these plants have significant contribution in structure and function of ecosystem. The authors personally observed that Saudi Arabia has economically and ecologically important desert truffles, but till now no one has properly studied the ecology and taxonomy of this important natural resource.

The geographical location of Saudi Arabia has provided

an ideal environment for the growth and nourishment of different medicinal and aromatic (MAP) species. MAP species are one of the most important elements of biodiversity that usually grows in the arid and semi-arid region of Saudi Arabia and possesses high pharmacological, economic and ecological values. Different parts of MAP species are sold in large quantities both in national and international markets, indicating its importance as a source of income for the inhabitants of the arid and semi arid areas of Saudi Arabia. Due to indiscriminate and over harvesting, some MAP species have become rare and sparse in many parts of Saudi Arabia as well as in other parts of the world. Such as uncontrolled collection of MAP species made them candidate species to be monitored as a part of meeting the international obligations under the Convention on Biological Diversity (CBD) and Saudi National Biodiversity Strategy and Action Plan.

The country on the whole has serious problem with the loss of floral richness and diversity (NCWCD, 2006). Deforestation, followed by heavy grazing/browsing by camels/goats and conversion of natural land into commercial and agriculture area are the major factors behind the rapid loss of biodiversity in general and floral diversity in particular.

GLOBAL SIGNIFICANCE OF MAPS

The global importance of medicinal and aromatic plants (MAPs) is evident from the fact that in 2007 worldwide trade of MAPs touched upon 60 billion US dollars (Sher et al., 2010). With the increase in demand for MAPs, such trade is expected to further grow to 5 trillion by the year 2050. Beside health benefits, MAPs provide crucial livelihood options for millions of rural people in South Asia and African countries, particularly women and low income groups. The World Health Organization (WHO) well documented that 80% population of Africa still use medicinal plants in their primary health care (Hussain, 1987; Jabar and Ahmad, 1987). The popularity of herbal drugs in the Middle East, Indo-Pak subcontinent, China, Japan, Europe, South America and in other countries is increasing day by day. Scientific surveys already concluded that growth and harvesting of medicinal plants are the main income source for different tribes living in remote areas like in the Northern Parts of Pakistan (Sher et al., 2011). However, commercial harvesting threatened the availability of more than 15,000 medicinal plants throughout the world and posed a serious problem as regards biodiversity conservation issues are concerned (El-Sheikh, 1996; Jabar and Ahmad, 1987). It is also worth mentioning that the use of wild edible herbs/culinary plants is increasing in the global food market for diverse items ranging from salads to desserts. WHO also launched global recommendations and programs for global integration of herbal medicine in health care system (Sher et al., 2010). To achieve such a goal, proper identification of medicinal plants and the conservation of sites where such plants are grown naturally are considered essential. In several developed countries, well planed research projects, and official moves are part of contribution to Target-5 of the Global Strategy for Plant Conservation.

The pressure arising from the implementation of WTO (World Trade Organization) rules is opening new avenues for the diverse use of wild herbs such as their uses as herbal dyes, herbal fertilizers and pesticides and other biocides. Saudi Arabia has an immense wealth of wild flora that contains important bioactive agents and has the potential of promoting the use of herbs and their useful biochemical compounds in various industries. However, like many other developing countries, it is yet in the developing stage and needs concerted efforts in different areas such as documentation of available flora and their traditional uses, discovering potential uses through phyto-chemical analysis through industrial application, tests, intellectual property rights, certification of products, expanding cultivation trials, *in-situ* conservation for threatened species, commercial production, and international marketing along with conservation and development as well as transfer of technology to the grass root level.

In this context, we realize the importance of the biological heritage of the mountainous and arid ecosystem of the country, with the aim to take a number of substantive measures to protect its biological diversity with special reference to MAPs. The current study, therefore, aim to provide baseline studies and useful suggestions to conserve globally significant MAP species and associated habitats in different ecologically important core area and hotspots (of biodiversity) of Saudi Arabia.

METHODOLOGY

Rational for selection of medicinal plants diversity

Biodiversity conservation is a huge subject and we, therefore, decided to concentrate on one particular category of plant use: the medicinal and aromatic plants. Accordingly, a MAPs conservation activity was launched and two considerations guide our choice. Firstly, the use of plants as medicine represents by far the largest category of use of plants or animals in terms of number of species (50,000 to 70,000 plant species worldwide (James, 1990; Ahmad and Ghazanfar, 1991). Secondly, MAPs connect to three basic human interests –health, income and culture identity– representing potentially powerful motivational forces for conservation and management.

The great majority of MAPs are harvested in the wild rather that cultivated a state of affairs that will certainly continue. The big methodological challenge in the conservation of MAPs is to determine how the management of wild MAPs can be improved. Conservation of wild MAPs requires conservation of their habitats and thus success in conserving MAPs (driven by the motivational forces, i.e. health, income and culture) has the potential to benefit many other types of plants and animals too.

In addition to the above mentioned criteria, ecological study on MAPs will be supportive to target 7 of Millennium Development Goals (‘Ensure Environmental Sustainability’), agreed at the Earth

Summit in Johannesburg in 2002, and the Global Strategy for Plant Conservation (GSPC) agreed in 2002 under the United Nation Convention on Biological Diversity (CBD). The Kingdom of Saudi Arabia is signatory of the CBD protocol and now bound to conserve 15 to 20% of the MAPs habitats (Chaudhary and Al-Jowaid, 1999).

General procedure

A study on the Ethnopharmaceutically valuable plants species of Saudi Arabia was conducted during spring and summer 2010. Prior to exploring the ethno medicinally important plant resources, topo-sheet, map and other general information of the investigated area were obtained from Ministry of Agriculture and water, Riyadh, Saudi Arabia. The area was accordingly divided into different sites and then frequent visits were made first in May, second in June and July, and third in August and September 2010. A semi-structured questionnaire was devised to document the traditional knowledge of local people regarding medicinal plants.

Pre-test

To identify any amendments required to the questionnaire, a pre-test was conducted in the nearby village of the valley. This was conducted in the first week of April 2010. Any revisions needed as a result of this pre-test were noted and undertaken in the following day of the pre-test.

Field survey

The traditional uses of ethnomedicinal plant resources were gathered from the local people. Participatory techniques were used to collect information and the main techniques and tools used to gather ethnobotanical data were household surveys, key informant interviews and focus group discussions. Generally, the respondents were elderly person and their age group varies from 40 to 60 years and total 218 households out of 400 were contacted and interviewed during the household survey. Their interest as local user, collectors and traders of medicinal plants were documented through questionnaire. Generally those elder persons whose practical knowledge was respected by others and those who practice popular folk medicines were contacted and interviewed about the plants. Information about the local names, local uses, parts used, time of collection, processing and recipe preparation were known and recorded from those local peoples.

Plants specimens were collected dried preserved and mounted on standard herbarium sheets and were identified with the help of available literature of Jabar and Ahmad (1987), Ministry of Agriculture and Water (1987). The nomenclature was later on confirmed from National Herbarium, of KSU, Riyadh, Saudi Arabia. A set of voucher specimens was deposited to National Herbarium, of KSU, Riyadh, Saudi Arabia.

RESULTS AND DISCUSSION

The overall goal of the study was to provide baseline studies and useful suggestions to conserve globally significant and endangered medicinal plants and their unique habitats. In this context the current study generally observed that the main threats to biodiversity in general and medicinal plants diversity in particular are associated to external pressures, such as human population increase (through internal growth and immigration), unplanned infrastructural development, localized overgrazing and over-exploitation of medicinal plants for both domestic and commercial purposes, and climatic change. Furthermore, lack of public awareness, lack of institutional capacity to perform mandates, fragmented information and insufficient coverage by the protected areas system, and underdeveloped monitoring and evaluation systems are additional causes which pose a threat to biodiversity. Moreover, management of threats including fire and invasive alien animal and plant species are not adequately linked to natural resource and biodiversity priorities. Therefore, all these factors synergistically enhance the adverse effects of each other for the loss of important biodiversity elements like medicinal plants.

This study also found that medicinal plants are still the basic resource for human health in Saudi Arabia. Appreciation for the preventative and therapeutic value of herbal remedies, and the additional benefits of their low cost, wide accessibility, and cultural relevance remains very strong and deep rooted in Greco-Arab System of medicine and other traditional cultures of Arab world.

This study also reported that out of 2, 250 species of flowering plants of Saudi Arabia, up to 600 (that is, 26.6%) have medicinal value. This finding, nevertheless, needs further quantification and documentation of medicinal plants with respect to their ethnobotanical/ ethnomedicinal and ecological importance. Detailed results on their medicinal uses according to the Greco-Arab System of medicine, market potential and conservation importance under both ex-situ and in-situ conditions will be ready by the end of 2011.

Sustainable use

The project is working at a number of levels to build durable linkages between sustainable uses and its benefits by re-examining and defining the roles of the various components of the existing system as: Regulators (existing state management institutions); Consumers (commercial sector, including researchers); and Producers (landholders and resource users, including collectors, traders, healers, grazers, etc.) Recognizing that landholders and resource users are the *de facto* managers of biodiversity at the local level, and, through adjustments in the existing policy and regulatory system the project is altering the balance of land use in favour of biodiversity conservation by conditionally devolving authority to those closest to the resource.

The project has providing a platform that has enabled the interests of both the state and collectors to be discussed in a structured manner, and agreement to be reached on the way forwards. Furthermore, it has helped the state agency to understand that in enabling a system that allows local management of medicinal plant resources it is not abrogating its responsibilities, indeed it is furthering the process of governance by distinguishing

between *government – the power over* – and *governance – the power to.* While project area ultimately has power over the MAP resources in as much as it can stipulate the conditionality of any transfer of rights and responsibilities to the collectors, it is effectively strengthening local governance by giving power to the women and men collectors, processors, traders and *hakims* to conserve, and benefit from, the MAP biodiversity.

Regenerative capacity of MAPs diversity and grazing

As stated above, overgrazing constitutes one of the main threats to MAPs in Saudi Arabia. It is generally believed that a relationship exists between the growth of plants and the impact of grazing (Al-Yemeni and Zayed, 1999). The regeneration response of most of MAPs species to overgrazing is poor. Although most of the MAPs are non-palatable species, under certain conditions even their mature plants are grazed and browsed. As a result all the species do not reach to the maturity to complete their life cycle. Therefore, overgrazing reduces the regeneration of species. Ecologically speaking, overgrazing is a dove tall to the degradation of existing vegetation and reduces the spread of selected species not only through direct consumption but also through materially altering their habitat. However, still a detailed study is required to establish such relationship in different sites of the different intensities of grazing and impact on various plant species.

The indirect effects of overgrazing include soil compaction, mechanical injuries to seeding and soil organism. These practices increase the susceptibility of the soil to erosion and loss of soil fertility. The browsed part of the species is susceptible to fungus infestation.

Sensitivity of MAPs diversity to harvesting

Both the harvesting intensity and period of harvesting impact the regeneration of plants. Incorrect time and inappropriate methods of collection affect the three vital attributes essential for the replacement of plants species (Sher et al., 2010) as follows:

1. The means of dispersal or persistence at the site before and after collection/disturbance: Local people often collect whole plants (such as *Carelluma* spp.) before they have reached to maturity without regard to the development of their reproductive parts that is, seeds and fruits to allow for regeneration.
2. The ability of the species to establish and grow to maturity in a developing plants community: *Salvadora persica, Hyoscyamus* spp*.* and *Capparis spinosa* are slow growing plants and the wrong time of harvesting and disturbance drastically reduce their ability to survive in the plant community.
3. The time taken to reach critical life stage and due to incorrect harvesting of the species. *Rheum* spp. and*, Corydalis* spp. etc are not allowed to complete their annual life cycle of vegetation and reproductive growth.

Biological responses of medicinal and aromatic plants to the collection intensity and period vary from species to species. For example, the harvest of *Carelluma* spp. rhizomes by local gatherers usually takes place in summer; during this period, these plants utilize the roots' nutrients for the development of aerial parts including those organs responsible of reproductive growth (that is, fruits and seeds). If the local people gather the whole plant (as much as they found) of *Carelluma* spp. when they are in full blooming conditions (and thus before the fruits have been dispersed and the biological cycle completed), the regeneration and sustainability performance of the plants are seriously compomised.

The wrong time of collection not only depletes the active chemical ingredients but also affect the potential of their production and sustainability. Therefore, plants are more vulnerable to the present ongoing practice and methods of collection. While for *Carelluma* spp. the time of collection is appropriate but poor harvesting techniques (that is, the uprooting of whole plant) and over exploitation exacerbate sever threat to this species by causing unnecessary levels of damage. As a result the population size of *Carelluma* spp*.* and other MAPs is reducing due to their low regeneration and high rate of extraction in wrong time, coupled with the loss of habitat and related biodiversity (Mille and Cope, 1996).

Strategy for MAPs conservation and management in Saudi Arabia

A joint medicinal plant conservation and management approach has been proposed and designed involving the collectors, users, traders, and herbal pharmaceutical companies and resources management institutions. This approach aims to promote sustainable and equitable management of MAPs by strengthening the capabilities of existing resource management institutions and formulating the local resource groups who can control access and monitor amount of harvesting and impact of harvesting. Moreover, strategies to develop participatory approach involving local community in the management should.

For the community based management, monitoring and evaluating activities. The focus will be the formation of medicinal plants users groups. The existing group of users is to be encouraged to form official MAPs users group involving different parties from the valleys local people and local institutions. The MAPs users' group committee should plan, monitor and evaluate medicinal plants management. This local committee should provide harvesting permits, specifying the species, parts use

amount, harvesting technique and collection sites within the boundary of the valleys, which each collectors and dealers must obtained from the committee before collection.

The proposed conservation and management activities of MAPs should be integrated with the grazing pattern of and it should be maintained systematically and sustainably. There are several traditional rules and regulations, still followed by the community in the area regarding the management of forest and pasture resources.

These rules and regulations together with other sustainable and well-adopted system like provision of fine, use of scientific calendar for resource harvesting, determination of specific days for harvesting resources etc. should be strictly followed by the committee while managing the medicinal plants.

The committee should monitor the population of harvested, non-harvested amount of harvesting and impact of harvesting. Population performance could evaluate at regular intervals (monthly or fortnightly) over the growing season of the plants. Local monitoring system could involve the use of different local indicators like cutting the number of plants in different age classes and observing the general performance of plants like robustness, wilting, leaf colour change, high change etc.

The following are the main (preliminary) achievements/results of the current ongoing study on medicinal plants biodiversity conservation strategy:

1. The project has established a national committee which is formulating a National Strategy and Action Plan for the conservation and sustainable use of medicinal plants.

Enhancement of global biodiversity conservation and sustainable use in the target site by implementing various activities on protection and management of medicinal plants and habitats. The designation of enclosures for strict protection of threatened endemic species will directly benefit overall plant diversity and density.

2. A gap analysis report on MAPs information has been developed and baseline data on the ecological surveys have been also completed

3. Local community capacity has been enhanced in dealing with conservation, sustainable management and production, and marketing of medicinal plant resources.

4. The project is maintaining its communications programme through regular e-bulletins, exhibitions, presentations, media releases and brochures.

The knowledge and capacity needed to deal with the issues that affect biodiversity in the region has also been enhanced and the programme's awareness campaigns have helped raise civil society's involvement and participation in conservation issues.

5. A strategy is being developed to tackle the problem of invasive species. Major stakeholders have agreed to concentrate clearing operations in priority areas.

CONCLUSION AND RECOMMENDATIONS

Saudi Arabia host many endemic and endangered species of MAPs, many of them have high pharmaceutical and economic value. Our study revealed that only few species were known while several species of MAPs were completely unknown to the community and plant scientists of the country. Indigenous knowledge behind the uses, collection and management of MAP species is fastly eroding. One reason for this is the lack of awareness among the local community regarding the economic and medicinal importance of MAPs. Another factor contributing in the declination of MAPs cover and eroding of indigenous knowledge is the inadequacy of the MAPs market and lack of government support. This is, therefore, an issue of national policies and must be addressed by the Ministry of Agriculture of Saudi Arabia. The approach to improve or restore the ill effects of resources misuse and economic degradation should be in multiple directions, from improving the economic standard to changing the attitudes of the local people should be adopted in future.

The population sizes and potential density of MAPs are fastly decreasing; adequate size of *in-situ* conservation plots is urgently required for the better management of MAP species. One important lesson learned from the current study is to establish community-based companies that depend on local biodiversity and can be adopted as a strategy to provide more equitable returns to community groups and hence incentives for conserving the resource base. This type of efforts may help in better understanding of local plant resources and potential MAPs. Lack of knowledge regarding the local potential at the national level would eventually lead to the genetic erosion of MAP species and the related indigenous knowledge system. In order to ensure the management and conservation of MAP diversity, documenting of indigenous knowledge system and its constant and consisting support is essential.

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REFERENCES

Ahmad HA, Ghazanfar SA (1991). Conservation of medicinal plants on the Arabian Peninsula. Two case studies (*Salvadora persica* and *Glycyrrhiza glabra* var. *glandulifera*). Med. Plant Conserv., 3: 15-16

Al-Yemeni MN and Zayed KM (1999). Ecology of some plant communities along Riyadh Al-Thumamah Road, Saudi Arabia. Saudi J. Biol. Sci., 6(1): 9-26

Al-Yemeni M N (2000). Ecological studies on San dunes vegetation in Al-Kharj region, Saudi Arabia. Saudi J. Biol. Sci., 7(1): 64-87.

Al-Yemeni M, Sher H (2010). Biological spectrum with some others ecological attributes of the Flora and vegetation of the Asir Mountain of South West, Saudi Arabia. Afr. J. Biotechnol., 9(34): 5556-5565.

Chaudhary SA, Al-Jowaid AA (1999). *Vegetation of the Kingdom of Saudi Arabia*, National Agriculture and Water Research Center, Ministry of Agriculture and Water, Kingdom of Saudi Arabia.

El-Sheikh AM, Shoukat AC, Hassan HM, Al-Farraj MM (1996). Endangered or rare plant species in Saidu Arabia, Technical report submitted to NCWCD, Riyadh, Saud Arabia.

Hussain AA (1987). *Medicinal plants in southwestern Saudi Arabia*. Department of Biology, College of education, King Saud University Abha Branch

Jabar BSM, Ahmad MM (1987). *Medicinal plants of Saudi Arabia*, Main Library, King Saud University, Riyadh, Saudi Arabia, 1

James PM (1990). Flora of the eastern Saudi Arabia. National Commission for Wild Life Conservation and Development, Riyadh, Saudi Arabia.

Mille AG, Cope TA (1996). *Flora of the Arabian Peninsula and Socotra*, Edinburgh University, National Commission for Wildlife Conservation and Development (NCWCD), Saudi ArabiaMinistry of Agriculture and Water Riyadh, Saudi Arabia (1987). Conservation of natural resources in the Kingdom of Saudi Arabia, Proceedings of the 1st Symposium of on Natural Resource Management in Middle East Riyadh Saudi Arabia, pp. 10-17.

National Commission for Wildlife Conservation and Development (NCWCD) (2006). The management plan for conservation of juniper woodland. Technical Report submitted to NCWC, pp. 1-141.

Sher H, Al-Yemeni MN, Yahya SM, Shah AH (2010). Ethnomedicinal and ecological evaluation of *Salvadora persica* L: A threatened medicinal plant in Arabian Peninsula. *J. Med. Plants Res.,* 4(12): 1209-1215Sher H, and Al-Yemeni MN (2011). Ecological investigation of the weed flora in arable and non arable lands of Al-kharj, Saudi Arabia. Afr. J. Agric. Res., 6(4): 901-906.

Sher H, Alyemeni M, Khan AR, Sabir A (2011). Assessment of local management practices on the population ecology of some medicinal plants in the coniferous forest of Northern parts of Pakistan, 18(2): 141-150.