Traditional Knowledge of Wild Plant Species Used by Local People Inhabiting the Southern Part of Wadi Araba Desert in South-West Jordan

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Abstract

Background

Ethnobotanical research studies in Jordan mostly targeted the medicinal uses of plants ignoring the other important uses. Comprehensive documentation of traditional knowledge of using native plants in the delicate desert ecosystem is very crucial for prioritizing biodiversity conservation and socio-economic improvement programs. This study therefore documents and analyzes the traditional knowledge of native plants used for grazing, firewood, food, and medicine by local inhabitants of the southern part of Wadi Araba desert in southwest Jordan.

Methods

The information was obtained using a structured survey targeting 296 informants inhabiting the southern part of Wadi Araba. The documented data was quantitatively analyzed by calculating the frequency of citation for the uses categories and species used.

Results

The results showed that the most important species used as a source of feed for the grazing animals and for firewood is *Haloxylon persicum*, which also indicates that the species is under overexploitation stress. About 91% of the informants mentioned that they collect plants for medicinal uses compared to 7% who collect them for food, and 6.4% of the informants mentioned that they get the plants from their families and they rarely cultivate them. The informants attributed the reduction in vegetation cover to the lack of water and overgrazing. Whereas, firewood scarcity and long distance to the grazing and wood cutting sites are the most obstacles that face firewood collection.

Conclusion

Our study concluded that the local people of the study area are still interested in the utilization of the native plants in their surroundings as their ancestors did. Yet, there is some pressure on certain plant species and certain geographic areas that conservation and development programs should take into consideration. This information obtained in this study is interesting for economic improvement and biodiversity conservation programs in adopting small businesses that cultivate the most collected plants to reduce pressure on the ecosystem and to generate income for local families.

Introduction

Despite the desertification and climate change that are exacerbating biodiversity erosion in the dry areas, some local people in the surrounding delicate ecosystem still count on the native plants to sustain some needs. They still collect and use wild plants for food, medicine, shelter, dyes, firewood, grazing, and they are also considered an important part of their culture and arts. These different uses by people over the

years formed the indigenous or traditional knowledge on plant uses that was inherited from one generation to another.

Recently, many natural ecosystem conservation and management programs use the traditional knowledge as an indicator for changes of species/vegetation abundance over the years and also to prioritize species protection activities and development programs. According to Mattalia et al 2018, the pastoral communities hold living traditional knowledge that may offer solutions for resilient natural resources management around the world. However, this knowledge is seriously threatened worldwide due to the deterioration of the natural environment and the changes in lifestyle Varga et al (2020). Therefore, it is indispensable to record this traditional knowledge before it dies out by the disappearance of its old secret-keepers or by the lack of interest of the younger generations.

In Jordan, several studies targeting the traditional knowledge on the native plant uses have been performed. However, the majority of these studies targeted the medicinal uses ignoring the other different important uses, amongst the others are Al Tabini et al 2012; Aburjai, 2007; Oran, & Al-Eisawi, 2015; Nawash, O. and Horani 2011, Nawash et al. 2012. On the contrary, the traditional knowledge on other uses like grazing and wood cutting was not satisfactorily documented particularly in the desert ecosystems of Jordan. Recently, some community-based ecosystem rehabilitation programs were adopted and implemented successfully. Some of these programs utilized the traditional knowledge on the local uses of native plants to improve the quality of life of local people and to preserve biodiversity. Yet, there is still a crucial need to document the traditional uses of plants comprehensively to get wider and various choices of local people-based ecosystem rehabilitation projects.

Wadi Araba desert ecosystem in southwest Jordan harbors a Saharo-Arabian vegetation type with African vegetation penetration that is inhabited by local nomads. The majority of these nomads are herders that their income is falling close or below the poverty line Alassaf et al (2021). The delicate vegetation is still providing the local people with different services including firewood, feed for animals, medicine, and food. Some plant species that are endemic to this area are vulnerable or endangered according to the IUCN of Jordanian threatened plant species. With the elevated poverty, climate change and with the presence of pandemic that made the economic situation worse, it is very important to focus on creating small projects that both people and the ecosystem get rewarded from.

Given the need to record and evaluate the traditional knowledge on native plant uses in the desert of Wadi Araba for biodiversity conservation and socio-economic development purposes, we aim at collecting and analyzing the traditional different uses of wild plants by local people in the study area for (1) grazing, the grazing season and the percentage of reliance on them (2) firewood (3) food and medicine and (4) the changes of the plant abundance as noticed by local people

Methods

Study area

Wadi Araba desert extends along 170 km from the southern part of the Dead Sea in the North to the northern part of the Gulf of Aqaba in the south. It is bounded between latitudes 31° 11' N and 29° 07' N, and longitudes 35° 31' E and 35° 00' E. The area of Wadi Araba is characterized by the presence of Saharo-Arabian vegetation type penetrated by Sudanian vegetation and surrounded by the Eastern mountains dominated by Mediterranean vegetation type. This study will focus on the southern part of Wadi Araba particularly the areas of Rahmah, Qatar, Al-Reshah, and Beir Mathkour Fig (1).

Data Collection and interviewees

Data on the traditional knowledge of the local communities in Wadi Araba were collected between November 2019 to January 2020. The random sampling method was used to select 296 residents, we tried to select respondents to reflect equal proportions of men and women. The sampling size from each community was determined based on each community size. The respondents were selected based on their gender and willingness to participate in this study, thus each respondent gave written consent to participate in this survey, according to the ethical approval granted by the National Agricultural Research Center (NARC) and the University of Jordan to conduct the study according to the general regulations in both institutions.

A three-part structured questionnaire was designed to capture information and opinions of respondents on the traditional uses of plants and animals living in Wadi Araba. The first part covered the demographic information of the respondents, such as gender, age, income, family size, and education. The second part focused on the traditional knowledge on the flora on Wadi Araba besides respondents' opinions and perceptions on the vegetation cover and status. The third part is dedicated to collecting information and opinions about flora in Wadi Araba and its uses and such as the wild and edible plants, complete disappearance of plants, plant cover, and the dependence on collecting firewood. Voucher specimen were deposited at the University of Jordan Herbaria. The plant names were reviewed according to the Plant List website.

Demographic features of the participants

The demographic profile of the participants consists of gender, age, family size, education, and occupation. Due to the conservative nature of the local communities in Wadi Araba, 68.6% of the respondents were male and most of them were married (83%). The survey targeted respondents of different ages; thus, the average age was about 43 ± 12.2 years, and on average they had finished the 9th grade ± 2.8 school years. Wadi Araba is known as one of the poorest regions in Jordan where the average monthly income of respondents was about JOD 324 ± 147.8 , which is close to the national poverty line (JOD 323). A large percentage of the respondents (26.7%) were housewives. While other 23 % of the respondents (male and females) were working at governmental institutions and other 15.5% were retired from the public institutions and military forces, and very few (2%) were farmers.

Data Analysis

The citation

To interpret the data collected, simple calculations were carried out. Each time the species or use was mentioned by informant is considered several citations or occurrences. The Frequency of Citation (FC) was calculated following Faruque et al. (2018) as follows: $FC = (\text{Number of times a particular species was mentioned}) / (\text{total number of times that all species were mentioned}) \times 100$

Results And Discussion

Grazing and plants consumed by livestock

A total of 73% of the respondents noticed a difference in the rangeland density in the past 5 years. Similarly, 74% of the informants mentioned that there are certain wild plants (28 species) that are preferred by the grazing animals. The most important one is *Haloxylon persicum* that was cited 67 times by the informants followed by *Acacia tortilis* (54 times), both as the native plants desired by grazing animals in all seasons (Table 1). *Haloxylon persicum* is a highly palatable desert shrub for livestock (Zhang 2000). Local women herders in Wadi Araba practiced hitting the *Acacia tortilis* and *Acacia raddiana* tree's branches to let the pods fall down for feeding the small grazing animals like goats. Camels due to their big heights browse the plant without the help of herders (Nawash 2006). On the other hand, there was a remarkable drop of citation frequencies for the other species with fair citation frequencies for *Tamarix tetragyna*, *Reatama Ratem*, *Hammada salicornica*. This may be attributed to the less desirability or palatability of the other species by the grazing animals. *Retama ratem* is preferred for its pods and leaves according to Neffati and louchaichi (2015) and should be browsed as soon as they emerged as it falls within two weeks after emergence. *Tamarix tetragyna* is a common halophyte that dominates saline marshes and Taba Inland Sabkha in south Wadi Araba. It's considered a high potential non-traditional fodder producing desert halophyte and its high animal nutritive value and low water requirements (Zahran and El-Amier 2013). Our study showed that 17 out of 18 informants that mentioned this species as a source of fodder also mentioned that they use it in all seasons. Thus, it could be an excellent plant to be included in the vegetation regeneration programs in Wadi Araba as a sand dune fixer, salt and drought resistant, and high fodder producing plant.

Regarding the grazing season, about 73% of the informants cited that their animals graze on the natural vegetation in all seasons and 20% of them mentioned spring as the season to count on natural vegetation to feed their animals. Summer and winter were rarely mentioned as grazing seasons. The majority of the species mentioned to be grazed on in all seasons are perennial shrubs and trees. The percentage of reliance on the plants as a source of animal feed varied remarkably from 10 to 90%.

Table (1): Number of citations and grazing season and average reliance of local people on plant species of Wadi Araba study area.

Scientific Name	local Name	No. of citation	Grazing Season					Average of Reliance %
			Over the year	Summer	Spring	Winter	Spring and winter	
<i>Acacia raddiana</i>	Altalh	1	1	0	0	0	0	10
<i>Acacia tortilis</i>	Alsayal	54	36	3	5	0	3	37
<i>Achillea fragrantissima</i>	Qiasom	1	0		1			
<i>Ananbasis articulata</i>	Ajram	4	4	0	0	0	0	22
<i>Arnebia hispidissima</i>	Erniebeh	1	0	0	1	0	0	10
<i>Arnebia tinctoria</i>	Arnibah	1			1			30
<i>Artimisa inculata</i>	Shih	1			3			
<i>Calligonum comosum</i>	Al-Arta	1					1	
<i>Calotropis procera</i>	Oshar	1	1					30
<i>Cinchona spp.</i>	Kiniah	2	1			1		30
<i>Diplotaxis harra</i>	Al-Harah	1	0	0	0	0	0	1
<i>Eminium spiculatum</i>	Jaadeh	1			1			
<i>Erucaria boveana</i>	Alslih	2			2			20
<i>Globularia arabica</i>	Handagog	3	40		1			40
<i>Haloxylon persicum</i>	Ghada	67	35	2	3	1	1	50
<i>Hammada salicornica</i>	Alramth	10	9	0	1	0	0	26
<i>Helianthemum lippii</i>	Jard	2	2					30
<i>Lycium shawii</i>	Awsaj	8	2	0	5	0	1	31

<i>Malva sylvestris</i>	khobieseh	1	0	0	1	0		20
<i>Malva sylvestris</i>	khobieseh	1			4	0	0	
<i>Moluccella laevis</i>	Athnebeh	2	1		1			20
<i>Ochradenus baccatus</i>	ALQardy	8	7	1	0	0	0	24
<i>Prosopis juliflora</i>	Al-Salam	2	2	0	0	0	0	30
<i>Retama rateam</i>	Ratem	14	11	0	2	0	1	31
<i>Rumex cyprius</i>	Al-humied	7			7			56
<i>Salsola baryosma</i>	Tartir	5	5	0	0	0	0	33
<i>Suadea vera</i>	Al-Sabt	1	0	0	1	0	0	0
<i>Tamarix tetragyna</i>	AL-Tarfa	18	17	0	1	0	0	31

Medicinal and Food uses

The majority of the informants (87%) stated that medicinal and nutritional plants are available in their surroundings against 13% who denied that. Likewise, about 91% of the informants mentioned that they use these plants for medicinal and health purposes versus 7% of informants that mentioned that they use them as a source of food (Fig 2). This indicates that using medicinal plants is still active in the study area. The collected quantities mentioned for both uses are very small ranging from 0.05 to 0.5 Kg, annually. This may be attributed to the small amount of plant material needed for medicine and health and also the rarity of the plant abundance in the fragile desert ecosystems.

Generally, the majority of local people (92.3%) target their surroundings to collect the needed plants and small group of them (6.4%) get them from their families (Fig 3). However, they rarely cultivate or purchase plants for medicinal purposes. This may draw the attention of ecosystem services and conservation programs to support technically and financially small projects to produce the most needed plants in order to reduce the pressure on the natural resources and improve the income of the local people.

A total of 32 species were mentioned by the informants to be used for food or/and medicine with a remarkable presence of the genus *Artemisia* as a medicinal plant (Table 2). It is one of the largest genera in the Asteraceae family with more than 500 species and it is used in the treatment of different ailments and as folk remedies since olden times (Abad & Bedoya 2014). The Local people in the Middle East and North African countries prepared a mixture of dry leaves as a Parasitical drug that is composed of

Artemisia judaica, *Artemisia oncosperma* and *Artemisia inculata* (Ahmed and Habeeb 2009). *Artemisia judica* or known in the common Arabic language “Be’athran” is endemic in Jordan to the Wadi Araba area (Nawash and Al-Horani 2011) and is being intensively used over the years as firewood and to prepare herbal tea. It is considered a vulnerable species according to the IUCN RED list of Jordan 2014).

Eminium spiculatum, or Jadeh as named locally is well known medicinal plant in Jordan used by local people for diabetes was cited 92 times as medicinal plant in this study. Research in Iraq showed a remarkable blood anti-coagulant feature (Al-Farwachi, and Albadrani 2013) and anti-microbial and anti-fungal activities of *Eminium spiculatum* leaf extract (Suleman et al. 2018)

Although *Origanum syriacum*, in Arabic (Zatar) an aromatic plant that is well known as food in the Jordanian and Mediterranean diet, its mostly cited as a medicinal plant by 57 informants compared to 3 only citing the species as a food and 3 citing for both uses. This

Other plants species that are mentioned by the informants and are well known for their medicinal features are *Cassia senna*, *Cloeme droserifolia* and *Rumex cyprius*.

Table (2): Number of citations of the uses of plants for food and medicine and their sources

Plant Scientific Name	No. of citations	Source of plant				Uses* followed by No. of Citations
		No. Of citations				
		Cultivation	collecting	Purchasing	Family	
<i>Achillea fragrantissima</i>	121	1	110	1	9	M117, F1, B3,
<i>Artemisia inculata</i>	125	1	114	3	10	M
<i>Artemisia judiaca</i>	124	0	108	1	13	M121, F3
<i>Artemisia monosperma</i>	3	0	3	0	0	M
<i>Cassia senna</i>	24	0	24	0	0	M
<i>Cichorium pumilum</i>	8	0	8	0	0	M
<i>Cinnamomum camphora*</i>	3	0	3	0	0	M2, B1
<i>Cistanche salsa</i>	4	0	4	0	0	M3,M1
Citrullus colocynthis	2	0	2	0	0	M
<i>Cleome droserifolia</i>	15	0	15	0	0	M14,F1
<i>Crataegus aronia</i>	1	0	1	0	0	M
<i>Crocus aleppicus</i>	1	0	1	0	0	F
Cucumis prophetarum	4	0	4	0	0	M
<i>Eminium spiculatum</i>	92	0	82	1	6	M84, F3, B3
<i>Ephedra aphylla Forssk</i>	9	0	9	0	0	M
<i>Erucaria boveana Cosson</i>	3	0	3	0	0	M1,F1,B1
<i>Gagea reticulata</i>	5	0	5	0	0	M
<i>Globularia arabica</i>	2	0	2	0	0	M1,F1
<i>Hammada salicornica</i>	1	0	1	0	0	M
<i>Helianthemum lippii</i>	1	0	1	0	0	F
Juniperus phoeenicea	1	0	1	0	0	M

<i>Malva sylvestris</i>	5	0	5	0	0	F
<i>Matricaria aurea</i>	2	0	1	1	0	M
<i>Neurada procumbens</i>	1	0	1	0	0	M
<i>Origanum syriacum</i>	65	0	63	0	2	M57, F3, B5
<i>Parietaria alsinifolia</i>	1	0	1	0	0	F
<i>Paronychia sinaica</i>	1	0	1	0	0	M
<i>Prosopis frakta</i>	8	0	8	0	0	M
<i>Rumex cyprius</i>	9	0	9	0	0	M5,F3,B1
<i>Salvadora persica</i> L.	1	0	1	0	0	M
<i>Silene vulgaris</i>	1	0	1	0	0	F
<i>Urtica pilulifera</i>	2	0	2	0	0	M1,F1

*Uses: M=Medicine, F=Food, B=both.

*Numbers followed by the letter of use is the number of citations for that use

Local knowledge on wood cutting

Wood cutting for fire is practiced by 62% of the local community in Wadi Araba versus 38% that do not collect wood. The frequency of citation values plant species mentioned as source of firewood is represented in table (3). Not surprisingly, *Haloxylon persicum* (Al-Ghada), is the top native plant species (FC=57) that is collected for firewood due to its long-lasting spark qualities. The plant is remarkably distributed over the sand dunes in Wadi Araba and Wadi Rum deserts in Jordan (Nawash 2006).

According to Zohary (1940), the deserts of Central Asia yield up to 50,000 kg of *Haloxylon persicum* charcoal per hectare. The population of *Haloxylon persicum* as a plant for firewood; and for fodder as discussed in section () facing threat due to over-grazing, habitat destruction and over collection for wood and charcoal (Alkhalifah and Shanavaskhan, 2007). Suliman, (2018) Concluded in an ecological and botanical diversity study that it is critical that the Kingdom of Saudi Arabia and other nations in which *H. persicum* occurs to protect the species because due to the vital role it plays to the desert ecosystem topography and stability. Moreover, not missing the cultural value of the plant in the Arabian deserts which was mentioned in many poems, tales and songs Nawash (2008).

Acacia tortilis had the second high frequency citation value (FC =40) as firewood plant used by the informants. Studies showed that it is a good bio-source of energy Charis et al (2019). Moreover, research

results done by (Nasser and Aref 2014) showed that it **had the highest heating value amongst six acacia species grown in southwest Saudi Arabia.**

Anabasis articulata, *Retama raetam* and *Prosopis juliflora* got low frequency citation values. They may be due to the low quality of these plants wood as a firewood as they are kept green all year round and the quality of the wood for fire.

The shrub *Calligonum comosum* was not mentioned as source of wood despite its presence in the area and its smokeless burning wood quality and many other valuable uses. This may be explained by the dramatic decline and low abundance of the species population in its natural habitats. In Jordan, the species is listed as endangered species in the IUCN red list due to overgrazing and agricultural transformation Taifour and EL-Oqlah (2014)

Table (3): Frequency of citations of native plants used as firewood

Plant species	Arabic name	No of times the species was mentioned as used for firewood	Frequency of citation (FC)
<i>Haloxylon persicum</i> Bunge	Al Ghada tree	145	57
<i>Acacia tortilis</i> (Forssk.) Hayne	Al Sial tree	102	40
<i>Retama raetam</i> (Forskal) Webb & Berth.	Retem	3	1
<i>Anabasis articulata</i> (Forssk.) Moq.	Al Ajram	4	1.5
<i>Calligonum comosum</i> L'Hér	Irtā'a	0	0
<i>Prosopis juliflora</i> *	Al Salam	1	0.5

*Invasive not native species

Winter is the most favorable season for collecting wood. The total amounts of wood collected in winter is 302105 KG and that is almost 2.5 times of the summer amounts of a value of 124495 KG. The frequency of citation of use of wood for heating was 61% compared to cooking of 39%. On the other hand, none of the informant mentioned collecting wood to sell it in the market or for any other purpose rather than heating and cooking.

Firewood scarcity and long distance to reach the grazing sites are the most important factors mentioned by the informants as obstacles facing them when collecting firewood Fig (5). Firewood scarcity is a result

also to other factors like water shortage, drought and over grazing. Not surprisingly, grazing in border is an obstacle as due to the location of Wadi Araba at the border of Israel security issues the armed soldiers and mine buried in the land. Lack of water and higher demands of wood cutting are also factors that leading to the result in the main factor mentioned firewood scarcity.

Vegetation cover and species presence

About 74 % of the informants noticed a reduction in the vegetation cover percentage compared to 7% noticing an increment and 19% that reported no change in the percentage cover over the past 5 years. This variation is attributed variation within the habitats that encountered in the study area.

According to the local people's perception, drought is the shifting and irregularities of rainfall whereas lack of rain is related to quantity that is reducing along the years. According to the respondents, the most common factors caused the variation in vegetation cover are the lack of water/and rain and overgrazing with a frequency of citations 42 and 31.4, respectively. whereas, Fire wooding and drought are the second two important factors with a frequency of citations of 27 and 22, respectively (Fig 6).

In this scenario, we have two main factors causing the reduction on vegetation cover one is uncontrollable (rain, drought and high temperature) and the other is man-made or controllable (over grazing and wood cutting). The uncontrollable factors such as lack of rain and drought are results of climate change that are altering the ecosystems Memon et al (2018).

Conclusion

The local people of southern Wadi Araba desert developed a valuable knowledge on the different uses of plants that live in their surroundings. Despite the harsh desert environment, these plants sustain a good part of the people's needs for firewood, medicine and for the grazing livestock.

There is a pressure practiced on the delicate desert ecosystem in general and on some certain native plant species in particular. The perennials *Haloxylon persicum* and *Acacia tortilis* are extensively used as fodder and firewood. The genus *Artemisia* is remarkably used for medicinal purposes. This information that is based on people's traditional knowledge highlights the importance of initiating and prioritizing initiatives and small business that regenerate the deteriorated ecosystems and overexploited plants. For example, projects like propagating and producing endangered native plants yet intensively utilized e.g. *Artemisia judicia* could generate income for local families and reduce the pressure on natural presence of the species in its habitats. This also implies on other over exploited plant species in the context of the reduction of natural vegetation cover that is recorded by the interviewees.

Declarations

Ethical approval and consent to participate: Individual consent to participate in the study was obtained prior to the study by the administration of the questionnaire. Only people that consented to participate in

the study were considered. The authors also declare of no report on the involve or use of any animal or human data or tissue.

Conflicts of Interest: The authors declare no conflict of interest

Consent of publication: Not applicable.

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A.A., N.H managed the project.

All authors have read and agreed to the published version of the manuscript.

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Figures

Figure 1

A map of the study area.

Figure 2

Uses frequency of the plants recorded in the study area

Figure 3

Percentage of citations of the medicinal plant's sources used by the informants

Figure 4
Number of citations of the native plants collection sites

Figure 5

Factors responsible of the difficulty in collecting firewood according to the informants.

Chart Title

Figure 6

Percentage of citations of Factors causing reduction of vegetation over the years