Sharing the ecological knowledge of plants used in handicrafts as a survival strategy of rural communities of Dera Ghazi Khan district, Pakistan

Muhammad Sajjad, Zaheer Abbas, Shujaul Mulk Khan, Abdullah Abdullah, Sunghoon Yoo, Heesup Han, António Raposo and Rainer W. Bussmann

Correspondence

Muhammad Sajjad[1], Zaheer Abbas[1*], Shujaul Mulk Khan[2], Abdullah Abdullah[2], Sunghoon Yoo[3], Heesup Han[4], António Raposo[5] and Rainer W. Bussmann[6,7]

[1]Department of Botany, Division of Science and Technology, University of Education Lahore, Pakistan
[2]Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan
[3]Audit Team, Hanmoo Convention (Oakwood Premier), 49, Teheran-ro 87-gil, Gangnam-gu, Seoul 06164, South Korea
[4]College of Hospitality and Tourism Management, Sejong University, 98 Gunja-Dong, Gwanjin-Gu, Seoul 143-747, South Korea
[5]CBIOS (Research Center for Biosciences and Health Technologies), Universidade Lusófona de Humanidades e Tecnologias, Campo Grande 376, 1749-024 Lisboa, Portugal
[6]Ilia State University, Institute of Botany and Bakuriani Alpine Botanical Garden, Department of Ethnobotany, 1 Botanical Str. 0105 Tbilisi, Georgia
[7]Department of Botany, State Museum of Natural History Karlsruhe, 76135 Karlsruhe, Germany

*Corresponding Author: zaheer.abbas@ue.edu.pk

Ethnobotany Research and Applications 27:7 (2024) - http://dx.doi.org/10.32859/era.27.7.1-15
Manuscript received: 18/01/2024 – Revised manuscript received: 25/03/2024 - Published: 28/03/2024

Research

Abstract

Background: Craftwork is one of the vital components of phyto-culture worldwide. It offers a livelihood to marginalized communities in the rapidly changing environmental conditions with the preservation of cultural diversity. This study aimed to evaluate the indigenous knowledge about the utilization and cultural importance of plant-based handicrafts in the rural communities of Dera Ghazi Khan District, Pakistan.

Methods: In order to collect the desired data preliminary, surveys and field trips were carried out in sixteen remote sites of the study area from September 2021 to May 2022. Altogether, 105 respondents were sampled via snow-boll sampling techniques. Semi-structured interviews with open-ended questions were employed after getting verbal consent. The participants were evaluated for their ethnicity, age, language, education, and livelihood. The status, challenges and transmission of traditional knowledge were also assessed.

Results: Five plant taxa were recorded for craftwork, i.e., *Saccharum bengalense* Retz.(Poaceae), *Phoenix dactylifera* L., *Nannorrhops ritchieana* (Griff.) Aitch. (Arecaceae), *Typha latifolia* L. (Typhaceae), and *Tamarix aphylla* (L.) H.Karst. (Tamaricaceae). These species grow around wetlands and only *Phoenix dactylifera* L. was cultivated species. The participants

cited 49 handicraft products manufactured from the reported species. Maximum products (14. 28%) were made from the raw materials of *Phoenix dactylifera* L. followed by *Nannorrhops ritchieana* (Griff.) Aitch. (12, 24%), *Typha latifolia* L. (9, 18%), and *Saccharum bengalense Retz.(*8, 16%) and *Tamarix aphylla* (L.) H.Karst. (6, 12%). All these handicraft products were in rough and limited marketing loop. The documented species were also valued for traditional therapies of 25 diseases related to respiratory, digestive, urinary, dermal and cardiovascular systems. Relative frequency citations (RFCs) were ranged from 0.17 – 0.24 for calculated for *Nannorrhops ritchieana* (Griff.) Aitch. and *Phoenix dactylifera* L. respectively.

Conclusion: Similarly, in the current era of modernization, the traditional knowledge of crafting plants is seemingly underappreciated. Although it is still in practice with subjection to limitation, fragmentation, and eroding. In this regard, social discouragement, harsh socio-ecology, modern life patterns and shifting earning trends are potential factors for its depletion. Inclusion of this valued knowledge in school syllabi, development of vocational centers, and devising of a proper market chain could be game changers for revitalization and achievement of sustainable development goals for these impoverished but professional communities.

Keywords: Phytoculture, marginalized communities, craftworks, livelihood, modernization

Background

Plant-based traditional handicrafts (craftworks or simply craft) is the central component of global folk heritage (Nedelcheva et al. 2011, Abbas et al. 2019, Abdullah et al. 2020, Ding et al.2022). The products are manufactured by hand or by simple tools for purposes like furnishing, roofing, fencing, decoration, carrying, etc. (Bahru et al. 2012, Yadav et al. 2022). The handicraft industry plays a central role in income generation, poverty alleviation, and phytocultural preservation of remote and traditional communities globally (Dogan et al. 2008, Kang et al. 2017). A large percentage of these fiber goods are used in domestic activities such as furniture manufacturing and use, food preparation, and clothing manufacturing (Abdullah et al. 2020). Ethnobotanical research has also been used in the conservation of biodiversity, ecology, archaeology, and anthropology (Otieno et al. 2011). Despite these facts, ethnobotanical and ethno-geographic research concentrating specifically on handcrafted products is still rare, and studies attempting to examine the cultural diversity of handicraft products are extremely rare (Roosevelt 1999, Báez-Lizarazo et al. 2017). However, pervading industrialization, globalization and modernization have potentially risked maintaining and practicing this valued folk culture (Bruschi et al. 2014, Iskandar et al. 2022). Unprecedented environmental disasters (flood, drought, raised temperature) also adversely influence the growth, population, and distribution of these important plant taxa. The industries of crafting species are generally retained and limited domestically by the remote and rural population of the world for their livelihoods. On the other hand, they also promote the conservation of these thatching plants due to their survival dependency (Begossi et al. 2000, Reddy et al. 2008). Plants species employed for handicraft production are widely addressed in studies in many parts of the world (Savo & Caneva 2011, Karahan et al. 2015, Andesmora et al. 2017, Pullanikkatil et al. 2021). Pakistan hosts approximately 140 million rural populations (https://data.worldbank.org/) including pheasant, agro-pastoral and impoverished communities.

These communities have been engaged with handicraft practices for centuries as subsistence strategies in social hierarchies. But being a laborious activity with less profit, the generational interest is rapidly shifting towards other businesses (Arshad et al. 2022, Aziz et al. 2022). Ethnobotanical literature has well represented the medicinal taxa of the country, whereas the less is known about the plants valued for handicraft production. Research into plant species that are essential for crafting, including their accurate local names, scientific identification, and ecological characteristics, can provide insights into the conservation measures necessary to ensure their survival. Additionally, understanding the cultural context and the people who use these plants is crucial for effective conservation efforts. (Dogan et al. 2008, Báez-Lizarazo et al. 2017). It also enables the identification of the relative cultural significance of different plant species and their patterns of use within specific communities. The research was carried out in the remote tribal communities of DG Khan Punjab province, Pakistan. These communities live in typical villages life and reside between the Koh-e-Sulaiman range and the great River Indus. These marginalized human populations are considered as extremely underprivileged due to deprived of own cultivable lands and proper living systems due to dominant feudalism. These relegated people spend their life in small slums of flimsy huts and houses. In such circumstances they fight for their survival in the social hierarchies by small earning sources. In this study we hypothesized that handicraft plants have a pivotal role in the survival of these communities. With the passage of time the practice of plant-based handicraft will erode in the current pervading globalization and socio-cultural scenario. Therefore, present study was devised to explore the interaction of crafting plants with people of the study area with the objectives, 1) to document the diversity of plants used for handicraft industry in the rural communities, 2) to document the traditional knowledge regarding the plant processing and product manufacturing, 3) to discover the marketing scenario and role of handicraft plants in the livelihood of indigenous people.

Materials and Methods

Research area and field work

Dera Ghazi Khan (30'03" N and 70'38" E) is located on the west bank of the river Indus spanning an area of 13,740 Km^2 within an altitudinal range of 122-1972m (Malana & Khosa 2011, Ahmad et al. 2020). It is sandwiched between the River Indus and the Sulaiman Mountains (Koh-e-Sulaiman, Solomon Mountains) from the west and east respectively (Mazhar & Rehman 2019). It borders Dera Ismail Khan in the north and Rajanpur in the south as shown in (Fig. 1). The topographic feature is varied displaying eastern plain fields to western hilly and mountainous terrains. The Sulaiman Mountains separate the lowlands of the study area from Baluchistan's uplands (Ahmad et al. 2020). Occasionally rolls in sand waves, arid lands locally called Daman (desert) (Anwar & Khalid 2018). The soil are deep, well-shattered, generally textured, and calcareous with insufficient organic materials (Iqbal et al. 2019). All seasons can be observed. Prolonged summer is characterized by scorching heat with hostile diurnal and nocturnal temperatures. The annual temperature ranges from 4°C-46°C with scanty rainfall (5.512 inches) (Chughtai et al. 2013). Winter is short, cool and dry. However, western mountain terrains receive infrequent light snowfall may be received particularly at Fort Munro (1972m). Floristically, it is situated at the transition zone of Western Irano-Turanian and Saharo Sindian regions based on Ali and Qaiser (1986) phyto-geographic classification. Vegetation is dry subtropical types with the good presentation of scrub communities (Iqbal et al. 2019). Eco-physiologically, the plants are xero, chasmo and mesophytic in nature.

Significant macrophytic vegetation is growing along water bodies. *Moringa oleifera* Lam., *Eucalyptus camaldulensis* Dehnh. *and Bauhinia variegata* L. are the common tree species. The arid lands host several species *Rhazya stricta* Decne., *Nerium oleander* L., *Capparis spinosa* L. and *Withania coagulans* (Stocks) Dunal etc. According to the 2017 census, the population is 10 million less with a density of 200 people per square kilometer making up the demographic population density and 2.98 annual growth (Leghari et al. 2020). The area is predominantly inhabited by Seraiki speakers (81%) with Balochi (14.7%), Urdu (2.6%), Pashto (0.8), Punjabi (0.7%), Sindhi (0.1%) and others (0.1%) (Dad et al. 2016, Ullah et al. 2021). The urban people are engaged in various businesses and agriculture practices. The main crops are wheat, rice and cotton, but sugarcane, millet, corn, oilseeds, pulses, fruits and vegetables are also grown (Arim *et al*. 2016). The remote communities rely on daily wages or associated with low profit traditional practices such as collection of medicinal plants, wild edible food plants or fiber rich species used in handicrafts.

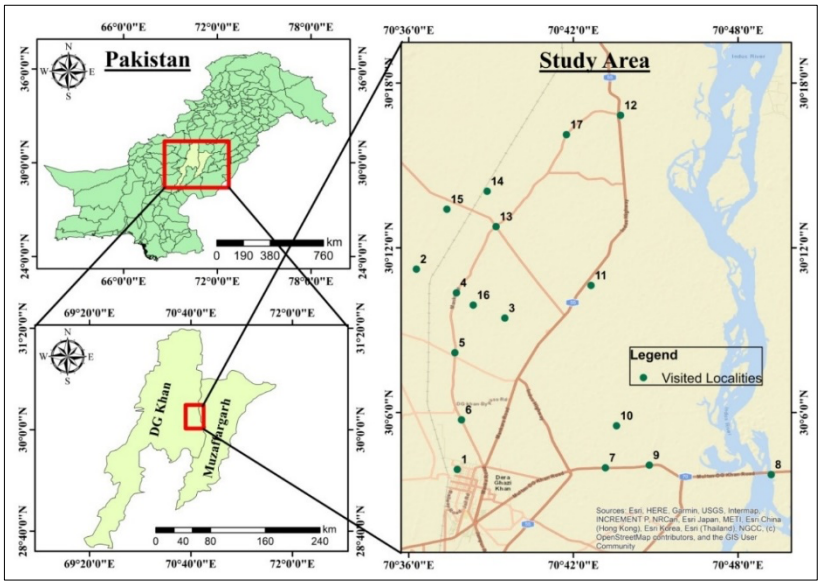

Figure 1. Map of the study area depicting visited localities.

Ethnobotanical Data collection

Preliminary surveys were carried out in the remote communities to collect information data regarding the diversity of handicraft plants, habitats of thatching plants, thatching/handicraft sites, thatched products, and marketing chain. During these field trips, informal and semi-structured interviews were made. The habitats, collection techniques and thatching sites were observed. Urban markets were also visited to collect information about the number of products, varieties, marketing chains and prizes. Finally, field notes were recorded, and a semi-structured questionnaire was developed.

Proper field trips were carried out in the study area from September 2021 to May 2022 to collect systematic data on plant taxa used in handicraft manufacturing. A total of sixteen localities were visited, i.e., Sakhi Sarwar, Bandha, Dohra, Yaroo Khosa, Chahbri Bala, Kot Haibat, Sarwar Wali, Ghazi Gahat, Drahama, Pul Shuriya, Pir Adil, Shah Sadar din, Kot Mubarak, Bahadur Garh, Basti Jahangail and Chah Hazara. Purposive and snowball sampling techniques were adopted, and verbal consent was taken before the interview process. The conversation was made in huts, at collecting sites, and at drying and thatching sites. Semi-structured, in-depth, and open-ended interviews were conducted. Interviews were also conducted irrespective of age, and cast. After taking their details, the respondents were asked about the local names of thatching plants, parts used, growing season, harvesting season, growing areas, used part(s), drying process, thatching process, marketing trends, and handicraft products made from these plants. The majority of the communications took place in the study region and the results were useful in determining which thatching plants are employed. Interviews were conducted in homes, villagers' meeting areas, thatching areas, huts, and shops. Most of the interviews were conducted in Seraiki. During the interviews, the Urdu language was used as *Lingua Franqua* with the people other than Seraiki. In the field, plants were identified by local names and collected for scientific identification. The rules set by the International Society of Ethnobiology (ISE) code of ethics (https://www.ethnobiology.net/what-we-do/coreprograms/ise-ethics-program/code-of-ethics/) were followed. The plants were identified through local people with their vernacular names. The botanica nomenclature was primarily based on flora of Pakistan. Then the assigned binomial nomenclature and families was confirmed using the World Flora Online (http://www.worldfloraonline.org/). All these plants were deposited in the herbarium of the University of Education Lahore, campus Dera Ghazi Khan.

Data analyses

The collected data in the form of questionnaires were incorporated, sorted and organized using MS Excel (2010). The data was quantitatively analyzed by sorting the data. The frequency of citations was calculated for each species.

Relative frequency citations (RFCs)

The local preference for foraging plants was calculated by using the Relative Frequency of Citations (RFCs) (Vitalini et al. 2013).

$$RFC = FC/N$$

Here, FC = Number of informants who cited the fodder plant

N= the total number of informants who participated in the survey RFCs value varies from 1 (when all the informants cited a particular thatching plant) to 0 (when nobody had cited a particular plant). All-inclusive details of visited localities are mentioned in Table 1.

Table 1. Description of visited localities of the study area.

Serial number	Name of locality	Altitude (m)	Longitude (E)	Latitude (N)	Population
1	Sakhi Sarwar	139	70.629	30.065	1800000
2	Bandha	142	70.604	30.187	1000
3	Dohra	133	70.658	30.157	2000
4	Yaroo Khosa	136	70.629	30.172	10000
5	Chahbri Bala	135	70.628	30.136	8000
6	Kot Haibat	139	70.632	30.095	7000
7	Sarwar Wali	129	70.719	30.066	7000
8	Ghazi Gahat	128	70.820	30.062	700
9	Drahama	131	70.746	30.067	2000
10	Shuriya	134	70.726	30.091	1500
11	Pir Adil	135	70.710	30.177	5000
12	Sadar Din	142	70.728	30.280	10000
13	Kot Mubarak	137	70.653	30.212	5000
14	Bahadur Garh	135	70.647	30.234	100
15	Basti Jahangail	133	70.623	30.223	1500
16	Chah Hazara	136	70.639	30.165	1000

Results and Discussion

Participants' demography and vernacular nomenclature

Ethnobiologists usually use the phrase "folk biology "to refer to biological taxonomy and reasoning that is distinctive to cultural groupings (Nayak 2011). The description of study-targeted communities is a prerequisite for the evaluation of any plant-people interaction. A total of 105 people (men) were interviewed belonging to different casts, languages, ages, and professions. The respondents were categorized into three age groups etc. Elders (over 40-60 years old) made up the biggest group of informants (57.14%) interviews were conducted with all the men. Women generally live reclusive lives due to strict tribal social settings (Bibi et al., 2022). Out of 105, study participants 2.5% were Urdu speakers, 86.66% Seraiki, and 10.47 % Balochi. The study area exhibits Seraiki-Baloch blend communities. Similarly, most of the respondents were farmers 17.14%, 15.23% were laborers, and 22.85% were engaged with handicraft activities. Only 15.23% of the 105 respondents had completed elementary school and only 59% of them were illiterate as shown in Table 2. It highlights the dearth of formal education opportunities for traditional knowledge holders in the study sites. Ethnobiology, in particular, is a systematic topic that encompasses the cultural study of how people learn, name, use, and organize knowledge about the biota that surrounds them. The vernacular nomenclature was based on the Seraiki language, and Balochi also used homonyms.

Table 2. Demographic features of respondents/participants.

Variables	Categories	Number of people	Percentage
	Men	105	100
Ethnic groups	Urdu	3	2
	Seraiki	91	86
	Balochi	11	10
Age Groups	Between 20 - 40 years	25	23
	Between 40 - 60 years	60	57
	Between 60 - 80 years	19	18
	Above 80 years	1	0.9
Education Level	Illiterate	62	59.
	Primary	16	15
	Middle	16	15
	High School	8	7.6
	Graduate	3	2.8
Social Livelihoods	Farmers	18	17.
	Peasant	16	15
	Labour	19	18
	Thatching expert	24	22

Diversity, ecology and phytogeography of crafting plants

A total of five plant taxa were documented as belonging to five genera and four families i.e. *Saccharum bengalense Retz.*(Poaceae), *Phoenix dactylifera* L.*, Nannorrhops ritchieana* (Griff.) Aitch. (Arecaceae), *Typha latifolia* L. (Typhaceae), and *Tamarix aphylla* (L.) H.Karst. (Tamaricaceae). These cited plants species are well-known for their fiber and handicraft industry (Abid et al. 2007, Masoko et al. 2008, Wazir & Farooq 2010, Fatima et al. 2016). (*Saccharum bengalense* Retz.) **sar/sarkanda/kana** is a wild perennial herb. It is commonly known as Munj Sweet cane and vegetatively grows either through underground rhizomes or by clonal dissemination. (*Phoenix dactylifera* L.) **kahjee/kahjoor** is a perennial cultivated tree. Sometimes it grows wild and reproduces by suckers or seeds. Similarly, (*Typha latifolia* L.) **kondur** is a perennial wild herb. Rhizomes are the source of the plant's growth. (*Tamarix aphylla* (L.) H.Karst.) **tohla** is an intermediate-sized shrub distributed along water bodies. It reproduces by seeds. (*Nannorrhops ritchieana* (Griff.) Aitch.) **peech** is a cultivated or wild shrub. It is mostly distributed along the riverbank and propagates through seeds. Based on distribution, these plants are Afro-Asian taxa and are found in Pakistan, India, Iran, Afghanistan, Oman, and Saudi Arabia, Egypt, Iran, Sudan, Morocco, etc. The studied region is a transition zone of Western Irano-Turanian and Saharo Sindian regions and hence hosts a great diversity of plants with Afro-Asian characteristics.

Handicraft processing

***Saccharum bengalense* Retz.**

It is very difficult to use **sar/sarkanda** for any kind of thatching purposes because the leaves of **sar/sarkanda** are cutters and the hair-like structures on leaves get stuck in the hands while cutting. The craftsmen cut it with great care and with simple

tools. Its bunches are made for easy drying, thatching and transportation. After cutting, it is dried for a few days. The dust and hair of leaves are also cleaned for the proper thatching process. After drying, its leaves are separated from the stem. The stem is used in many handmade items such as brooms and curtains. In order to manufacture various products from *Saccharum bengalense* Retz. two to four people are required. It is used in the formation of many indigenous items like, brooms (small and large) and mats for making roofs and curtains. Small-size flat baskets (Chaaj used for the cleanliness of grains), hats and cages are also made from this plant material.

***Typha latifolia* L.**

Any handicraft using **kondur** leaves is incredibly tough to make and takes two to five people to complete. The leaves are cut and left to dry for 40 to 50 days in the sun. When the leaves are sufficiently softened, they are converted into any handicraft product by soaking them in water overnight. Items like caps and prayer mats are manufactured from the wet leaves once the leaves have been adequately softened. These leaves are thoroughly hammered with a stick to transform them into fibers, which are then used to make ropes. To build a home and cap, the leaves are not soaked in water, but rather, just dried.

***Tamarix aphylla* (L.) H.Karst.**

Tamarix aphylla (L.) H.Karst. is an important plant of thatching and weaving cultures. Its shoots are gathered once their leaves have fully fallen, and they are sufficiently dried. Any handmade item created from **tohla** shoots is a demanding and arduous task. The handmade item is primarily constructed from its shoots. Its shoots are plucked from secluded locations and growing grounds and left in the sun to completely dry for about a week. These shoots are utilized in various thatching operations to create different handicrafts goods, such as tiny baskets, large baskets, and baskets for vegetables. Some examples of handicraft products of all above three species are shown in (Fig. 2).

***Phoenix dactylifera* L.**

Kahjee leaves are also mostly used for thatching. Before making anything from palm leaves, the local people make the palm leaves available. Leaves are properly dried in the sun for 7 to 10 days. After cutting them the tree, the leaves are removed from Rachis, and then the rough and irregular margins of the leaves are separated with the help of an axe. Leaves are soaked in water overnight before making handicrafts. The crooked is created from its leaves first, after which mats and other products are produced. When these leaves become soft, various items are made from them like plates, mats, hot pots, hats, sleeping mats and prayer mats, etc. For aesthetic purposes, the **kahjee** leaves are dyed with a variety of dyes, including green, blue, red, black, pink, and yellow. Until the colors are thoroughly absorbed into the fibers, pigments are continuously swirled into freshly heated water using a wooden stick. The dried colorful leaves are then blended with the ordinary leaves to create a variety of handcrafted items.

***Nannorrhops ritchieana* (Griff.) Aitch.**

Nannorrhops ritchieana (Griff.) Aitch. is considered a crucial component of Sulaiman piedmont traditional culture. The leaves are soaked in water for easy weaving. The unwanted parts of the leaves are removed properly. The remaining leaves are washed again with water and then dried. These dried fibers are used to make various handicrafts like ropes, newar and mats, etc. The leaves and fibers of the Mazri palm are colored using green, blue, red, black, pink, and yellow dyes for ornamental uses. A wooden stick is used to continually swirl dyes into freshly heated water until the colors are well absorbed into the fibers. It is hung on ropes or dispersed in the sand to properly dried. Then it is combined with the dried colored leaves in various handicrafts. Some products made by *Phoenix dactylifera* L. and *Nannorrhops ritchieana* (Griff.) Aitch. as illustrated in (Fig. 3).

Products manufacturing and marketability

Indigenous cultures all over the world have used plants and plant products for thousands of years. Almost all human societies have valued plant fibers, and there have been. Comprehensive insight of ecology and ethnobotanical features of these plant taxa of Dera Ghazi Khan shown in Table 3.

Figure 2. *Saccharum bengalense* Retz.: Handicraft products made from **sar/sarkanda** (*Saccharum bengalense* Retz.). (A) Plant photo (B) Expert making items from the stem of **sar/sarkanda**. (C) Hut made from the leaves and stem of **sar/sarkanda** (D) Broom made from the leaves. (E) Curtains. (F) Man removing leaves from stem (G) Cage made from the stem of **sar/sarkanda**. (H) Mats. (I) Roofs made from the mats. (J) Stocked leaves and stem for making handicraft products. (K) Flat basket used to clean the grains of wheat. *Typha latifolia* L.: Handicraft products made from **kondur** (*Typha latifolia* L.). (A) Plant photo. (B) Expert making items from the leaves of **kondur**. (C) Newaar or ropes. (D) Used only as Newaar for making beds. (E) Basket used in bakery for sweets. (F) Hut. (G) Charpai or bed stead. (H) Prayer mats for group. (I) Small decorative baskets. (J) Crops tied with **kondur** (*Typha latifolia* L.) leaves. (K) A man cutting plants from field. *Tamarix aphylla* (L.) H.Karst.: Handicraft products made from **tohla** (*Tamarix aphylla* (L.) H.Karst.). (A) plant photo. (B) Expert making items from the shoots of **tohla**. (C) Piles of collected shoots. Shoots for drying. (D) Tokraa used as cages and used for covering. (E) Flat basket used for many purposes like carrying stones for making roads. (F) Middle size baskets used for picking the garbage. (G) Small basket, anything can be put in it and taken away. (H) Many baskets are stored at one place. (I) Shoots are drying.

Figure 3. *Phoenix dactylifera* L.: Handmade items made from **kahjee (***Phoenix dactylifera* L.) (A) Plant photo. (B) Collection of dry leaves for handicrafts product. (C) Salt pot. (D) Plate (Changair). Take this plate with you on the trip for bread Prayer cap. (E) Sleeping mat (Taddi). (F) Prayer mat (Musalla) for an individual. (G) Newaar for making beds. (H) Hot pot. (I) Hat. (J) Prayer cap (Topi). (K) Small coloured plate (Changair). (L) Large plate (Chaba): *Nannorrhops ritchieana* (Griff.) Aitch.: Handicraft products made up of **peech** (*Phoenix dactylifera* L.) (A) Plant photo. (B) Thatching experts are making handicrafts from the leaves of mazri palm. (C) Hand fans. (D) Newaar for making beds. (E) Ropes (Rasiyaan). (F) Broom (Bohari). (G) Coloured plate (Changair). (H) Prayer and sleeping mats. (I)Bed (Kahtra).

Table 3. Ecological and ethnobotanical attributes of handicraft plant taxa of Dera Ghazi Khan, Punjab Province, Pakistan.

Ecological & Ethnobotanical variables	***Saccharum bengalense* Retz. / Poaceae**	***Typha latifolia* L. / Typhaceae**	***Tamarix aphylla* (L.) H. Karst. / Tamaricaceae**	***Phoenix dactylifera* L. / Arecaceae**	***Nannorrhops ritchieana* (Griff.) Aitch. / Arecaceae**
Common name	Munj sweet cane	Bulrush	Athel pine	Date palm	Mazri palm
Local name	**Sar/Sarkanda**	**Kondur**	**Tohla**	**Kahji**	**Peech**
Habitat type	Grows along the river, canal banks, roadsides, rail sides, waste grounds, and agricultural fields	Grows in marshes, riverbanks, along lake margin, roadside,	Grows along the stream, lake margins, riverbanks, and saline area	Cultivated in arid and semi-arid regions	Occurs mountains and semi-arid desert areas
Habit/abundance	Herb/very common	Herb/very common	Shrub/very common	Tree/common	Shrub/Rare

Reproduction/ propagation	vegetative propagation rhizome, or clonal dissemination	Propagate through rhizome	Reproduce by seeds	Suckers or seeds	reproduce by seed
Source/life form	Wild/Chamaephyte	Wild/Chamaephyte	Wild/Phanerophytes	Cultivated & wild/ Phanerophytes	Cultivated & wild/ Phanerophytes
Part(s) used	leaves/stem	Leaves	Shoots	Leaves	leaves
Elevation m/ft.	139m/417	139m/417	128m/384	135m/405	50-1450m
Local distribution	Sind, Punjab & Khyber Pakhtunkhwa	Sind, Punjab & Khyber Pakhtunkhwa	Sind, Punjab & Khyber Pakhtunkhwa	Punjab and Sind lower Baluchistan and Khyber Pakhtunkhwa	Sind, west Punjab and Mekran, Peshawar,
Global distribution	North and Northwest India, Afghanistan and Pakistan	Europe, Central and Southeast Asia.	Northern and Eastern Africa, the Middle East, Pakistan, India, and Afghanistan	Native to West Asia and North Africa	Afghanistan and South Persia
Marketing trend/total products	yes/ 8	yes/ 9	yes/ 6	yes/ 14	yes/ 12
Relative frequency citations	0.19	0.2	0.18	0.24	0.17

Plant fiber manufacturing for more than 10,000 years (Mwaikambo 2006). In our study, 49 products were made from five species. The raw materials of *Phoenix dactylifera* L. was the most used in the manufacture of products (14 items), followed by *Nannorrhops ritchieana* (Griff.) Aitch. (12), *Tamarix aphylla* (L.) H.Karst. (6), *Typha latifolia* L. (9), and *Saccharum bengalense* Retz. *(*8). Báez-Lizarazo et al. (2017) explored aquatic vascular plants in Brazil and found them crucial for local subsistence. *Typha latifolia* L. is distributed from the temperate to the Arctic Circle, and its various crafting importance was reported on earlier (Kashif & Khan 2007). In our study, it has been reported for the production of 49 products. In the Balkans states *Typha latifolia* L. has been reported as one of the useful fiber plants for domestic handicrafts (Dogan et al. 2008). Similarly, crafted products of *Typha latifolia* L. and *Phoenix dactylifera* L. are used as substitute for plastic bags (Khan et al. 2022). According to Thomas (2021), the *Typha latifolia* L. and *Saccharum bengalense Retz.*is used as thatching plants in Bannu, village sites of Sheri Khan Tarakai and Lewan, which are linked to our findings. It is recorded that the *Typha latifolia* L. has been used in Ethiopia for thatching (Lim 2016). *Tamarix aphylla* (L.) H.Karst. is also used by indigenous people of Iran for medicine and thatching purposes and is locally called *Ghaz* (Taghipour et al. 2020) as well as in Khyber Pakhtunkhwa. *Tamarix aphylla* (L.) H.Karst. is a plant that grows along waterways in dry places. Some ethnobotanical uses of all these five taxa are shown in Table 4.

Table 4. Ethnomedicinal uses of the documented handicraft plant species.

Botanical Name / Family	**Local Name**	**Parts Used**	**Disease Treated**	**Drug Formulation**	**Mode of Administration**
Typha latifolia L. Typhaceae	**Kondur**	rhizomes, leaves, pollen and seed fluff	urinary tract infections (cystitis, urethritis, renal infection), dermal inflammation, swelling and wound healing, bronchitis, pneumonia,	decoction is formed and taken, and apply paste of these parts in case of dermal disorders	Oral &Topical

			indigestion and constipation		
Saccharum bengalense Retz. Poaceae	**Sar/Sarkanda**	rhizomes, roots & stem	digestive disorders, weaknesses, renal health	decoction is made	Oral
Tamarix aphylla (L.) H. Karst. Tamaricaceae	**Tohla**	root, stem, leaves & bark	bronchitis, asthma, diarrhea, dysentery, stomachache, skin ailments (eczema, rashes & wounds), fever and urinary stones	Decoction is made. Paste is made to apply on skin.	Oral and Topical
Phoenix dactylifera L. Arecaceae	**Kahji**	fruits, leaves, pollens and seeds	Constipation, indigestion, diarrhea. anemia, coughs, sore throat, to boost energy and cardiovascular diseases	decoction is made.	Oral
Nannorrhops ritchieana (Griff.) Aitch. Arecaceae	**Peech**	stem, leaves & fruits	Indigestion, stomachache, diarrhea joint pain, inflammation, irritation and minor wounds of skin	decoction is made	Oral and Topical

It can withstand both salty and alkaline soils quite well. From Morocco and Algeria in North Africa, eastward through Egypt, south to the Horn of Africa, and into Kenya the Middle East and the Arabian Peninsula and it extends east via Iran and into Pakistan, Afghanistan, and India (Mahmoud et al. 2015). Our results support the information from Abdullah et al.*(*2020), a study that documented in ex- Fata and Balochistan the ethnobotany of *Nannorrhops ritchieana* (Griff.) Aitch.*,* these similarities may be due to the deep by also having comparable cultural values and conventions, the diverse ethnic populations residing in Punjab, Baluchistan, and Khyber-Pakhtunkhwa have enjoyed a mutually beneficial relationship for generations. According to Ajaib *et al*. (2013), the fibers of these thatching plants are used for making different handicrafts products and the fruits of *Phoenix dactylifera* L. and *Nannorrhops ritchieana* (Griff.) Aitch. are used by many local peoples. The Nannorrhops ritchieana (Griff.) Aitch. names alters from area to area and tribe to tribe. In Arabi, it is called Sa'f (Mosti et al. 2006), Mazri palm in English (Palm) and many other names in different languages. This traditional knowledge of thatching of Mazri palm shows that this plant is widely used in thatching. In a similar way, ethnobotanical research has evaluated cultural differences (Fandohan et al. 2010). The study of making handicraft products from date palm/Kahji in Morocco was discussed by (Yunusa et al. 2021), which is related to our study. According to Rahar et al. (2010), *Saccharum bengalense Retz.*is used to make ropes and baskets traditionally, which is related to our study. In dry and semi-arid areas of the world, such as North Africa, the Arabian Peninsula, and Iran, date palm trees are widely planted (Chaluvadi et al. 2019). This is important traditional knowledge that we want to keep alive to the benefit of handmade items. The local people are considered the main custodian of knowledge. If they get benefits, then this knowledge can be preserved for a long time and can be improved. Products made from these thatching plants still play important role in the livelihood of local communities, especially in DG Khan and adjacent areas. Handicraft products made from these plants are not only important for the rural people, but also the urban people benefit from them. We believe that this study will provide a solid foundation of facts to support the important cultural tradition of making handcrafted goods and utensils. These findings may also be of interest to academics and industry professionals worldwide who study or work with plant handicrafts, particularly those made from these species.

Ethnopharmacology and Quantitative analysis

Plants have always provided medicine for mankind in addition to other services such as fodder, fibers, fuel etc. The interviews also revealed the medicinal importance of the species in addition to crafting materials. The plant parts i.e. rhizome roots, leaves, seeds and pollen of these species were used to formulate local drugs in the form of decoction and paste. They were used to treat 25 health problems related to digestive, respiratory, dermal, cardiovascular and urinary systems. The local preference and cultural status of the thatching plants were evaluated using relative frequency citations (RFCs). RFCs indicated that the studied community uses all documented species commonly for handicraft manufacturing. But they preferred *Phoenix dactylifera* L. and *Typha latifolia* L. more as compared to other species. Date palm is commonly found in the area and more products can be made. On the other hand, the *Typha latifolia* L. is commonly distributed nearer to their house and ease for material collection.

Conservation issues

Plants provide immense resources and raw materials for the survival of humans in the form of seeds, fruits, dyes, chemicals for medicine, fibers and building materials. Besides, various beliefs and myths are also connected with plants. The present research work highlights the diversity, ethnobotany, and ethnoecology of the plants used in different handicrafts of DG Khan District and its adjoining areas. The status of this knowledge is sustained at that time, but this knowledge is limited only to the older people because the new generation is more inclined towards modernity and fashion, and they do not wish to acquire this knowledge. This study shows that this knowledge is still in practice, but its unappreciated by younger societies, which can lead to its extinction. The traditional knowledge and plant population have high sustainability issues. If the government takes steps to protect this knowledge, we can significantly avoid plastic contamination by using hand-made products from these plants. Given the economic importance of these plants, it is imperative that the government not only needs to take steps to preserve this knowledge but also to create cottage industries. The introduction of new varieties of handicrafts based on traditional knowledge to further innovate the growth of small-scale cottage enterprises will be an important step for its conservation and value addition. The government and nongovernment organizations should take actions for proper conservation and fostering its importance.

Traditional knowledge: status and challenges

Ethnobotanical studies play a crucial role in the preservation of indigenous knowledge, phyto-cultural variety, and the discovery of new species (Hosseinzadeh et al. 2015). The remote communities of DG Khan possess ample indigenous knowledge about the plants utilized for handicraft production. The interviews revealed that it is being limited to aged people and causes low intergenerational transmission as described in several studies (Aziz et al. 2022, Bibi et al. 2022). In marginalized human societies, the utilization and business of thatching plants is perceived as laborious practices with low profit (Arshad et al. 2022). Young people's preferences have changed for income generation, lifestyle and vocation. Consequently, these factors have strikingly jeopardized handicraft practices. Moreover, lack of encouragement from consumers, vocational centers, and proper market chains for crafted materials have also contributed to making folk knowledge vulnerable. Events such as special day celebrations to promote the value and transmission could be effective to invigorate the local traditional knowledge. The inclusion of ethnobotany/local ecological knowledge in the syllabus at the school level could also be fruitful for the retention and practice of the available indigenous knowledge. Similarly, remoteness, drought, accessibility, poor infrastructure, socio-political uncertainty, and feudalism social set up trigger the migration of handicraft professionals to urban centers. This causes obvious fragmentation in the local knowledge. The main reason for the disappearance of this knowledge is the lack of interest in its preservation by government agencies. Earlier, due to the lack of modern home-building equipment and the use of plastic, everyone preferred products made from thatching plants. But now this knowledge is becoming more and more limited due to modernization. Similarly, there is no policy at the government level to preserve cultural heritage and knowledge. In the absence of any action at the government level, these experts have been mired in poverty for centuries and this knowledge of thatching is slowly disappearing. The local communities across the country that are linked to these thatching plants have a variety of traditional uses.

Conclusion

The handicrafts species play pivotal role in the livelihood of the marginalized human communities of Dera Ghazi Khan. A considerable number of old people are involved in its handicrafts formation. Unfortunately, in the younger generation, this important trend of handicrafts formation is decreasing due to modernization and the easy availability of plastic handicrafts. To conserve and foster this important traditional knowledge the government needs to formulate a policy to support the traditional knowledge herders in compliance with SDGs (sustainable developmental goals) provided by UN (United Nation), as well as create small scale cottage industries.

Declarations

Ethics approval and consent to participate*:* Consent was obtained from all participants before conducting interviews. No further ethics approval was required.
Consent for publication*:* N/A
Availability of data and materials*:* N/A
Competing interests*:* The authors declare that they have no competing interests.
Funding*:* No funding was provided by any source to conduct this survey.
Authors' contributions*:* **MS** fieldwork, data collection, data organization, wrote the first draft of manuscript (MS), **ZA** experimental design, supervision, thorough revision **SMK, RBU**, scientific inputs, MS revision, language improvement, **AA** revision **SY, HH, AR** Technical checking and revision. The final manuscript was reviewed by all authors and approved for submission.

Acknowledgements

All authors are very grateful to the people of the study area for their hospitality, co-operation and sharing their knowledge.

Literature Cited

Abbas Z, Alam J, Muhammad S, Bussmann R.W, Khan S.M, Hussain M. 2019. Phyto-cultural diversity of the Shigar valley (Central Karakorum) Baltistan, northern Pakistan. Ethnobotany Research and Applications 18:1-18. doi: 10.32859/era.18.31.1-18

Abdullah SMK, Pieroni A, ul Haq Z, Ahmad Z. 2020. Mazri (*Nannorrhops ritchiana* (Griff) Aitch.): a remarkable source of manufacturing traditional handicrafts, goods and utensils in Pakistan. Journal Ethnobiol Ethnomed 16:45. doi: 10.1186/s13002-020-00394-0

Abid R, Sharmeen S, Perveen A. 2007. Stomatal types of monocots within flora of Karachi, Pakistan. Pakistan Journal of Botany 39:15-21

Ahmad S, Zafar M, Shinwari S, Ahmad M, Shinwari Z.K, Sultana S, Butt M.A. 2020. Ethno-medicinal plants and traditional knowledge linked to primary health care among the indigenous communities living in western hilly slopes of Dera Ghazi Khan, Pakistan. Pakistan Journal of Botany 52:519-530. doi: 10.30848/PJB2020-2(19

Ajaib M, Khan Q, Khan Z. 2013. A contribution to the ethnobotanical studies of some plants of Loralai District, Baluchistan. Biologia (Pakistan) 59: 323-327.

Andesmora EV, Muhadiono M, Hilwan I. 2017. Ethnobotanical study of plants used by people in Hiang Indigenous Forest Kerinci, Jambi. Journal of Tropical Life Science 7: 95-101. doi: 10.11594/jtls.07.02.02

Anwar MF, Khalid S. 2018. Nineteenth century libertarian and enlightened social and cultural organization of Baloch Tribes of Dera Ghazi Khan. Pakistan Social Sciences Review doi: 10.35484/pssr.2018(2-II)15

Arshad F, Waheed M, Harun N, Fatima K, Khan BA, Fatima K, Abbas Z, Jabeen S, Majeed M. 2022. Indigenous farmer's perception about fodder and foraging species of Semi-arid lowlands of Pakistan: A case study of District Kasur, Pakistan. Taiwania 67: 510-523. doi: 10.6165/tai.2022.67.510

Aziz M.A, Volpato G, Fontefrancesco M.F, Pieroni A. 2022. Perceptions and Revitalization of Local Ecological Knowledge in Four Schools in Yasin Valley, North Pakistan. Mountain Research and Development 42: R1-R9. doi: 10.1659/MRD-JOURNAL-D-21-00061.1

Báez-Lizarazo M.R ,Santoro F.R, Albuquerque U.P, Ritter M.R. 2017. Aquatic vascular plants as handicraft: a case study in southern Brazil. Acta Botanica Brasilica 32:88-98. doi: 10.1590/0102-33062017abb0282

Bahru T, Asfaw Z, Demissew S. 2012. Indigenous knowledge on plant species of material culture (construction, traditional arts & handicrafts) used by the Afar & Oromo Nations in & around the Awash National Park Ethiopia. Global Journal of Human Social Science Geography and Environmental Geosciences 12:1-23.

Begossi A, Hanazaki N, Peroni N. 2000. Knowledge and use of biodiversity in Brazilian hot spots. Environment, Development and Sustainability 2:177-193. doi: 10.1023/A:1011409923520

Bibi F, Abbas Z, Harun N, Perveen B, Bussmann R.W. 2022. Indigenous knowledge and quantitative ethnobotany of the Tanawal area, Lesser Western Himalayas, Pakistan. PloS one 17: e0263604. doi: 10.1371/journal.pone.0263604

Bruschi P, Mancini M, Mattioli E, Morganti , Signorini MA. 2014. Traditional uses of plants in a rural community of Mozambique and possible links with Miombodegradation and harvesting sustainability. Journal of Ethnobiology and Ethnomedicine 10:1-22. doi: 10.1186/1746-4269-10-59

Chaluvadi SR, Young P, Thompson K, Bahri BA, Gajera B, Narayanan S, Krueger R, Bennetzen JL. 2019. *Phoenix* phylogeny, and analysis of genetic variation in a diverse collection of date palm (*Phoenix dactylifera*) and related species. Plant Diversity 41: 330-339. doi: 10.1016/j.pld.2018.11.005

Chughtai MI, Kausar T, Mahmood K, Naeem M, Awan AR. 2013. Studies on limnological characteristics and planktonic diversity in DG Khan canal water at DG Khan (Pakistan). Pakistan Journal of Botany 45:599-604.

Dad, K, Muhammad S, Khan GA. 2016. Farmer`s satisfaction level about tribal area development project at Dera Ghazi Khan, Punjab, Pakistan. International Journal of Agricultural Extension 3: 161-164.

Ding XY, Guo C-A, Hu HB, Wang YH. 2022. Plants for making wooden bowls and related traditional knowledge in the Gyirong Valley, Tibet, China. Journal of Ethnobiology and Ethnomedicine 18: 1-11. doi: 10.1186/s13002-022-00514-y

Dogan Y, Nedelcheva AM, Dragica OP, Padure IM. 2008. Plants used in traditional handicrafts in several Balkan countries. Indian Journal of Traditional Knowledge 7:157-161

Fandohan B, Assogbadjo AE, Kakaï RG, Kyndt T, Caluwé ED, Codjia JTC, Sinsin B. 2010. Women's traditional knowledge, use value, and the contribution of tamarind (*Tamarindus indica* L.) to rural households' cash income in Benin. Economic Botany 64: 248-259. doi: 10.1007/s12231-010-9123-2

Fatima G, Khan IA, Buerkert AJS. 2016. Socio-economic characterisation of date palm (*Phoenix dactylifera* L.) growers and date value chains in Pakistan. Springer Plus 5:1-13. doi: 10.1186/s40064-016-2855-4

Hosseinzadeh S, Jafarikukhdan A, Hosseini A, Armand R. 2015. The application of medicinal plants in traditional and modern medicine: a review of Thymus vulgaris. International Journal of Clinical Medicine 6: 635.

Iqbal M, Jabeen S, Jamil S, Umer S, Nawaz I, Habiba U, Manzoor N. 2019. Floristic composition and Indigenous uses of grass flora of western areas of Dera Ghazi Khan. International Journal of Environmental Sciences & Natural Resources 16: 44-49. doi: 10.19080/IJESNR.2019.16.555940

Iskandar BS, Iskandar J, Suroso S, Alfian RL, Mulyanto D. 2022. Non-edible plants traded in traditional markets of Beringharjo, Yogyakarta and Pasar Baru, East Kalimantan, Indonesia: The role of biocultural system. Biodiversitas Journal of Biological Diversity :23. doi: 10.13057/biodiv/d230932

Kang J, Kang Y, Feng J, Liu M, Ji X, Li D, Stawarczyk K, Łuczaj Ł. 2017. Plants as highly diverse sources of construction wood, handicrafts and fiber in the Heihe valley (Qinling Mountains, Shaanxi, China): the importance of minor forest products. Journal of Ethnobiology and Ethnomedicine 13: 1-14. doi: 10.1186/s13002-017-0165-8

Karahan F, Altay V, Keskin M. 2015. An ethnobotanical study on woody plants benefits from handicrafts in Antakya District (Hatay-Turkey). Internastional Journal of Science and Technology Research 1: 1-18.

Kashif M, Khan FA. 2007. Divergence in sugarcane (*Saccharum officinarum* L.) based on yield and quality traits. Pakistan Journal of Botany 39:1559-1563.

Khan SM, Haq ZU, Khalid N, Ahmad Z, Ejaz U. 2022. Utilization of three indigenous plant species as alternative to plastic can reduce pollution and bring sustainability in the environment. Natural Resources Conservation and Advances for Sustainability. Elsevier, pp: 533-544. doi: 10.1016/B978-0-12-822976-7.00001-6

Leghari MFA, Gillani AH, Abbas MW. 2020. Modern Trends and Voting Behaviours in Politics of District Dera Ghazi Khan, Pakistan. Global Regional Review 1: 323-331. doi: 10.31703/grr.2020(V-I).35

Lim T. 2016. *Typha domingensis*. Edible Medicinal and Non-Medicinal Plants. Springer, pp: 114-121.

Mahmoud T, Gairola S, El-Keblawy A. 2015. Large old trees need more conservation attention: A case of *Tamarix aphylla* in the arid deserts of the United Arab Emirates. Journal of Asia-Pacific Biodiversity 8: 183-185. doi: 10.1016/j.japb.2015.04.006

Malana MA, Khos, MA. 2011. Groundwater pollution with special focus on arsenic, Dera Ghazi Khan-Pakistan. Journal of Saudi Chemical Society 15:39-47. doi: 10.1016/j.jscs.2010.09.009

Masoko P, Mokgotho M, Mbazima V, Mampuru L. 2008. Biological activities of *Typha capensis* (Typhaceae) from Limpopo Province (South Africa). African Journal of Biotechnology 7: 3743-3748

Mazhar F, Rehman A. 2019. Assessing temperature variations in Punjab, Pakistan using Mann Kendall trend analysis and inverse distance weighting (IDW) for spatial interpolation. European Online Journal of Natural and Social Sciences 8: 717-726.

Mosti S, Raffaelli M, Tardelli M. 2006. A contribution to the flora of Wadi Andur (Dhofar, Southern Oman). Webbia 61: 253-260. doi: 10.1080/00837792.2006.10670805

Mwaikambo L. 2006. Review of the history, properties and application of plant fibres. African Journal of Science and Technology 7: 120-133

Nayak JK. 2011. Ethnobiology, Ethnomedicine and Ethnopharmacology Practices Among Three Tribes of Similipal Biosphere Reserve, Odisha. Tigerpaper 28(1)

Nedelcheva A, Dogan Y, Obratov-Petkovic D, Padure I.M. 2011. The traditional use of plants for handicrafts in southeastern Europe. Human Ecology 39: 813-828. doi: 10.1007/s10745-011-9432-9

Pullanikkatil D, Thondhlana G, Shackleton C. 2021. The cultural significance of plant-fiber crafts in Southern Africa: a comparative study of Eswatini, Malawi, and Zimbabwe. Forests, Trees and Livelihoods 30: 287-303. doi: 10.1080/14728028.2021.1998797

Rahar S, Nagpal N, Swami G, Arora M, Bansal S, Goyal S, Singla S, Singh P, Kapoor R. 2010. Medicinal aspects of saccharum munja. Research Journal of Pharmacy and Technology 3: 636-639.

Reddy K, Pattanaik C, Reddy C, Murthy E, Raju V. 2008. Plants used in traditional handicrafts in northeastern Andhra Pradesh. Indian Journal of Traditional Knowledge 7: 162-165

Roosevelt AC, 1999. Twelve thousand years of human-environment interaction in the Amazon floodplain. Advances in Economic Botany 13: 371-392.

Savo V, Caneva G. 2011. Domestic and handicraft folk uses of plants in the Amalfi coast (Southern Italy). BMIB-Bollettino dei Musei e degli Istituti Biologici: 73.

Taghipour MT, Nameni R, Taghipour M, Ghorat F. 2020. Phytochemical Analysis and Antimicrobial Activity of Ziziphus spina-christi and *Tamarix aphylla* Leaves' Extracts as Effective Treatment for Coronavirus Disease 2019 (COVID-19) Thrita: 9. doi: 10.5812/thrita.107776

Thomas .D. 2021. A Heritage of Small Things: Archaeological and Ethnographic Aspects of the uses of Plant Materials in Bannu District, Pakistan. Ancient Pakistan 32: 17-31.

Ullah I, Abbasi MG, Abbasi MM, Arafat Y, Asghar G. 2021. Historical background of the origin and evolution os Saraiki langiage in central Pakistan: A case study of Saraiki language in Dera Ghazi Khan.. PalArch's Journal of Archaeology of Egypt/Egyptology 18:621-627.

Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico GJJOE. 2013. Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)An alpine ethnobotanical study. 145: 517-529. doi: 10.1016/j.jep.2012.11.024

Wazir S.M, Farooq A. 2010. Ethnobotatanical survey of plants of Kurram river beds of district Bannu, Pakistan.. Pakistan Journal of Plant Sciences 16:22

Yadav U, Tripathi R, Yadav G, Tripathi M. 2022. Proposal of a Global Handicraft Index for Sustainable Development: A visionary approach for small industry and developing strategies for handicraft (Rural Industry). European Journal of Sustainable Development Research 6: em0185. doi: 10.21601/ejosdr/11909

Yunusa I, Musa B, Asmau A, Ruqaya Y, Unekwu H. 2021. In vivo anti-inflammatory and analgesic activities of methanol and n-hexane extracts of Phoenix dactylifera fruits. Ghana Journal of Science 62: 1-15. doi: 10.4314/gjs.v62i2.1