Scientific Research Report

Ethno-Dentistry of Medicinal Plants Used in North Waziristan, Pakistan

Sabith Rehman [a*], *Zafar Iqbal* [a], *Rahmatullah Qureshi* [b], *Taghrid S. AlOmar* [c], *Najla Almasoud* [c], *Muhammad Younas* [b], *Abdur Rauf* [d], *Muhammad Irfan* [e]

[a] *Department of Botany, Hazara University Mansehra, Khyber Pakhtunkhwa, Pakistan*
[b] *Department of Botany, PMAS-Arid Agriculture University, Rawalpindi, Pakistan*
[c] *Department of Chemistry, College of Science, Princess Nourahbint Abdulrahman University, Riyadh, Saudi Arabia*
[d] *Department of Chemistry, University of Swabi, Swabi, Anbar, Pakistan*
[e] *Department of Botany, University of Swabi, Swabi, Anbar, Pakistan*

ABSTRACT

Objective: This study aimed at recording therapeutic plant species used by inhabitants to treat dental disorders in the district of North Waziristan, Pakistan. The indigenous people of the studied area are dependent on medicinal plants for their basic health care needs including dental care.

Methods: Ethnomedicinal data were collected using a semi-structured questionnaires, and in addition 130 local informants were interviewed. The collected data were evaluated using various quantitative indices, including use value (UV), relative frequency of citation (RFC), fidelity level (FL%), and Jaccard Index (JI).

Results: A total of 69 plants belonging to 48 plant families used in dental disorders were identified. The Lamiaceae was the leading family that shared 7 species, followed by Solanaceae (4 spp).The dominant life form used was herbs (47.83%), folowed by leaves (43.90%) in preparing remedies for different dental disorders. Decoction was the most common mode of preparation (34.21%), followed by pastes (21.05%). The highest RFC (0.36) was reported for *Bergenia ciliata*, followed by *Salvadora oleoides* (0.35). The majority of the plants (36 spp) were utilised as herbal medicine to treat toothache, followed by 13 species for periodontal (gum) infections, 11 species used for teeth cleaning, and 9 species for halitosis (bad breath).

Conclusions: This study is the first-ever record of ethnomedicinal applications for the treatment of dental diseases from Pakistan. Some of the forgeoing hebal medications should be further evalauted for the development of pahrmaceutical bio-products for the treatment of dental disorders.

Introduction

Since the beginning of life, people have looked for medicaments to treat illnesses. Today, plants are gaining popularity in health care products, energy drinks, massage products, multivitamins, and weight loss products.[1,2] These uses have expanded the area of herbal remedies and improved their credibility. Dentists have also begun utilising herbs to alleviate toothache, gum diseases, and ulcerations.[3,4]

Oral health is an essential part of the primary health of an individual.[5,6] According to the World Health Organization (WHO), oral disorders are the main health problem at the global level in the 21st century[7,8] The most common worldwide oral disorders are cavities, toothache, gum disease, and dental abscesses.[9–11] According to the global burden of disease, oral disorders upset approximately 3.5 billion citizens globally with dental cavities.[12]

Dental care and oral health are vital parts of overall health.[13] Oral diseases affect a large segment of the world population i causing pain and discomfort , thus affecting the overall quality of life. Two of the most common oral diseases are caries and periodontitis.[11] This disease is common in

poor sociodemographic groups and is often not properly treated.[14] Dental disorders mostly occur due to bacterial infections as well as dietary and lifestyle factors.[15]

Therapeutic plant species have been extensively used in from ancient times for curing dental disease Various plant parts are used for gingivitis, teeth cleaning, preventing cavity formation, or mucosal disorders. According to the WHO, 80% of inhabitants in developing countries use medicinal plants to reduce gum swelling and stop oral pathogen growth and for antiseptic and analgesic effects.[11,14,16] There are more than 6000 vascular plants in Pakistan, of which 12% are utilised for medical purposes[17] and for human health disorders.[18,19] Most people living in rural areas still use therapeutic plants as an alternative to allopathic drugs.[20] Herbal medications are preferred because of easy accessibility and low cost, with no or fewer side effects.[21]

A number of studies have been reported from Pakistan on the ethno-dentistry of plants. According to Birjees et al,[20] 83 plant species belonging to 36 families were used for the treatment of 95 different disorders. Zaman et al[22] reported 100 plant species belonging to 50 families. Moreover, Abidullah et al[23] reported 95 plant species belonging to 39 families. The study revealed that rural communities use leaves, branches, and fibres of several medicinal plant species for dental diseases such as toothache, tooth decay, bad breath, and pyorrhoea and as toothbrushes for cleaning teeth.[24] However, there has been no organised ethnomedicinal study showing polyherbal remedies used by indigenous healers for the medication of dental disorders from Pakistan. Keeping this in view, this study aimed to determine the indigenous knowledge and the use of medicinal plants for the treatment of dental disorders by the indigenous people in North Waziristan, Pakistan.

Materials and methods

Study area

The study area lies between 32° 57′ 24.9408′ N latitudes and 70° 10′ 9.8220′ E longitude.The area is bounded by District South Waziristan in the south; District Kurram, District Hangu, and Afghanistan to the North; District Bannu to the east; and Afghanistan to the west. The area is divided into 9 Tehsils: Mir Ali, Spinwam, Shewa, Miran Shah, Data Khel, Ghulam Khan, Razmak, Dossali, and Garyum. The annual rainfall is 45 cm. The study area under forests is 475,000 acres. The area is spread over 4707 km^2 (1817 mi^2). The major tribes are Wazir and Dawar. Pashto is the main spoken language.

Medicinal plant collection

The area was surveyed from April 2018 to October 2020, and indigenous people including local healers/herbal dentists (*Hakeems*), shepherds, older people, and farmers were interviewed. In all, 130 local respondents of various age groups were interviewed using semi-structured questionnaires as well as face-to-face discussions. During the survey, gender, age, occupation, education, local names, growth form, folk uses, parts used, mode of preparation, and administration were documented.

Identification and preservation of plants

The specimens were pressed, dried, poisoned, and mounted on herbarium sheets. These were identified by Prof Dr Rahmatullah Qureshi (plant taxonomist) and confirmed by using available published literature.[25] The nomenclature was followed after https://wfoplantlist.org/plant-list. The voucher plant specimens were kept in the PMAS Herbarium, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, and Mansehra Dhudial (HU), Pakistan, for future reference.

Data analysis

The collected data were analysed by using different quantitative indices, including use value (UV), relative frequency of citation (RFC), fidelity level (FL%), and Jaccard Index (JI).

RFC

The RFC value reveals the indigenous significance of each plant species using the following formula.[26]

$$RFC = FC/N$$

Where FC=number of respondents utilising a given plant
N= The total numberof respondents interviewed (N = 130).

UV

The UV was used to find out the level of utilisation of each plant in the research area. It was determined by using the following formula.[26]

$$UV = \frac{Ui}{Ni}$$

Where "Ui" is the number of use reports mentioned by each respondent for a given plant species and "Ni" is the total number of respondents.

FL%

FL% was used to categorise the documented plants based on their mentioned relative usefulness. It was calculated by using the following formula.[27]

$$FL = \frac{Np}{N} \times 100$$

Where "Np" is the number of respondents who cited the use of a specific plant to cure a specific disease and "N" is the number of respondents who use any plant to treat any disease.

JI

JI is used to compare the previously published work from allied, regional, and global levels and was calculated by using the following formula.[28]

$$JI = c \times 100/a + b - c$$

Table 1 – Demographic data.

Variable	Categories	No. of informants N = 130	Percentage (%)
Gender	Male	106	81.54
	Female	24	18.46
Age, y	30−45	13	10.00
	46−60	39	30.00
	61−75	53	40.77
	>75	25	19.23
Major tribes	Wazir	85	65.38
	Dawar	45	34.62
Occupation	Herbalists	73	56.15
	Housewives	22	16.92
	Professional	35	26.92
Education background	Illiterate	55	42.31
	Primary level	32	24.62
	Middle level	16	12.31
	Secondary level	11	08.46
	Undergraduate	10	07.69
	University level	6	04.62

Where "a" is the number of plant species recorded in other studied areas, "b" is the number of plant species recorded in our study area, and "c" is the common number of plants in both areas.

Results

In the current survey, a total of 130 respondents including 106 males (81.54%) and 24 females (18.46%) were interviewed through semi-structured questionnaires as well as face-to-face interviews (Table 1). Since female respondents are unable to converse with male respondents outside of their homes, there is a disproportionately large number of male informants. Further, 56.15% of informants were herbalists and 26.92% were professionals in the research area. The respondents between the ages of 61 and 75 years (40.77%) held the most traditional knowledge, followed by those aged 46 to 60 years (30.00%) and those older than 75 years (19.23%). A total of 69 plants belonging to 48 plant families were documented (Table 2). The Lamiaceae family contributed 7 species, followed by Solanaceae (4 spp) and Amaranthaceae, Asteraceae, Fabaceae, and Polygonaceae (3 spp each). Regarding growth form utilised in dental medication, herbs were very commonly used (47.83%), followed by trees (26.09%), shrubs (21.74%), and ferns (2.90%), whilst sedges (1.45%) were rarely used (Figure 1). Because herbs are available in various seasons and often contain a high amount of bioactive compounds, their therapeutic action is more effective than that of trees and shrubs.

In all, 69 therapeutic plants belonging to 48 plant families were used to treat 13 different dental disorders by the indigenous people (Table 2). Most were used to treat toothache (36 spp), followed by treatment of gum infections (13 spp), teeth cleaning (11 spp), and treatment of bad breath (9 spp), gum swelling (8 spp), and dental caries (7 spp). All dental disorders were treated through oral application, as documented by numerous other researchers.

In terms of plant parts, leaves (43.90%) were the most highly utilised part to treat dental disorders, followed by roots (10.98%) and young branches (7.32%), as shown in Figure 2. Indigenous people utilised each plant part; however, leaves were the most commonly used due to their ready availability and easy preparation of medicine. Decoction was the most commonly used mode of preparation (34.21%), followed by paste (21.05%), toothbrush (13.16%), chewing (11.84%), powder (7.89%), and infusion (2.63%) (Table 2).

RFC is used to document the most therapeutic plants from the study area that are being used for the treatment of dental disorders. In the study area, the RFC value of therapeutic plants recommended for the treatment of dental disorders varied between 0.10 and 0.36. The highest RFC value was calculated for *Bergenia ciliata* (0.36), followed by *Salvadora oleoides* (0.35), *Ephedra procera* (0.34), *Berberis lycium* (0.33), *Juglans regia* (0.32), and *Olea ferruginea* (0.31), respectively (Table 2). Plants with high RFC values are considered well known and are more popular amongst the indigenous people. The lowest RFC value was obtained for *Urtica diocia* (0.10). Therapeutic plant species with high RFC values should be further evaluated to analyse them pharmaceutically and phytochemically for drug discovery.

The UV of a plant species is used to evaluate its relative importance; that is, it considers potential for utilisation. In the present survey, the UV of therapeutic plants suggested to treat dental disorders ranged from 0.23 to 0.87. The highest UV was reported for *Bergenia ciliata* (0.87), followed by *Salvadora oleoides* (0.84), *Ephedra procera* (0.82), *Berberis lycium* (0.81), *Juglans regia* (0.80), and *Olea ferruginea* (0.80). The lowest UV (0.23) is obtained for *Robinia pseudo-acacia* (Table 2). It is not true that medicinal plants with low UV are less important, but there is less availability of the specific therapeutic plant. The high UV of therapeutic plants in the research area is recognised for their frequent distribution in the study area, and indigenous communities are very well known for their therapeutic plant use. Plant species with low UV should not be neglected to ensure the transfer of inherited information to future generations. FL% is used for identifying plant species that are mostly preferred by indigenous people for the treatment of

Table 2 – List of ethnodentistry medicinal plants with scientific name, local name, family name, voucher No., growth form, part used, UVs, URs, FC, RFC, and FL.

Scientific name/ voucher No.	Local name	Family	Life form	Part used	Preparation mode	Medicinal use	FC	RFC	UV	UR	FL%
Acacia modesta Wall. SR-13196	Palusa	Mimosaceae	Tree	Bark, young branches	Powder, toothbrush	Bleeding gums, cleaning teeth, microbes of themouth	39	0.30	0.67	26	79.49
Acacia nilotica (L.) Delile. SR-13448	Kekar	Mimosaceae	Tree	Bark, young branches	Powder, toothbrush,	Cleaning teeth, Gum infections, dental caries, plaque,	36	0.28	0.64	23	69.44
Achyranthes aspera L. SR-13311	Ghoshkai	Amaranthaceae	Herb	Leaves, root	Decoction	Toothache, gumsswelling	37	0.28	0.73	27	86.49
Adiantum capillus-veneris L. SR-13459	Ebe bote	Pteridaceae	Fern	Fronds (leaves)	Decoction	Guminfections	31	0.24	0.68	21	67.74
Ajuga integrifolia Buch. Ham. SR-13425		Lamiaceae	Herb	Leaves	Paste	Toothache	35	0.27	0.60	21	65.71
Allium cepa L. SR-13461	Pyoz	Alliaceae	Herb	Bulb	Paste	Toothache	21	0.16	0.52	11	66.67
Allium sativum L. SR-13462	Yeza	Alliaceae	Herb	Bulb	Paste	Toothache, tooth decay, dental caries	27	0.21	0.56	15	70.37
Aloe vera (L.) Burm. f. SR-13472	Zargeya	Asphodelaceae	Shrub	Leaves	Gel	Gumsswelling, bleeding gums	33	0.25	0.58	19	63.64
Amaranthus viridis L. SR-13341	Surmi	Amaranthaceae	Herb	Leaves	Paste	Toothache	24	0.18	0.63	15	58.33
Artemisia martima L. SR-13264	Terkha	Asteraceae	Shrub	Leaves	Chewing	Bad breath	34	0.26	0.62	21	73.53
Astragalus grahamianus Benth. SR-13578	Zaria	Fabaceae	Shrub	Leaves	Paste	Gum infections	25	0.19	0.68	17	68.00
Berberis lycium Royle SR-13444	Danedar bote	Berberidaceae	Shrub	Young branches, root	Toothbrush, powder	Cleaning teeth, toothache	43	0.33	0.81	35	97.67
Bergenia ciliata (Haw.) Stemb. SR-13586	Zakhmai	Saxifragaceae	Herb	Rhizome	Paste	Toothache, tooth decay	47	0.36	0.87	41	100.00
Calotropis procerasubsp. Hamiltonii (Wight) Ali SR-13185	Spalmai	Asclepidiaceae	Shrub	Aerial part	Latex	Toothache	26	0.20	0.54	14	65.38
Cannabis sativa L. SR-13324	Bhanga	Cannabaceae	Herb	Leaves	Decoction	Dental caries, bad breath	35	0.27	0.57	20	82.86
Capsicum annuum L. SR-13488	Marach	Solanaceae	Herb	Leaves	Chewing	Toothache	19	0.15	0.58	11	68.42
Dysphania ambrosioides (L.) Mosyakin & Clemants SR-13531	Ghota surme	Amaranthaceae	Herb	Whole plant	Paste	Toothache	25	0.19	0.52	13	56.00

Table 2. (*Continued*)

Scientific name/ voucher No.	Local name	Family	Life form	Part used	Preparation mode	Medicinal use	FC	RFC	UV	UR	FL%
Citrullus colocynthis (L.) Schrad. SR-13486	Maraghenia	Cucurbitaceae	Herb	Fruit	Decoction	Toothache, infected teeth	29	0.22	0.52	15	65.52
Citrus limon (L.) Osbeck SR-13526	Lembo	Rutaceae	Shrub	Leaves	Decoction	Toothache, gums swelling	36	0.28	0.67	24	72.22
Cordia myxa L. SR-13476	Lawsera	Boraginaceae	Tree	Fruit, leaves	Paste	Oral ulcer	33	0.25	0.64	21	78.79
Coriandrum sativum L. SR-13468	Dhania	Apiaceae	Herb	Leaves	Chewing	Toothache	29	0.22	0.55	16	58.62
Cyperus rotundus L. SR-13296	Delgai	Cyperaceae	Sedge	Bulb	Decoction	Gum infections	28	0.22	0.50	14	57.14
Dalbergia sissoo DC. SR-13127	Shawa	Papilionaceae	Tree	Young branch	Toothbrush	Cleaning teeth	27	0.21	0.48	13	59.26
Datura stramonium L. SR-13584	Berbaka	Solanaceae	Shrub	Seeds	Paste	Toothache	32	0.25	0.59	19	65.63
Dodonaea viscosa (L.) Jacq. SR-13269	Ghawajara	Sapindaceae	Shrub	Leaves	Decoction	Bad breath, dental caries	26	0.20	0.46	12	69.23
Ephedra procera Fisch. & Mey. SR-13444	Mova	Ephedraceae	Shrub	Aerial part	Decoction	Bleeding gums	44	0.34	0.82	36	100.00
Equisetum arvense L. SR-13216	Bandkai	Equisetaceae	Ferns	Aerial part	Decoction, rubbing	Bleeding gums, cleaning teeth	26	0.20	0.50	13	65.38
Euphorbia hirta L. SR-13225	Pratta	Euphorbiaceae	Herb	Whole plant	Decoction	Gum infections	29	0.22	0.52	15	68.97
Ficus carica L. SR-13124	Anzar	Moraceae	Tree	Fruit	Decoction	Gums swelling, tooth-ache, dental abscess	31	0.24	0.58	18	64.52
Ficus palmata Forssk. SR-13139	Zangali anzar	Moraceae	Tree	Stem, leaves	Latex	Toothache, tooth decay	25	0.19	0.56	14	56.00
Geranium wallichianum D. Don ex Sweet SR-13389	Varekia	Geraniaceae	Herb	Rhizome	Powder	Toothache	30	0.23	0.50	15	53.33
Indigofera heterantha Brandis. SR-13423	Ser-gulai	Papilionaceae	Shrub	Leaves, twigs	Paste, toothbrush	Gums infections, toothache	29	0.22	0.55	16	58.62
Isodon rugosus (Wall. ex Benth.) Codd SR-13385	Khez	Lamiaceae	Shrub	Leaves	Chewing	Toothache	34	0.26	0.62	21	70.59
Juglans regia L. SR-13457	Matak	Juglandaceae	Tree	Root, bark	Decoction, toothbrush	Dental caries, gums swelling, toothache, cleaning teeth	41	0.32	0.80	33	100.00
Justicia adhatoda L. SR-13233	Bikarh	Acanthaceae	Shrub	Leaves	Paste	Toothache	26	0.20	0.62	16	57.69

Table 2. (*Continued*)

Scientific name/ voucher No.	Local name	Family	Life form	Part used	Preparation mode	Medicinal use	FC	RFC	UV	UR	FL%
Marrubium vulgare L. SR-13239	Babar	Lamiaceae	Herb	Leaves	Powder	Gums swelling, toothache	25	0.19	0.52	13	64.00
Melia azedarach L. SR-13266	Bhakana	Meliaceae	Tree	Young branches	Toothbrush	Gums swelling	29	0.22	0.66	19	89.66
Mentha longifolia (L.) L. SR-13331	Zangali venai	Lamiaceae	Herb	Leaves	Chewing	Bad breath	38	0.29	0.61	23	76.32
Mentha viridis (L.) L. SR-13284	Sarkore velanai	Lamiaceae	Herb	Leaves	Chewing	Bad breath	38	0.29	0.55	21	73.68
Olea ferruginea Wall. ex Aitch. SR-13404	Zangali zaiton	Oleaceae	Tree	Leaves	Chewing	Bad breath, toothache	40	0.31	0.80	32	100.00
Opuntiaficus-indica (L.) Mill. SR-13481	Sapare gul	Cactaceae	Shrub	Fruit and flower	Infusion	Tooth abscess, oral ulcer	32	0.25	0.53	17	68.75
Peganum harmala L. SR-13163	Sponda	Zygophyllaceae	Herb	Seed	Decoction	Bad breath, toothache, oral ulcer, gum infections	27	0.21	0.48	13	66.67
Phoenix dactylifera L. SR-13248	Khajira	Arecaceae	Tree	Peduncle	Toothbrush	Cleaning teeth	31	0.24	0.55	17	61.29
Pistacia khinjuk Stocks SR-13464	Shnia	Anacardiaceae	Tree	Bark, leaves	Decoction	Gum disease, toothache	32	0.25	0.69	22	65.63
Plantago major L. SR-13308	Ghota	Plantaginaceae	Herb	Leaves	Decoction	Toothache, bleeding gums	27	0.21	0.56	15	66.67
Polygonum aviculare L. SR-13450	Prata	Polygonaceae	Herb	Aerial part	Paste	Gums swelling	32	0.25	0.44	14	53.13
Portulaca oleracea L. SR-13169	Parkhorai	Portulacaceae	Herb	Aerial part	Decoction	Dental abscess	28	0.22	0.50	14	57.14
Potentilla erecta (L.) Raeusch. SR-13432	Zer gulai	Rosaceae	Herb	Leaves	Paste	Toothache	29	0.22	0.45	13	55.17
Psidium guajava L. SR-13499	Ambret	Myrtaceae	Tree	Leaves	Chewing	Oral ulcer	23	0.18	0.48	11	56.52
Punica granatum L. SR-13333	Valengai	Punicaceae	Shrub	Root	Decoction	Gums bleeding	28	0.22	0.57	16	75.00
Quercus dilatata Royle. SR-13491	Serai	Fagaceae	Tree	Root	Decoction	Gum infections	34	0.26	0.65	22	79.41
Ranunculus muricatus L. SR-13322	zarkatel	Ranunculaceae	Herb	Flower	Infusion	Cleaning teeth	17	0.13	0.29	5	29.41
Ricinus communis L. SR-13132	Rind	Euphorbiaceae	Shrub	Leaves	Decoction	Toothache	24	0.18	0.46	11	50.00
Robinia pseudo-acacia L. SR-13298	Rambel	Papilionaceae	Tree	Bark	Powder	Toothache	26	0.20	0.23	6	53.85

Table 2. (*Continued*)

Scientific name/ voucher No.	Local name	Family	Life form	Part used	Preparation mode	Medicinal use	FC	RFC	UV	UR	FL%
Rumex dentatus L. SR-13517	Zanda	Polygonaceae	Herb	Leaves	Decoction	Toothache	23	0.18	0.39	9	52.17
Rumex hastatus D. Don. SR-13518	Zanda	Polygonaceae	Herb	Leaves	Rubbing	Cleaning teeth	24	0.18	0.54	13	66.67
Salvadora oleoides Decne. SR-13148	Plawan	Salvadoraceae	Tree	Root, Young branches	Toothbrush	Cleaning teeth, microbes of the mouth	45	0.35	0.84	38	100.00
Solanum surratense Brum. f. SR-13396	Korkondai	Solanaceae	Herb	Fruit	Smoke	Dental caries	32	0.25	0.66	21	71.88
Stellaria media (L.) Vill. SR-13146	Pest boti	Caryophyllaceae	Herb	Leaves	Paste	Dental abscess	28	0.22	0.57	16	53.57
Tagetes erecta L. SR-13144	Zenda gula	Asteraceae	Herb	Leaves	Paste	Dental caries	25	0.19	0.52	13	56.00
Tamarix aphylla (L.) H. Karst. SR-13215	Ghaz	Tamaricaceae	Tree	Leaves	Powder	Toothache	39	0.30	0.77	30	94.87
Taraxacum officinale F. H. Wigg. SR-13256	Khataki Gul	Asteraceae	Herb	Leaves, flower	Decoction	Gums swelling, toothache	33	0.25	0.52	17	69.70
Teucrium stocksianum Boiss SR-13274	Malnge	Lamiaceae	Herb	Leaves	Decoction	Gum infections	26	0.20	0.69	18	65.38
Thymus linearis Benth. SR-13388	varekia	Lamiaceae	Herb	Leaves	Chewing	Toothache	29	0.22	0.66	19	65.52
Urtica diocia L. SR-13128	Sezankai	Urticaceae	Herb	Root	Decoction	Toothache	13	0.10	0.31	4	30.77
Verbascum thapsus L. SR-13158	Neshe boti	Scrophulariaceae	Herb	Root	Decoction	Toothache	34	0.26	0.68	23	76.47
Vitex negundo L. SR-13171	Arwanad	Verbenaceae	Shrub	Leaves, Twigs	Paste, toothbrush	Toothache, gum infections, bad breath, cleaning teeth	35	0.27	0.69	24	74.29
Withania somnifera (L.) Dunal. SR-13230	Sre dane boti	Solanaceae	Shrub	Root	Decoction	Bad breath	37	0.28	0.70	26	72.97
Ziziphus mauritiana Lam. SR-13198	Bera	Rhamnaceae	Tree	Leaves	Decoction	Oral ulcer	36	0.28	0.69	25	69.44

UV, use value; FC, frequency of citation; RFC, relative frequency of citation; UR, use reports; FL, fidelity level.
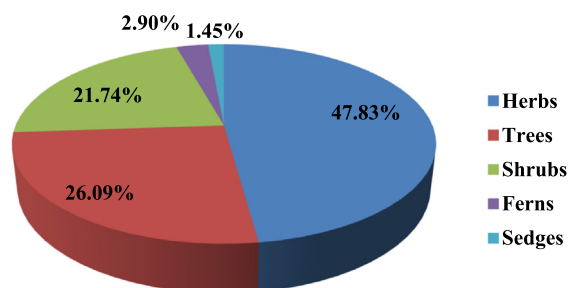
Fig. 1 – The proportion of growth forms of ethnomedicinal plants.

particular ailments. This index may be significant to identify the most preferred plants for treating a specific ailment.[29] In the research area, the FL% of therapeutic plant species suggested for the treatment of dental disorders ranged from 30.77% to 100%. The highest (100%) FL %was calculated for *Bergenia ciliata* (tooth decay), *Ephedra procera* (gum bleeding), and *Juglans regia* (cleaning teeth), followed by *Berberis lycium* (97.67%) for toothache. On the other hand, the lowest FL% was reported for *Urtica diocia* (toothache, 30.77%) (Table 2).

Novelty

This study is the first ever to report ethnomedicinal information about dental diseases in this research area. It was noted that the local people of the study area mostly depend on therapeutic plant species because of inadequate health care facilities. This indicates that the indigenous community has a very definitive knowledge of traditional plants.

Discussion

The present study reported 69 therapeutic plants belonging to 48 plant families, that are being used to treat dental disorders in Pakistan (Table 2). The majority of traditional herbalists in the study area were men. It is also important to note that approximately 84% of rural communities in our study area rely on traditional medicinal plants for their health care needs.[30] In our study, the dominant growth form utilised in dental medication was herbs (Figure 1). In addition, our

Fig. 2 – Plant parts used indental care medicines.

findings were also concordant with Birjees et al,[20] Amjad et al,[31] Malik et al,[32] Shah et al,[33] Rehman et al,[34] and Rehman et al.[35] Herbs often have a maximum amount of bioactive compounds,[36] so their therapeutic action is more effective than that of trees and shrubs.[37] Lamiaceae was the dominant family in the study area that contributed to treatment of dental disorders. In a previous study, a similar finding was documented by Rehman et al,[34] Rehman et al,[35] and Hussain et al.[38] Moreover, plants of the Lamiaceae family are rich in aromatic compounds, which are extremely effective in treating different disorders.[39] Leaves were the dominant plant component for preparing dental remedies to treat dental disorders. The findings in this study are also in accordance with studies carried out by Khan et al,[16] Birjees et al,[20] Hamayun et al,[40] Jan et al,[41] and Rehman et al.[42] The collection of leaves and effective preparation of drugs from leaves are much easier than using the rest of the plant parts.[43] The decoction is the most commonly used mode of preparation in the study area. Our findings were also in agreement with the previous studies of Khan et al,[16] Birjees et al,[20] Rehman et al,[34] and Murad et al.[44] Another important mode of preparation is the powder formation, which might have good efficacy due to its extremely high dissolving affinity.[40]

The most common dental disorder reported as diagnosed by the herbalists, was toothache, (which was treated by using 36 plant species), followed by periodontal infections (13 spp) and teeth cleaning (11 spp). The effectiveness of the documented therapeutic plants in treating dental disorders was recorded based on UV.[32] The highest UV was reported for *Bergenia ciliata, Salvadora oleoides*, and *Ephedra procera*. These therapeutic plants are frequently distributed in the study area, and the indigenous communities are very well versed in their therapeutic uses.[45] It is not true that medicinal plants with low UV are less important, but there is less availability of thespecific therapeutic plant.[46] Plant species with low UV should not be neglected so as to protect the transfer of inherited information to future generations.[47] RFC is used to recognise prospective medicinal plants for future dental disorder drug discovery research.[26] An essential medicinal plant having maximum RFC was *Bergenia ciliata*, followed by *Salvadora oleoides* and *Ephedra procera*. They are very familiar to the herbal practitioner associated with their medicinal value.[48] Plants with high RFC values are considered well known and more popular amongst indigenous people.[49] Therapeutic plant species with high RFC values should be evaluated through scientific studies for drug discovery.[26,50]

In the present study, the highest FL% was reported for *Bergenia ciliata* for tooth decay, *Ephedra procera* for gum bleeding, *Juglans regia* for cleaning teeth, followed by *Berberis lycium*for toothache. A high FL% indicates the respondents preference for treating the particular ailment.[51] Furthermore, the computation of the FL% suggests the most suitable plant for the treatment of each type of dental disorder.[52] In a previous study, fidelity levels were calculated against dental disorders.[53] The highest degree of JI was calculated by comparing with relevant studies,[20,22] which were recorded as 10.81, 9.74, and 8.57 (Table 3). The highest similarity value (1.20%) was reported by Birjees et al,[20] whilst the maximum dissimilarity value (20%) was reported by Saqib et al.[54] Medicinal claims for
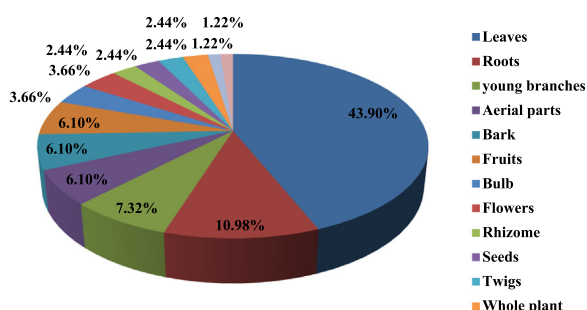
Table 3 – Comparison of present study with previous reports

Previous studies	No. of species reported (A)	No. of species in present study area (B)	Similar uses	Dissimilar use	Plants common in both areas (C)	Species only in aligned areas	% similarity	% of dissimilarity	Species only in studied area	C × 100	A + B	(A + B) − C	Jaccard Index (JI)	References
Garam Chashma valley, district Chitral	83	69	1	9	12	71	1.20%	11%	57	1200	152	140	8.57	Birjees et al, 2022
Tribal communities of Bajaur, Pakistan	95	69	0	16	16	79	0.00%	17%	53	1600	164	148	10.81	Abidullah et al, 2023
Medicinal plants used in selected areas of Pakistan	100	69	0	15	15	85	0.00%	15.00%	54	1500	169	154	9.74	Zaman et al, 2020
Mentha: nutritional and health attributes	10	69	0	5	2	2	0.00%	20.00%	67	200	79	77	2.61	Saqib et al, 2022

dental care products may be determined by phytochemical and pharmaceutical screening.

Conclusion

Healthy teeth are essential for the proper functionality of the body. In the allopathic system of medicine, the treatment of dental disorders is very expensive and is out of reach for many in countries such as Pakistan. Therefore, plants are utilised as a natural alternative to modern medicine. Traditional knowledge collected from the Pakistan reveals that indigenous communities are familiar with local plants and continue to depend on them for treating dental disorders. Owing to easy accessibility in their wild form, individuals utilise these traditional remedies. The inhabitants in this study utilised 69 plant species to treat various dental issues. Amongst them, 3 species—*Bergenia ciliata, Salvadora oleoides,* and *Ephedra procera* —were the most commonly used plants. Therefore, these local plants should be scientifically evaluated for the discovery of novel dental medicaments.

Conflict of interest

None disclosed.

Acknowledgments

Author contributions

Conceptualisation and data curation: SR. Funding acquisition: TSA and NAM. Investigation: SR and ZI. Resources: SR, TSA, and NAM. Supervision: RQ and ZI. Visualisation: ZI. Writing −original draft: SR. Writing−review and editing: RQ, MY, MI, and AR. All authors have read and agreed to publish the manuscript.

Funding

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.identj.2023.10.001.

REFERENCES

1. Petrovska BB. Historical review of medicinal plants' usage. Phcog Rev 2012;6:1.
2. Cruz Martínez C, Diaz Gómez M, Oh MS. Use of traditional herbal medicine as an alternative in dental treatment in Mexican dentistry: a review. Pharm Biol 2017;55:1992–8.
3. Kumar G, Jalaluddin MD, Rout P, Mohanty R, Dileep CL. Emerging trends of herbal care in dentistry. J Clin Diagn Res 2013;7.
4. Taheri JB, Azimi S, Rafieian N, Zanjani HA. Herbs in dentistry. Int Dent J 2011;61:287–96.
5. Sheiham A. Oral health, general health and quality of life. Vol. 83, Bulletin of the World Health Organization. SciELO Public Health 2005:644.
6. Watt RG. Strategies and approaches in oral disease prevention and health promotion. Bull World Health Organ 2005;83:711–8.
7. Petersen PE. Global policy for improvement of oral health in the 21st century—implications to oral health research of World Health Assembly 2007, World Health Organization. Community Dent Oral Epidemiol 2009;37:1–8.
8. Mak KK, Day JR. Dental health behaviours among early adolescents in Hong Kong. Int J Dent Hyg 2011;9:122–6.
9. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ 2005;83:661–9.
10. Beaglehole R. The oral health atlas: mapping a neglected global health issue. FDI World Dental Federation; 2009. p. 96–104.
11. Megersa M, Jima TT, Goro KK. The use of medicinal plants for the treatment of toothache in Ethiopia. Evid Based Complement Alternat Med 2019;2019.
12. Hay SI. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990−2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017;390.
13. Fiske J, Griffiths J, Jamieson R, Manger D. Guidelines for oral health care for long-stay patients and residents. Gerodontology 2000;17:55–64.
14. Palombo EA. Traditional medicinal plant extracts and natural products with activity against oral bacteria: potential application in the prevention and treatment of oral diseases. Evid Based Complement Alternat Med 2011;2011.
15. Lie XJ, Kolltveit KM, Tronstad L, Olsen I. Systemic diseases caused by oral infection clinical microbiology. Reviews 2000;13:547–58.
16. Khan A, Ali S, Murad W, et al. Phytochemical and pharmacological uses of medicinal plants to treat cancer: a case study from Khyber Pakhtunkhwa, North Pakistan. J Ethnopharmacol 2021;281:114437.
17. Bano A, Ahmad M, Hadda TB, et al. Quantitative ethnomedicinal study of plants used in the skardu valley at high altitude of Karakoram-Himalayan range, Pakistan. J Ethnobiol Ethnomed 2014;10:1–18.
18. Ozkan G, Kamiloglu S, Ozdal T, Boyacioglu D, Capanoglu E. Potential use of Turkish medicinal plants in the treatment of various diseases. Molecules 2016;21:257.
19. Jima TT, Megersa M. Ethnobotanical study of medicinal plants used to treat human diseases in Berbere District, Bale Zone of Oromia Regional State, South East Ethiopia. Evid Based Complement Alternat Med 2018;2018.
20. Birjees M, Ahmad M, Zafar M, et al. Traditional knowledge of wild medicinal plants used by the inhabitants of Garam Chashma valley, district Chitral, Pakistan. Acta Ecologica Sinica 2022;42:19–33.
21. Ishtiaq M, Maqbool M, Ajaib M, et al. Ethnomedicinal and folklore inventory of wild plants used by rural communities of valley Samahni, District Bhimber Azad Jammu and Kashmir, Pakistan. PLOS One 2021;16:e0243151.
22. Zaman W, Ye J, Saqib S, et al. Predicting potential medicinal plants with phylogenetic topology: inspiration from the research of traditional Chinese medicine. J Ethnopharmacol 2021;281:114515.
23. Abidullah S, Rauf A, Zaman W, et al. Consumption of wild food plants among tribal communities of Pak-Afghan border, near Bajaur, Pakistan. Acta Ecologica Sinica 2021;43:254–70.
24. Singh H, Krishna G, Baske PK. Ethnomedicinal plants used for dental care in Sundargarh, Mayurbhanj, Angul and Balangir districts of Odisha, India. Indian J Nat Prod Resour 2013;4:419–24.
25. Ali SI. Significance of flora with special reference to Pakistan. Pak J Bot 2008;40:967–71.
26. Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico G. Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)—an Alpine ethnobotanical study. J Ethnopharmacol 2013;145:517–29.
27. Sreekeesoon DP, Mahomoodally MF. Ethnopharmacological analysis of medicinal plants and animals used in the treatment and management of pain in Mauritius. J Ethnopharmacol 2014;157:181–200.
28. Kayani S, Ahmad M, Sultana S, et al. Ethnobotany of medicinal plants among the communities of Alpine and sub-Alpine regions of Pakistan. J Ethnopharmacol 2015;164:186–202.
29. Friedman J, Yaniv Z, Dafni A, Palewitch D. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev Desert, Israel. J Ethnopharmacol 1986;16:275–87.
30. Ahmad K, Ahmad M, Weckerle C. Ethnoveterinary medicinal plant knowledge and practice among the tribal communities of Thakht-e-Sulaiman hills, West Pakistan. J Ethnopharmacol 2015;170:275–83.
31. Amjad MS, Zahoor U, Bussmann RW, Altaf M, Gardazi SMH, Abbasi AM. Ethnobotanical survey of the medicinal flora of Harighal, Azad Jammu & Kashmir, Pakistan. J Ethnobiol Ethnomed 2020;16:1–28.
32. Malik K, Ahmad M, Zhang G, et al. Traditional plant based medicines used to treat musculoskeletal disorders in Northern Pakistan. Eur J Integr Med 2018;19:17–64.
33. Shah A, Sarvat R, Shoaib S, et al. An ethnobotanical survey of medicinal plants used for the treatment of snakebite and scorpion sting among the people of Namal valley, Mianwali district, Punjab, Pakistan. Appl Ecol Environ Sci 2018;16:111–43.
34. Rehman S, Iqbal Z, Qureshi R, Shah GM, Irfan M. Ethnomedicinal plants uses for the treatment of respiratory disorders in tribal District North Waziristan, Khyber Pakhtunkhawa, Pakistan. Ethnobot Res Appl 2023;25:1–16.
35. Rehman S, Iqbal Z, Qureshi R, et al. Ethnogynaecological knowledge of traditional medicinal plants used by the Indigenous communities of North Waziristan, Pakistan. Evid Based Complement Alternat Med 2022;2022:6528264.
36. Adnan M, Begum S, Latif A, Tareen AM, Lee LJ. Medicinal plants and their uses in selected temperate zones of Pakistani Hindukush-Himalaya. J Med Plants Res 2012;6:4113–27.
37. Adnan M, Ullah I, Tariq A, et al. Ethnomedicine use in the war affected region of northwest Pakistan. J Ethnobiol Ethnomed 2014;10:1–16.
38. Hussain S, Hussain W, Nawaz A, et al. Quantitative ethnomedicinal study of indigenous knowledge on medicinal plants used by the tribal communities of Central Kurram, Khyber Pakhtunkhwa, Pakistan. Ethnobot Res Appl 2022;23:1–31.
39. Tabuti JR, Kukunda CB, Waako PJ. Medicinal plants used by traditional medicine practitioners in the treatment of

tuberculosis and related ailments in Uganda. J Ethnopharmacol 2010;127:130–6.

40. Hamayun M. Ethnobotanical profile of Utror and Gabral valleys, district Swat, Pakistan. Ethnobotanical Leaflets 2005;2005:9.

41. Jan G, Khan MA, Ahmad H, Gul F. Indigenous medicinal plants used by local people of Shahi, Lower Dir (Khyber Pakhtunkhwa) southern Himalayan regions of Pakistan. Int J Biol Biotech 2011;8:345–53.

42. Rehman S, Iqbal Z, Qureshi R, et al. Ethnic practices in treating skin diseases: the traditional dermatologist's role. Clin Dermatol 2022;40:749–59.

43. Samoisy AK, Mahomoodally MF. Ethnopharmacological analysis of medicinal plants used against non-communicable diseases in Rodrigues Island, Indian Ocean. J Ethnopharmacol 2015;173:20–38.

44. Murad W, Azizullah A, Adnan M, et al. Ethnobotanical assessment of plant resources of Banda Daud Shah, district Karak, Pakistan. J Ethnobiol Ethnomed 2013;9:1–10.

45. Rahman IU, Ijaz F, Iqbal Z, et al. A novel survey of the ethno medicinal knowledge of dental problems in Manoor Valley (Northern Himalaya), Pakistan. J Ethnopharmacol 2016;194:877–94.

46. Mahmood A, Mahmood A, Malik RN, Shinwari ZK. Indigenous knowledge of medicinal plants from Gujranwala district, Pakistan. J Ethnopharmacol 2013;148:714–23.

47. Chaachouay N, Benkhnigue O, El Ibaoui H, El Ayadi R, Zidane L. Medicinal plants used for diabetic problems in the Rif, Morocco. Ethnobot Res Appl 2019;18:1–19.

48. Najem M, Daoudi A, Bouiamrine EH, Ibijbijen J, Nassiri L. Biodiversity of poisonous medicinal plants solicited in the traditional phytotherapy of the central Middle Atlas-Morocco. Ethnobot Res Appl 2019;18:1–22.

49. Faruque MO, Uddin SB, Barlow JW, et al. Quantitative ethnobotany of medicinal plants used by indigenous communities in the Bandarban District of Bangladesh. Front Pharmacol 2018;9:40.

50. Mukherjee PK, Nema NK, Venkatesh P, Debnath PK. Changing scenario for promotion and development of Ayurveda—way forward. J Ethnopharmacol 2012;143:424–34.

51. Islam MK, Saha S, Mahmud I, et al. An ethnobotanical study of medicinal plants used by tribal and native people of Madhupur forest area, Bangladesh. J Ethnopharmacol 2014;151:921–30.

52. Yaseen G, Ahmad M, Sultana S, Alharrasi AS, Hussain J, Zafar M. Ethnobotany of medicinal plants in the Thar Desert (Sindh) of Pakistan. J Ethnopharmacol 2015;163:43–59.

53. Srithi K, Balslev H, Wangpakapattanawong P, Srisanga P, Trisonthi C. Medicinal plant knowledge and its erosion among the Mien (Yao) in northern Thailand. J Ethnopharmacol 2009;123:335–42.

54. Saqib S, Ullah F, Naeem M, et al. Mentha: nutritional and health attributes to treat various ailments including cardiovascular diseases. Molecules 2022;27:6728.