An ethnobotanical study of medicinal plants used to treat skin diseases in northern Pakistan

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Abstract

Background: Skin diseases are a major health concern especially in association with human immune deficiency syndrome and acquired an immune deficiency. The aim of this study was to document the ethnomedicinal information of plants used to treat skin diseases in Northern Pakistan. This is the first quantitative ethnobotanical study of therapeutic herbs utilized by the indigenous people of Northern Pakistan for skin diseases.

Methods: Interviews were taken to obtain information from 180 participants. Quantitative methods including fidelity level (FL), Frequency of citation (FC), Use-value (UV), Jaccard indices (JI), Family importance value (FIV), Relative frequency of citation (RFC) and Chi-square test were applied. Medicinal plants uses are also compared with 50 national and international publications.

Results: In this study, we recorded 106 plant species belonged to 56 floral families for treatment of skin ailments. The dominant life form reported was herb while the preferred method of utilization was powder, along with leaf as the most used plant part. RFC ranges from 0.07 to 0.25% whereas the highest FIV was recorded for family Pteridaceae. FL values range from 36.8 to 100%. The study reported 88% of new plant reports for the treatment of skin diseases.

Conclusion: The present study revealed the importance of several plants used to treat skin diseases by the local communities of Northern Pakistan. The available literature supported the evidence of plant dermatological properties. Plants having high UV and RFC can be considered for further scientific analysis. There is dire need to create awareness among local, government and scientific communities for the preservation of medicinal species and ethnomedicinal knowledge in Northern Pakistan.

Keywords: Skin diseases, Medicinal plant, Northern Pakistan, Traditional, Ethnomedicines

Background

Skin diseases present a major health concern worldwide [1]. Skin problems significantly affect the quality of health and difficult to treat due to persistence [2]. The skin is an external organ covering the body and serves many important functions including percutaneous absorption, organ protection, fluid preservation, body shape maintenance, temperature regulation and eliminating toxins from the body by sweat excretion [1]. The etiology of skin diseases display a close connection between an individual’s health and socio-cultural environment [3]. Skin diseases affect people of all age groups and gender [4]. Skin ailments or infectious dermatological dermatological diseases are particularly present in tropical areas of Globe [5]. Skin diseases constitute about 34% of all the ailments and supposed to be the most common disease among rural people [6]. Skin diseases have gained attention in recent years due to the association with AIDS/HIV. Greater than 90% of infectious persons of HIV developed mucosal and skin problems at certain phase of disease [1]. Skin ailments such as boils, itching, ringworm, skin disorders, leprosy, wound, dermatitis, eczema, scabies, skin allergy swelling
and psoriasis are caused by a variety of microorganisms [7]. In previous reports, it was found that wound healing, eczema, dermatitis, fungal diseases, pyoderma, scabies, and skin allergies are the largest group of skin diseases that occur in most of the countries. Most of the plants used for treating skin disorders possibly have other additional properties like anti-inflammatory, antimicrobial, anti-viral, cicatrizant, hemostatic, analgesic effects that require pharmacological confirmation [8]. In literature, various plants have been reported to be used against skin infections like wound healing, scabies, swellings, boils, etc. [9–16].

In Pakistan, the number of patients suffering from skin diseases increases every year. The majority suffer from psoriasis, followed by pigment disorder, eczema, urticaria and fungal infection [17]. Climatic conditions like hot and humid weather intensify the prevalence of skin disorders. Although the mortality for skin infection is relatively low, the infection affects the quality of life. Modern skin therapies depend on the cause of the ailment. A skin disease caused by fungal and bacterial infection is medicated using antibiotics such as tolnaftate, clotrimazole, and gentamicin. It is believed that modern therapies have many disadvantages like antibiotic resistance, allergic and adverse reactions in some patients [18]. Modern medicines are very expensive with costly treatments so an alternative approach such as herbal medication in practiced.

Ethno-medicinal studies showed that herbal medicine is an alternative therapy for treatment and control of skin ailments [19]. Herbal anti-skin medicines have many useful properties including low side effects and cost treatment with high significant efficacy [20, 21]. Medicinal flora have shown a pivotal part in management of dermatological conditions [11, 22], particularly communities in developing countries local communities depend on traditional medicine for their health care [23]. The World Health Organization has a deep interest in the documentation of medicinal plant knowledge from from different areas of globe [24]. Currently, the Ministry of Public Health of Pakistan is promoting the usage of therapeutic herbs in health maintenance system [25].

In Pakistan, few previous reports exist the usage of therapeutic flora in skin care [1]. Therapeutic flora usage for treatment of skin ailments are documented in the literature [26], but, no specific study exists treatment of skin diseases. Various medicinal plants are also reported worldwide usage for the cure of skin disorders [7, 27–30]. The ethnobotanical literature on medicinal usage of flora for various ailments in Pakistan were mentioned in literature [31–37], but no systematic ethnomedical study has specifically focused on skin problems in the tribal areas of Northern Pakistan.

The objective of this research work is to document and examine the diversity of therapeutic flora used for treating the skin diseases in Northern Pakistan. This research will facilitate future scientific authentication through antimicrobial, pharmacological and phytochemical studies.

Methods

Description of study area

Northern Pakistan is home to the world’s largest peaks and high mountain ranges i.e., Karakorum, Alai Ranges, Kunlun, Hindukush and Tien Shan [38]. Its topography differs from rock parts in North to green plains and forest in South. These areas are rich in floral variation of therapeutic plant species [39]. This area includes Hazara division, Swat valley, Mansehra, Kaghan and some tribal areas of Northern parts (Fig.1). The area is located at 72°35′ to - 73°31′ E and 33°50′- to 34°23′ N. The province borders Afghanistan to North Western side, Kashmir to East Punjab Islamabad capital territory to East and FATA to South. The average temperature recorded in the past was minimum in January as 1.7 °C while the mean maximum was 32.41 °C in June [40]. The average annual rainfall is about 1125 mm. The major tribes residing in the area include Khattak, Yusufzai, Marwat, Shinwari, Afridi, Orakzai, Mahsud, Mohmand, Abbasies, Wazir, Tareen, Mashwani, Jadoon, Tanolis, Awans, Sardars, Sheikhs and Qureshi [1]. Northern Pakistan is a hilly area and the cultivated land is not enough for sustenance [41]. Medicinal plant collection and other non-timber forest products provide an additional source of income (12%), while daily salaries and wages constitute 20%, transmittals from other areas of Pakistan and overseas (17%), and other occupations (10%) [41]. About 80% population in Pakistan is rural households and has easy access to medicinal plants.

Ethical compliance

The present study was carefully designed with strict compliance of bio-ethics and approved by the Institutional Bioethics Committee (IBC) of Quaid-i-Azam University, Islamabad, Pakistan under the approval No PT-5695. The rules for plant collection and identification were followed according to National Biodiversity Action Plan as per the guidelines of Herbarium of Pakistan (ISL), Quaid-i-Azam University, Islamabad, Pakistan. Prior to data collection, a brief group discussion was held with the participants for agreement, to tell the objectives of research and to guarantee the safety of indigenous knowledge. These practices clear the aim of research and develop confidence in participants so they give reliable knowledge without any hesitation. Initially, 200 participants were selected of them.
were but among them, 20 were hesitant in providing knowledge leaving a total of 180 participants for data collection. While data documentation, all participants were contacted 3 times for the authentication of the knowledge given by informants. Any deviance of the informants idea from authentic knowledge given, the information was excluded and regarded inapplicable. The data quality was ensured through proper training of data collectors, pointing out missing information, duplication of the material, and careful analysis. The data quality was ensured through proper training of data collectors, pointing out missing information, duplication of the material, and careful analysis. The few plants in the MS are listed on the IUCN red list such as Taxus wallichiana (plant #104) is endangered, Colubrina oppositifolia (#84) is critical, Aconitum chasmanthum (#79) is critical and Plantago lanceolata (#69) is vulnerable. All plants listed in this study are authorized by the biodiversity action plan and duly authenticate by ethical committee of Quaid-i-Azam University, Islamabad and then included in the MS. The native communities of the area have knowledge about sustainable use of these plants and use of these plants with care (criteria of IUCN) so that they don’t get vanished and are safe for next generation.

Field study and data collection
This research work focused on the use of traditional plant resources with specific reference to the treatment of skin ailments. Fieldwork was performed between
April 2015 to August 2015. Collectively, 180 participants were interviewed after receiving their prior informed consent. Data was collected from native indigenous health practitioners (THPs) and local participants (female and males of altered groups of age, experiences and education levels). During field surveys, face to face interviews and semi-structured interviews were also conducted. Guided field walks were also conducted [42]. The questionnaire used for data collection includes two parts, (i) part dealing with the demographic data of participants, and (ii) part focusing on information about plants’ local name, mode of administration, preparation and part of the plant used against skin diseases. Documentation of data while field survey was evaluated and organized by usage of quantitative analysis. In addition, data was compared with previously published research articles on ethnomedicinal uses of plants to validate the plants with higher medicinal values for skin diseases.

Collection identification and preservation
In the current study, therapeutic flora documented by participants was identified by their common names [43]. The plant specimens were further authenticated by a Plant Taxonomist, Professor Mir Ajab Khan (Ph.D. in Plant Systematics) at the Herbarium of Pakistan (ISL), QAU Islamabad, Pakistan. All the plants species were further authenticated through available literature [42] and compared with herbarium specimens. In addition, some plants used by the local healers were photographed. Voucher plant specimens were collected in duplicate. Herbarium specimens were deposited in Herbarium of Pakistan (ISL, Registered at Index Herbarium http://sweetgum.nybg.org/science/ih/) and voucher specimens are presented in.

Quantitative data analysis
Use value (UV)
Use value is calculated to assess all probable usage of plant species. UV of plants gives a quantitative analysis for plant citation. UV tells the relative importance of plant flora recognized locally. UV was analysed according to [44].

\[
UV = \frac{u}{N}
\]

Where \(u\) is the total participants stating various uses of a plant and \(N\) is whole number of participants. UV is usually (1) if the number of usages is greater, and (0) if the usage report for plants species is less. UV not deliver data on multiple or single usage of plant flora is considerably low. UV does not deliver any data on the single or multiple uses of plant species.

Frequency of citation (FC) and relative frequency of citation (RFC)
FC is used for evaluating the most preferred plants or more used plant species. RFC was analysed to intrigue the knowledge of traditional flora about usage of therapeutic flora in the study site.

\[
RFC = \frac{FC}{N} (0 < RFC < 1)
\]

Where RFC is denoted by relative frequency citation, FC (Frequency of Citation) is the number of participants who stated the plant flora and \(N\) is whole number of informants [34].

Fidelity level (FL)
To analyse most preferred plant usage for the cure of a specific disease, we used (FL) index adopted by [37]. FFL indicates the importance of one species over other, to cure specific diseases. Fidelity level shows the percentage of participants who reported the use of specific plant species for a particular disease (Skin disease).

\[
FL (\%) = \frac{N_p}{N} \times 100
\]

Where, \(N_p\) is the number of participants that declare the usage of species for definite disease, and \(N\) is total participants that use plants as a medicines for the treatment of any given ailment [45].

Jaccard index (JI)
Jaccard index (JI) is evaluated by comparison of formerly published studies from local, regional and global level by analysing the percentage of cited plant species and medicinal usage, by using the following formula:

\[
JI = \frac{c \times 100}{a + b - c}
\]

where “\(a\)” is the number of species of area A, “\(b\)” is number of species of area B, and “\(c\)” is number of species common in A and B [46].

Chi-square test
The knowledge of medicinal species distributed between male and female participants between two age categories (36–46 and > 60 years of age) was comparatively analyzed by using Chi-square.

Results
Socio-demographic characteristics of participants
Collectively 180 participants were selected from several regions of Northern Pakistan. The majority of professional healers were males (61%). Based on age, the participants were divided into five groups (36–46 (11%), 47–57 (19%), 58–68 (24%), 69–79 (34%) and above 80 years (12%). Participants constitute 24 students, 41
herbalists, 32 physicians, 12 retirees, 46 housewives, 12 professionals, and 13 others. A large number (44%) of local healers also used allopathic medicines. Regarding education, 30% of the participants were illiterate, 35% of the traditional healers had attended primary school, 18% secondary education level, 9% tertiary education and only 8% of participants had attended universities. The majority of professional healers (43%) in the study area were married, followed by single (37%), widowed (16%) and 4% divorced. Most of the participants were living in rural areas (88%) and only 12% living in urban areas (Table 1).

Diversity of medicinal plants used
Therapeutic flora, used to cure skin diseases in Northern Pakistan are documented in Table 2. The study reported 106 medicinal plant species. The main growth habit of the plant flora was herbs 62%, followed by shrubs (20%) and trees (18%). The plants belonged to 56 families. Asteraceae (10 species) and Lamiaceae (7 species) represent the most dominant family in this study site (Fig. 2). The other important families in the study included Polygonaceae (6 species), then Ranunculaceae and Rosaceae (5 species each). The least species (1%) were observed in 37 families (Fig. 2).

Plant parts used in herbal medicines
Leaves (62%) were reported to be the most frequently used plant part to prepare herbal medicine either by singly or mixes by other plant parts. Leaves were followed by roots (19 species), flowers (18 species), seeds (15 species), fruit (11 species), whole plant (8 species) and stem, bulb, latex, aerial parts contributed (1 species each) (Fig. 3). A schematic representation of part used of medicinal plants is shown in (Additional file 1).

Mode of preparation
Mode of administration for herbal remedies used for treating skin diseases include decoction, infusion, powder, poultice, raw, extract, juice, cooked, paste and oil. Among various preparation methods, the powder was the most frequently used (23 species), followed by paste (19 species), decoction (16 species), extract (14 species), raw and poultice (each has 8 species) (Fig. 4). A schematic representation of the mode of utilization of medicinal plants is shown in (Additional file 1).

Used categories in skin diseases
In this study, the skin diseases were assembled into 13 groups. The skin category includes pimples, mumps, measles, wound healing, boils, skin burns, abscesses, inflammation, skin irritation, allergy, burning sensation, skin cleanser and sensation (Table 2). In this study, the maximum figure of plant was used in handling for wound healing (34 species) followed by skin burn (11 species). Other important skin ailments treated by plant flora in the area were boils and pimples (9 species). The lowest citation reports (1%) were recorded for mumps, measles and skin irritations (Fig. 5).

Quantitative ethnobotany
Value of medicinal plant
In addition to the use of questionnaires, various analytical tools were required so it could be possible to do quantification of data by cross verification of indigenous information to treat skin diseases in the study site. Species with the highest use value was Pisum sativum (Fabaceae) (UV 0.143) (Table 2). Other important plants were Cynodon dactylon (UV 0.125) reported by 16 participants and Bergenia ligulata reported by 17

Table 1  Demographic data of participants

| Parameters                     | Participants (N) | N (%) |
|--------------------------------|------------------|-------|
| Gender                         |                  |       |
| Female                         | 70               | 39    |
| Male                           | 110              | 61    |
| Age                            |                  |       |
| 36–46                          | 20               | 11    |
| 47–57                          | 35               | 19    |
| 57–67                          | 43               | 24    |
| 68–78                          | 62               | 34    |
| 80+                            | 20               | 12    |
| Education                      |                  |       |
| No formal education            | 55               | 30    |
| Primary                        | 63               | 35    |
| Secondary                      | 32               | 18    |
| Tertiary                       | 16               | 9     |
| Others                         | 14               | 8     |
| Collaboration with modern medicine |              |       |
| Collaborative                  | 80               | 44    |
| Non collaborative              | 100              | 56    |
| Occupation                     |                  |       |
| Student                        | 24               | 13    |
| Herbalists                     | 41               | 23    |
| Physician                      | 32               | 18    |
| Retired                        | 12               | 7     |
| Housewife                      | 46               | 25    |
| Professional                   | 12               | 7     |
| Others                         | 13               | 7     |
| Residence                      |                  |       |
| Urban                          | 22               | 12    |
| Rural                          | 158              | 88    |
| Marital status                 |                  |       |
| Single                         | 66               | 37    |
| Married                        | 78               | 43    |
| Widowed                        | 29               | 16    |
| Divorced                       | 7                | 4     |
Table 2 Medicinal plants used for skin diseases in Northern Pakistan

| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|-----------------------------------|----------------|-------|-----------------|--------------------|----------------|-------------|-----|-----|-----|-----|------------|
| Acanthaceae                       | Justicia adhatoda L. | Shrub | Leaf             | Decoction, powder | Wound healing   | Leaf are directly applied on wounds | 23  | 0.13 | 0.043 | 73.91 |             |
|                                   |                |       |                 |                    |                |             |     |     |      |      |            |
| Amaranthaceae                     | Carissa spinarum | Herb  | Leaf             | Paste              | Pimples        | Juice of plant is given 3 cups daily | 29  | 0.16 | 0.034 | 79.31 |             |
|                                   |                |       |                 |                    |                |             |     |     |      |      |            |
| Apocynaceae                       | Calotropis procera | Herb  | Whole plant     | Decoction          | Pimples        | Paste of plant is added in different a edibles for pimples | 36  | 0.20 | 0.028 | 91.67 |             |
|                                   |                |       |                 |                    |                |             |     |     |      |      |            |
| Apocynaceae                       | Dideospermum brunonis | Herb  | Whole plant     | Decoction          | Pimples        | Whole plant as it is or add in different dishes while cooking to cure pimples | 32  | 0.18 | 0.031 | 87.50 |             |
|                                   |                |       |                 |                    |                |             |     |     |      |      |            |
| Apocynaceae                       | Erythrina poeppigiana | Herb  | Latex           | Poulitice          | Wound healing  | Its poultice is used for wound cure | 40  | 0.22 | 0.025 | 92.50 |             |
|                                   |                |       |                 |                    |                |             |     |     |      |      |            |
| Apocynaceae                       | Desi aak       | Herb  | Flower and branches | Decoction          | Inflammation   | The decoction of flowers with honey in two ounce is given once a day | 18  | 0.10 | 0.056 | 61.11 |             |
|                                   |                |       |                 |                    |                |             |     |     |      |      |            |
| Apocynaceae                       | Apocynopsis spinosa | Shrub | Root, bark, Leaf | Paste              | Wound healing, boil | The paste prepared from bark and root is applied on wounds for healing | 25  | 0.14 | 0.080 | 80.00 |             |
| Family / Scientific name / coll # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|----------------------------------|----------------|-------|-----------------|--------------------|-----------------|-------------|-----|-----|-----|-----|------------|
| Apocynaceae Rauvolfia serpentina L. | Tilan | Shrub | Leaf | Extract | Skin problem | Extract or paste prepared from flower and leaf is used to cure anemia, skin diseases and blood purification | 22 | 0.12 | 0.045 | 86.36 | | |
| Asteraceae Anaphalis margaritacea (L.) Benth. & Hook.f. | LI 12 | Herb | Whole plant, flowers | Paste | Skin burn | Poultice made of whole plant is useful for skin burns | 32 | 0.18 | 0.031 | 81.25 | | |
| Asteraceae Artemisia vulgaris L. | Jackay | Herb | Leaf | Powders | boils | Dried leaves are grinded to fine powder and taken 3 spoons in the early morning. | 45 | 0.25 | 0.022 | 80.00 | | |
| Asteraceae Gerbera gossypina (Royle) Beauverd | Kofe | Herb | Roots | Paste | Wound healing | Paste prepared from roots is applied to newly cut wounds to control the bleeding. | 39 | 0.22 | 0.026 | 69.23 | | |
| Asteraceae Graphium affine D.Don | Jangli dodal | Herb | Leaf | Decoction | Skin problems | A decoction made from leaves is used to cure sore throat, influenza and weeping pruritus of the skin. | 12 | 0.07 | 0.083 | 50.00 | | |
| Asteraceae Lauarea medicaulis (L.) Hook.f. | LI 60/ | Herb | Leaf | Powder | Wound healing | Dried leaves are powdered and taken with water twice a day. | 19 | 0.11 | 0.053 | 78.95 | | |
| Asteraceae Sauarea jappa (Decne.) Sch.Bip. | LI 93 | Herb | Roots | Extract | Skin problem | Tonic, carminative, used in cholera and in chronic skin problems | 39 | 0.22 | 0.026 | 76.92 | | |
| Asteraceae Semecarpus chrysanthenoides DC | LI 94 | Herb | Leaf | Oil | Skin problem | Oil is used for treatment | 36 | 0.20 | 0.056 | 80.56 | | |
Table 2  Medicinal plants used for skin diseases in Northern Pakistan (Continued)

| Family / Scientific name / Coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|-----------------------------------|----------------|-------|-----------------|--------------------|----------------|-------------|----|-----|----|----|------------|
| Asteraceae                        |                |       |                 |                    |                |             |    |     |    |    |            |
| Asteraceae Sonchus asper (L.)     |                |       | Flower, Leaf    | Powder             | Skin problem   | Dried flowers and leaves are powdered and taken for the treatment of rheumatism. | 26  | 0.14 | 0.038 | 100.00 | 7  | 9  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Asteraceae                        |                |       |                 |                    |                | The tea prepared from flowers is used internally to cure pimples and is used cosmetically to clear the skin | 35  | 0.19 | 0.029 | 94.29  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Asteraceae                        |                |       |                 |                    |                | A poultice made from flowers is used for the treatment of a range of skin disorders including ulcers, sores, and inflammations. | 27  | 0.15 | 0.037 | 77.78  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Balsaminaceae                     |                |       |                 |                    |                | The plant paste is used externally for burns | 33  | 0.18 | 0.030 | 81.82  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Boraginaceae                      |                |       |                 |                    |                | The paste prepared from leaves and roots is externally applied on wounds. | 21  | 0.12 | 0.048 | 80.95  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Boraginaceae                      |                |       |                 |                    |                | The flowers are good expectorant, used for wound healing and treating tumors. Flowers are used to cure coughs, sores, and swellings. | 28  | 0.16 | 0.036 | 78.57  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Boraginaceae                      |                |       |                 |                    |                | Leaf poultice are applied on the burn wounds with ghee/oil. | 33  | 0.18 | 0.030 | 72.73  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Brassicaceae                      |                |       |                 |                    |                | Leaf are cooked and used for wound healing | 21  | 0.12 | 0.048 | 66.67  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Buxaceae                         |                |       |                 |                    |                | Oil of Leaf are applied on skin | 29  | 0.16 | 0.034 | 79.31  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  |
| Family / Scientific name / coll. | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|---------------------------------|----------------|-------|-----------------|-------------------|----------------|-------------|----|-----|----|----|------------|
| Schneid. LI 21                  |                |       |                 |                   |                |             |    |     |    |    |            |
| Cannabis sativa L               | Bhang          | Shrub | Flower, fruit, Leaf | Juice, powder | Dandruff, wounds healing | 17  0.09  0.118  94.12 | 1  n, 2  a, 3  l, 4  n, 5  a, 6  c, 7  a, 8  n, 9  L, 10  a, 11  c, 12  a, 13  n, 14  c, 15  a, 16  n, 17  c, 18  a, 19  c, 20  a, 21  c, 22  c, 23  c, 24  c, 25  a, 26  c, 27  a, 28  c, 29  a, 30  c, 31  a, 32  s, 33  s, 34  s, 35  s, 36  n, 37  c, 38  n, 39  a, 40  a, 41  c, 42  a, 43  n, 44  a, 45  n, 46  c, 47  n, 48  c, 49  n, 50  c |
| Caparaceae                      | Keera          | Tree  | Seeds           | Decoction         | Wound healing | Decoction prepared from seeds is taken 3 cups daily to cure wounds. | 24  0.13  0.042  91.67 | 1  n, 2  c, 3  a, 4  n, 5  a, 6  c, 7  a, 8  n, 9  c, 10  a, 11  c, 12  a, 13  n, 14  c, 15  a, 16  n, 17  c, 18  a, 19  c, 20  a, 21  c, 22  c, 23  c, 24  c, 25  n, 26  c, 27  n, 28  c, 29  a, 30  c, 31  n, 32  c, 33  n, 34  a, 35  c, 36  n, 37  c, 38  n, 39  a, 40  a, 41  c, 42  , 43  a, 44  c, 45  n, 46  c, 47  n, 48  c, 49  n, 50  c |
| Caprifoliaceae                   | Murma          | Roots | Juice           | Pimples           | The root juice is used to cure hystera, pimples, rheumatism, nausea and cholera | 22  0.12  0.045  86.36 | 1  n, 2  c, 3  a, 4  n, 5  a, 6  c, 7  a, 8  n, 9  c, 10  a, 11  c, 12  a, 13  n, 14  a, 15  c, 16  a, 17  c, 18  a, 19  c, 20  a, 21  c, 22  c, 23  c, 24  c, 25  n, 26  c, 27  n, 28  c, 29  n, 30  c, 31  n, 32  c, 33  n, 34  a, 35  c, 36  n, 37  c, 38  n, 39  a, 40  a, 41  c, 42  a, 43  c, 44  c, 45  n, 46  c, 47  n, 48  c, 49  n, 50  c |
| Caryophyllaceae                  | Barks           | Powder | Skin problem | Powdered bark along with milk is taken orally at morning to treat skin problems. | 38  0.21  0.026  89.47 | 1  n, 2  c, 3  a, 4  n, 5  c, 6  a, 7  a, 8  n, 9  c, 10  a, 11  c, 12  a, 13  c, 14  n, 15  c, 16  a, 17  c, 18  a, 19  c, 20  a, 21  c, 22  c, 23  c, 24  c, 25  c, 26  c, 27  n, 28  c, 29  n, 30  c, 31  a, 32  c, 33  c, 34  a, 35  c, 36  n, 37  c, 38  n, 39  a, 40  a, 41  c, 42  a, 43  c, 44  c, 45  c, 46  c, 47  a, 48  c, 49  n, 50  c |
| Commelinaeae                    | Chora           | Herb  | Leaf, Fruit | Raw | Whole fruit is used to treat wounds | 33  0.18  0.030  84.85 | 1  n, 2  c, 3  a, 4  n, 5  a, 6  c, 7  a, 8  n, 9  c, 10  a, 11  c, 12  a, 13  c, 14  n, 15  c, 16  a, 17  c, 18  a, 19  c, 20  a, 21  c, 22  c, 23  c, 24  c, 25  a, 26  c, 27  a, 28  c, 29  c, 30  n, 31  a, 32  c, 33  c, 34  a, 35  c, 36  n, 37  c, 38  n, 39  a, 40  a, 41  c, 42  a, 43  c, 44  c, 45  c, 46  c, 47  a, 48  c, 49  n, 50  c |
| Convolvulaceae                  | Neeleharee      | Tree  | Roots          | Decoction         | Skin problems | Crushed roots are boiled in water and some sugar is added. | 28  0.16  0.036  92.86 | 1  n, 2  c, 3  a, 4  n, 5  a, 6  c, 7  a, 8  n, 9  c, 10  a, 11  c, 12  a, 13  c, 14  a, 15  c, 16  a, 17  c, 18  a, 19  c, 20  a, 21  c, 22  a, 23  c, 24  c, 25  c, 26  c, 27  a, 28  c, 29  a, 30  c, 31  a, 32  c, 33  a, 34  c, 35  c, 36  a, 37  c, 38  n, 39  a, 40  a, 41  c, 42  n, 43  c, 44  c, 45  c, 46  c, 47  n, 48  c, 49  n, 50  c |
| Cucurbitaceae                   | Tori            | Herb  | Fruit          | Infusion          | Skin burn | Infusion of fruits used to cure skin burns | 26  0.14  0.038  92.31 | 1  n, 2  c, 3  a, 4  n, 5  a, 6  c, 7  a, 8  n, 9  c, 10  a, 11  c, 12  a, 13  c, 14  a, 15  c, 16  a, 17  c, 18  a, 19  c, 20  a, 21  a, 22  c, 23  c, 24  c, 25  c, 26  c, 27  a, 28  c, 29  a, 30  c, 31  a, 32  c, 33  c, 34  c, 35  c, 36  n, 37  c, 38  n, 39  a, 40  a, 41  c, 42  a, 43  c, 44  c, 45  c, 46  c, 47  n, 48  c, 49  n, 50  c |
| Cucurbitaceae                   | Gya Kadoo       | Herb  | Leaf, Fruit    | Raw | Wound healing, skin burn | Eaten daily as tonic | 28  0.16  0.071  57.14 | 1  n, 2  c, 3  a, 4  n, 5  a, 6  c, 7  a, 8  n, 9  c, 10  a, 11  c, 12  a, 13  c, 14  a, 15  c, 16  a, 17  c, 18  a, 19  c, 20  a, 21  a, 22  c, 23  c, 24  c, 25  c, 26  c, 27  a, 28  c, 29  a, 30  c, 31  a, 32  c, 33  c, 34  c, 35  c, 36  c, 37  c, 38  a, 39  a, 40  a, 41  c, 42  a, 43  c, 44  c, 45  c, 46  c, 47  n, 48  c, 49  n, 50  c |
| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|-----------------------------------|----------------|-------|-----------------|--------------------|----------------|-------------|-----|-----|-----|-----|------------|
| Cucurbitaceae Miromordica charantia L. LI 67 | Kareela | Herb | Flowers, roots | Paste | Wound healing | Paste of herb is applied for wound healing | 19 | 0.11 | 0.053 | 94.74 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Cupressaceae Juniperus communis L. LI 56 | Gojar | Tree | Berries | Decoction | Skin problem | An ointment of berries are used in skin problem | 25 | 0.14 | 0.040 | 76.00 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Cupressaceae Juniperus excelsa M. Bieb. LI 57 | Pencil Cedar | Tree | Bark | Powder | Skin Problem | Powder of the bark is used in certain skin infection areas | 11 | 0.06 | 0.091 | 72.73 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Cyperaceae Cyperus difformis L LI 38 | Motkopragha | Herb | Whole plant | Paste | Skin problems | Paste prepared from whole plants is applied externally to cure skin infections. | 14 | 0.08 | 0.071 | 71.43 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Elaeagnaceae Hippophae rhamnoides L LI 53 | Tree | Fruit, seeds | Decoction | Skin problems | A decoction of the fruits are used for skin problems | 37 | 0.21 | 0.027 | 83.78 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Equisetaceae Equisetum arvense L LI 43 | Chew Shina | Herb | Whole plant | Powder | Skin problems, allergy | Plant material are mixed with different herbs and used on skin troubles and allergy | 36 | 0.20 | 0.056 | 86.11 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Euphorbiaceae Euphorbia helioscopia L LI 44 | Cat milk | Herb | Leaf | Powder | Wound healing | Dried leaves are mixed in water and taken orally for 4-5 days. | 22 | 0.12 | 0.045 | 81.82 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Fabaceae Butzer monosperma (Lam.) Kuntze L LI 14 | Chichra | Tree | Root | Decoction | Skin problem | Root decoction is used in skin diseases | 36 | 0.20 | 0.028 | 94.44 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 |
| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|-----------------------------------|----------------|-------|----------------|-------------------|----------------|-------------|----|-----|----|----|------------|
| **Fabaceae** | | | | | | | | | | | | |
| *Delbergia sissoo* L. | Shesham | Tree | Leaf | Decoction, infusion | Skin problem, abscesses | Leaves are dried, mixed with water and taken orally for 4-5 days. | 40 | 0.22 | 0.050 | 95.00 | | |
| | | | | | | | | | | | | |
| **Fabaceae** | | | | | | | | | | | | |
| *Pisum sativum* L. | Matar | Herb | Seed | Extract | Skin burn | Fresh seeds are milled then extract drops being used. | 21 | 0.12 | 0.143 | 80.95 | | |
| | | | | | | | | | | | | |
| **Fabaceae** | | | | | | | | | | | | |
| *Trogonella foemina-graecum* L. | Jangli | Herb | Leaf, flowers | Decoction | Wound healing | Leaf and flowers are boiled in water used for cure wounds | 39 | 0.22 | 0.026 | 82.05 | | |
| | | | | | | | | | | | | |
| **Gentianaceae** | | | | | | | | | | | | |
| *Sewertia abyssinica* Hochst. | Cheotla | Shrub | Flower, Leaf | Paste | Skin problems | Plant is crushed into paste and applied on skin. | 17 | 0.09 | 0.099 | 94.12 | | |
| | | | | | | | | | | | | |
| **Lamiaceae** | | | | | | | | | | | | |
| *Ajuga integrifolia* Buch.-Ham.-ex D. Don | Bootei | Herb | Leaf | Powder | Boils | One table spoon of powdered leaves is taken for boils treatment on daily basis. | 22 | 0.12 | 0.045 | 81.82 | | |
| | | | | | | | | | | | | |
| *Lamium rugosum* (Wall. ex Benth.) | Spenkey | Shrub | Leaf | Powder | Wound healing | Powdered leaves are taken 3 times a day after each meal. | 20 | 0.11 | 0.050 | 90.00 | | |
| | | | | | | | | | | | | |
| **Lamiaceae** | | | | | | | | | | | | |
| *Micromeria biflora* (Buch.-Ham.-ex D.Don) | Narayansharmay | Herb | Flowers, Leaf, roots | Paste | Wound healing | Root Leaf and flower paste is used for poultice making to treat wounds. | 15 | 0.08 | 0.067 | 60.00 | | |
| | | | | | | | | | | | | |
| **Lamiaceae** | | | | | | | | | | | | |
| * Nepeta hindostana* (B.Heyne ex Roth) | Indian catnip | Herb | Leaf | Extract | Skin problems | The leaf extract is prepared and one small teaspoon is taken twice a day. | 21 | 0.12 | 0.048 | 80.95 | | |
| | | | | | | | | | | | | |
| **Lamiaceae** | | | | | | | | | | | | |
| *Ghawareja* | Ghawareja | Shrub | Leaf | Extract | Skin disorders | Leaves extract is taken orally to cure mouth ulcers and skin disorders. | 23 | 0.13 | 0.043 | 100.00 | | |
| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|-----------------------------|----------------|-------|----------------|--------------------|----------------|-------------|-----|------|----|-----|------------|
| Lamiaceae Salvia fruticosa wall. ex Benth LI 92 | Khaar dug, Zarshali | Herb | Leaf | Poultice | Wound healing, skin itching | Poultice of the Leaf are used for external skin itching | 17 | 0.09 | 0.059 | 64.71 | 25, 26, 27, 28, 29, 30 |
| Lamiaceae Teucrium stocksii Borr. LI 101 | Kwandi Bootay | Herb | Leaf | Decoction | Wound healing | Decoction of Leaf is employed in wound healing | 25 | 0.14 | 0.040 | 88.00 | 26, 27, 28, 29, 30 |
| Loxanthaceae Loxanthus pulchra Wall LI 62 | Parvikh | Shrub | Leaf | Powder | Wound healing | Leaf powder is used for wound healing | 32 | 0.18 | 0.031 | 71.88 | 32, 0.18, 0.031, 65.71 |
| Lythraceae Lawsonia inermis L. LI 61 | Mhendi | Shrub | Leaves | Infusion | Skin burn, boils | Crushed leaves are dissolved in water and infusion made is taken for 4-5 days | 39 | 0.22 | 0.051 | 61.54 | 25, 26, 27, 28, 29, 30 |
| Malvaaceae Abelmoschus esculentus (L.) Moench LI 1 | Bhindi | Herb | Seeds | Tea | Pimples, Inflammation | Three teaspoons of ground leaves are mixed in three cups of hot water and used twice a day. | 29 | 0.16 | 0.034 | 72.41 | 32, 0.16, 0.034, 65.71 |
| Meliaceae Melia azadarach L. LI 65 | Drak | Tree | Leaf | Powder | Pimples, Inflammation | Three teaspoons of ground leaves are mixed in three cups of hot water and used twice a day. | 27 | 0.15 | 0.074 | 74.07 | 30, 0.15, 0.074, 65.71 |
| Mysoreaceae Mysorex africana L. LI 63/ | Gugal | Shrub | Leaf | Powder | Skin problems | Leaves are used to cure cough, cold, flu and skin disorders. | 35 | 0.19 | 0.029 | 91.43 | 25, 0.19, 0.029, 65.71 |
| Nitrariaceae Peperomia harmala L. LI 72 | Isman | Herb | Leaf | Extract | Skin problems | The aqueous extract of leaves is used thrice a day to treat skin problems. | 35 | 0.19 | 0.029 | 65.71 | 25, 0.19, 0.029, 65.71 |
| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|-----------------------------------|----------------|-------|----------------|-------------------|----------------|-------------|----|-----|----|-----|------------|
| Nyctaginaceae | Snnati | Herb | Leaf | Infusion | abscesses | Leaves are crushed and added in water, used to cure skin abscession. | 27 | 0.15 | 0.037 | 81.48 | 47 n, 48 c, 49 n, 50 c |
| Oleaceae | Ghawareja | Shrub | Leaf Seeds | Tea | Skin problems | Leaves are boiled and the tea is taken orally to cure mouth ulcers and skin disorders. | 31 | 0.17 | 0.032 | 80.65 | 1 n, 2 c, 3 n, 4 c, 5 n, 6 c, 7 n, 8 n, 9 c, 10 c, 11 c, 12 c, 13 c, 14 c, 15 c, 16 c, 17 c, 18 c, 19c, 20 c, 21 c, 22 c, 23 c, 24 c, 25 n, 26 c, 27 n, 28 n, 29 n, 30 c, 31 n, 32 n, 33 n, 34 c, 35 n, 36 n, 37 c, 38 a, 39 c, 40 a, 41 c, 42 n, 43 c, 44 c, 45 c, 46 c, 47 n, 48 c, 49 n, 50 c |
| Papaveraceae | Bhutiana | Herb | Roots | Powder | Skin burn | The powdered root is effective as an antiperiodic, appetizer, diuretic and skin tonic. | 34 | 0.19 | 0.029 | 91.18 | 47 n, 48 c, 49 n, 50 c |
| Phyllolacmea | Akhok | Shrub | Flower, roots | Powder | Wound healing | Shade dried flowers are powdered and mixed with sugar, is recommended for wound healing. | 37 | 0.21 | 0.027 | 83.78 | 47 n, 48 c, 49 n, 50 c |
| Pinaceae Crass | Deodar | Tree | Roots | Extracts | Skin problems | Oil extracted from roots is used for skin disorders. | 36 | 0.20 | 0.028 | 86.11 | 47 n, 48 c, 49 n, 50 c |
| Pinaceae Pinus | Cheerh | Tree | Seed, stem | Juice | Skin problems | Juice of Seed is given 3 cups daily | 16 | 0.09 | 0.063 | 56.25 | 47 n, 48 c, 49 n, 50 c |
| Pinaceae Pinus | Wollchamza A.B. | Tree | Seed | Powder | Wound infection | The seeds are grinded to flour and few grains of sugar are mixed and taken with tea in the morning. | 18 | 0.10 | 0.056 | 44.44 | 47 n, 48 c, 49 n, 50 c |
| Plantaginaceae | Kutalasafed | Herb | Roots | Burning sensations | It is useful in the treatment of burning sensation. | 39 | 0.22 | 0.026 | 76.92 | 47 n, 48 c, 49 n, 50 c |
| Plantaginaceae | Achar | Herb | Seed | Poultice | Skin problems | Poultice of fresh seeds is wrapped around | 31 | 0.17 | 0.032 | 83.87 | 47 n, 48 c, 49 n, 50 c |
| Table 2 | Medicinal plants used for skin diseases in Northern Pakistan (Continued) |
|---------|---------------------------------------------------------------------|
| **Family / Scientific name / coll. #** | **Vernacular Name** | **Habit** | **Plant Part used** | **Mode of utilization** | **Disease treated** | **Preparation** | **FC** | **RFC** | **UV** | **FL** | **Comparison** |
| LI 78 | | Herb | Seed, Leaf | Poultice | Wounds | healing, boils | the boils, after three days the pus drains out and the heals up within a week. | 33 | 0.18 | 0.030 | 75.76 |
| Plantaginaceae Plantago lanceolata L. LI 79 | | | | | | | | | | | |
| Poaceae Cyperus dactylon (L.) Pers. LI 37 | | Herb | Whole plants | Powder | Wound healing | skin problems | Whole plant is grinded with water to cure skin problem | 16 | 0.09 | 0.125 | 68.75 |
| Polygonaceae Fagopyrum acutatum (Lehm.) Mansf. ex Klammer LI 45 | | Buck wheat | Herb | Leaf | Powder | Wound healing | Powder Leaf mixed with oil is applied over area | 26 | 0.14 | 0.038 | 80.77 |
| Polygonaceae Polygonum nepalense Meissn. LI 81 | | Hulla | Herb | Seeds | Paste | Wounds | A poultice prepared from the roots is used on fresh wounds. | 30 | 0.17 | 0.033 | 76.67 |
| Polygonaceae Rumex afriacus Jacq. LI 87 | | Sar-shing | Roots | Decoction | Skin problems | Decoction of roots is taken with aloe vera to treat skin problems | 34 | 0.19 | 0.029 | 76.47 |
| Polygonaceae Rumex dissectus H. Lév. LI 88 | | Khatimmer | Herb | Leaf, roots | Extract, powder | Wound infections | Fresh Leaf extracts are crushed and used to stop wounds bleeding | 29 | 0.16 | 0.034 | 86.21 |
| Polygonaceae Rumex dentatus L. LI 89 | | Shallkay | Herb | Leaves, seeds | Powder | Boils | 2-3 leaves are powdered. Tea made by adding 4-5 grams of powder in 2 cups of water. This can be taken for treating boils. | 27 | 0.15 | 0.037 | 88.89 |
| Polygonaceae Fagopyrum tataricum (L.) Gaertn. LI 46 | | Bio Kho-Bro | Herb | Leaf | Paste | Skin problem | Paste is applied on skin affected areas | 35 | 0.19 | 0.029 | 91.43 |
| Family / Scientific name / coll. no. | Vernacular name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | PC | RFC | UV | FL | Comparison |
|--------------------------------------|----------------|-------|-----------------|--------------------|----------------|-------------|----|------|-----|----|------------|
| Primulaceae Androsace rotundifolia Lehmann ex Roem. & Schult. LI 9 | Marcholla | Herb | Leaf | Extracts | Skin problem | Aqueous leaf extract is prepared and used in treating skin infections. | 22 | 0.12 | 0.045 | 72.73 | 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Pteridaceae Adiantum vernutatum D. Don ex Holmes LI 4 | Pata, kakwa | Herb | Leaf | Paste | Wound healing | The rhizome paste is applied to heal cuts and wounds. | 48 | 0.27 | 0.021 | 91.67 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Ranunculaceae Aconitum chasmorrhizum Stapf ex Holmes LI 2 | Bishmoulo (Shina) Mori | Herb | Leaf | Decoction | Mumps, measles | Decoction of the leaf is given for 2 weeks to cure diseases | 44 | 0.24 | 0.023 | 88.64 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Ranunculaceae Aconitum delphinifolium DC. LI 3 | Booma | Herb | Leaf | Decoction | Wound healing, boils | Dried leaves are boiled in water to make decoction and is taken on daily basis to cure boils. | 31 | 0.17 | 0.065 | 90.32 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Ranunculaceae Aquilegia pubiflora Wall. ex Royle LI 13 | Koo-kuk | Herb, floral parts | Paste | Skin burns and wound healing | Fresh plant parts are crushed in water to prepare paste and applied on affected areas to avoid pain from burns and wounds. | 39 | 0.22 | 0.051 | 79.49 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Ranunculaceae Catha alba Cambess LI 25V | Neel kanthi | Leaf | Extract | Skin problems | Leaf extract is used for clearing skin lesions, sores and skin diseases. | 21 | 0.12 | 0.048 | 80.95 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Ranunculaceae Nigella sativa L. LI 69 | Kalloonggee | Herb | Seed, Leaf | Wound healing | Latex is effective for rheumatic pain. | 26 | 0.14 | 0.038 | 61.54 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Rhamnaceae Colubrina oppositifolia Briq. ex H. Marni LI 23 | Lansa | Shrub | Leaf | Paste | Wound healing, Skin problem | Leaf paste is applied on wound and bruises | 32 | 0.18 | 0.063 | 81.25 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 | 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 |
| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|----------------------------------|----------------|-------|----------------|-------------------|----------------|-------------|----|-----|----|----|------------|
| **Rosaceae Malus** | Manka | Tree | Leaf | Raw, Juice | Boils | Juice extracted from the | | | | | |
| **Malus** | | | | | | | | | | | |
| **Medicinal plants used for skin diseases in Northern Pakistan (Continued)** |
| **Table 2** | | | | | | | | | | | |
| **Rosaceae Prunus** | Apricot | Tree | Fruit | | Skin problem | 32 | 0.18 | 0.031 | 96.88 | | |
| **Prunus armeniaca** | | | | | | | | | | | |
| **L. Li** | | | | | | | | | | | |
| | **Zanthoxylum** | | | | | | | | | | |
| **Dumbara Shrubs** | | leaf | | | | | | | | | |
| **Table 2** | | | | | | | | | | | |
| **Rosaceae Prunus** | Anu | Tree | Fruit and Leaf | | Skin problems | 18 | 0.10 | 0.056 | 55.56 | | |
| **persica** | | | | | | | | | | | |
| **(L.) Batsch** | | | | | | | | | | | |
| **Li** | | | | | | | | | | | |
| | **Rosaceae Rosa** | Gubab | Shrub | Flower | Raw | Skin problem | 40 | 0.22 | 0.050 | 95.00 | | |
| **chinensis** | | | | | | | | | | | |
| **Jaq Li** | | | | | | | | | | | |
| **85** | | | | | | | | | | | |
| | **Rosaceae Rubus** | Akh ray, | Shrub | Flowers, roots | Decoction | Wound healing, Boils | 36 | 0.20 | 0.028 | 75.00 | | |
| **abuchanensis** | Karwara | | | | | | | | | | |
| **Sudre** | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Rubisia Gollum** | Khrhatani | Herb | Leaf | Poul tide | Wound healing | Poul tide prepared from leaves is applied on wounds and used as an antiseptic. | 19 | 0.11 | 0.053 | 36.84 | | |
| **abujymese Bobbas** | | | | | | | | | | | |
| **Li** | | | | | | | | | | | |
| **48** | | | | | | | | | | | |
| | **Rubia ceae** | Loothar | Herb | Leaf | Poul tide | Wound healing | Leaf are externally used on wounds as antiseptic | 21 | 0.12 | 0.048 | 80.95 | | |
| **Galium apanine** | | | | | | | | | | | |
| **L. Li** | | | | | | | | | | | |
| **49** | | | | | | | | | | | |
| | **Rutaceae Zanthoxylum** | Dumbara | Shrubs | Leaf, Raw, paste | | Skin burn | | | | | | |
| **ammatrun DC. Li** | | | | | | | | | | | |
| **11** | | | | | | | | | | | |
| | **Rutaceae Citrus** | Lemon | Tree | Fruit | Juice | Skin irritation | Juice of fruit is applied on skin to reduce skin irritation | 14 | 0.08 | 0.071 | 78.57 | | |
| **medica** | | | | | | | | | | | |
| **L. Li** | | | | | | | | | | | |
| **30** | | | | | | | | | | | |
| | | | | | | | | | | | |
| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL | Comparison |
|-----------------------------------|----------------|-------|-----------------|--------------------|----------------|-------------|----|-----|----|----|------------|
| **Rutaceae Citrus sinensis L.** | Orange         | Tree  | Fruit           | Raw                | Pimples        | Fruit as a whole is used to reduce pimples | 20  | 0.11 | 0.050 | 80.00 |                  |
| **Salicaceae Salix babaionica L.** | Bainsa         | Tree  | Leaf, roots     | Extract            | Skin cleanser  | The extract of Leaf and root are taken for skin cleanser | 20  | 0.11 | 0.100 | 60.00 |                  |
| **Sapindaceae Dodonaea viscosa (L.) Jacq** | Ghwaraskay, Samtha | Shrub | Leaf             | Powders            | Skin burn, wound healing | Grinded leaves are mixed in water to make juice and used for skin problems | 33  | 0.18 | 0.061 | 84.85 |                  |
| **Salix babylonica L.** | Batseyya       | Bark  | Paste            | Whole plant        | Wound healing  | Paste of Bark is antibacterial and is used to heal up wounds and cuts | 18  | 0.10 | 0.056 | 61.11 |                  |
| **Sapindaceae Bergenia ciliata (Hav.) Stenm.** | Zakamlat      | Herb  | Whole plant     | Extracts           | Wound healing, boil | Extract of whole dried plant is mixed in hot water and applied externally on, boil, cuts and wounds | 17  | 0.09 | 0.118 | 76.47 |                  |
| **Sapindaceae Bergenia lypulata Engl.** | Zakham-i- hayat | Herb  | Leaf, flower    | Powder             | Sun strokes, wound healing | Powder of Leaf and flowers are mixed with butter and sun blocking cream | 34  | 0.19 | 0.059 | 85.29 |                  |
| **Scrophulariaceae Veronica thapsus L.** | Gadikand       | Aerial part | Infusion        | Pimples, skin problem | Aerial plants are crushed, mixed in water and taken for 4-5 days to cure skin problems | 38  | 0.21 | 0.053 | 76.32 |                  |
| **Solanaceae Datura stramonium L.** | Dhatura        | Shrub  | Seeds, Leaf     | Paste              | Boils          | Leaf are applied on boils | 21  | 0.12 | 0.048 | 71.43 |                  |
participants (UV 0.118) (Table 2). *Adiantum venustum* had very low use value (UV 0.021).

**Relative frequency of citation (RFC %)**

The RFC represented the prominent species used for skin related diseases based on the ratio between the number of participants (FC) for a plant and the overall number of participants in the research study. RFC ranged from 0.07 to 0.25 and we classified all species into 3 groups: RFC 0.07 to 0.12 (39 species); RFC 0.13 to 0.18 (37 species); RFC 0.19 to 0.27 (30 species) (Table 2). According to pharmacological and ethnobotanical records, the majority of plants in the first group were reported with high medicinal potential. The highest values were recorded for *Adiantum venustum* (0.27) used in the form of paste for wound healing properties. *Artemisia fragrans* (0.25) used in the treatment of boils, similarly *Aconitum chasmanthum* (0.24) used as a decoction for treatment of mumps and measles. Other high RFC species were *Trigonella foenum-graecum, Verbascum thapsus, Aucubia vulgaris, Rosa chinensis, Gerbera gossypina, Helianthus annuus and Aquilegia pubiflora.*

**Fidelity level (FL)**

FL value is calculated for handling specific ailment in this study site. We examined the disease categories to focus the most significant medicinal plant species in each category of skin ailment in terms of FL. It is analyzed for the plant species which were used to cure the most commonly reported category for

### Table 2: Medicinal plants used for skin diseases in Northern Pakistan (Continued)

| Family / Scientific name / coll. # | Vernacular Name | Habit | Plant Part used | Mode of utilization | Disease treated | Preparation | FC | RFC | UV | FL |
|-----------------------------------|----------------|-------|-----------------|--------------------|-----------------|-------------|-----|-----|----|----|
| **Solanaceae**                     |                |       |                 |                    |                 |             |     |     |    |    |
| Solorum virgininum L. LI 95       | Kandiarli      | Fruits| Leaf            | Decoction, extract | Skin problem     | Fruits are prepared and decoction mixed in water is used for treating boils to cure skin problems. The fruits and leaves extract are applied on body swells to get relief. | 28 | 0.16 | 0.036 | 96.43 | 47 | 48 | 49 | 50 |
| **Tamaricaceae**                   |                |       |                 |                    |                 |             |     |     |    |    |
| Tamarix aphylla (L.) H. Karst. LI 98 | Ghaz           | Herb  | Leaf            | Decoction          | Wounds          | The decoction of the plant is given to the patient for 1 week | 12 | 0.07 | 0.083 | 58.33 | 47 | 48 | 49 | 50 |
| **Thymelaeaceae**                 |                | Shrub | Seeds           | Raw                | Skin problems    | Extract of the fruits obtained and is used daily | 29 | 0.16 | 0.034 | 72.41 | 47 | 48 | 49 | 50 |
| Daphne pastichiana Zuk. LI 100    | Bichu-butii    | Herb  | Leaf, Seeds     | Paste              | Wound healing    | Its leaf and seeds are mixed with oil and used on skin for wound. | 18 | 0.10 | 0.056 | 83.33 | 47 | 48 | 49 | 50 |

**Note:**
- FC: Frequency of citation
- RFC: Relative frequency of citation
- UV: Used value
- FL: Fidelity level
- Dissimilar plants with previous literature
- Similar plants with previous literature

**References:**
1 = [47], 2 = [48], 3 = [22], 4 = [29], 5 = [1], 6 = [5], 7 = [49], 8 = [50], 9 = [51], 10 = [26], 11 = [7], 12 = [27], 13 = [5], 14 = [52], 15 = [53], 16 = [54], 17 = [55], 18 = [28], 19 = [56], 20 = [57], 21 = [58], 22 = [59], 23 = [60], 24 = [61], 25 = [17], 26 = [62], 27 = [63], 28 = [64], 29 = [65], 30 = [66], 31 = [67], 32 = [28], 33 = [68], 34 = [69], 35 = [30], 36 = [70], 37 = [71], 38 = [72], 39 = [73], 40 = [11], 41 = [74], 42 = [75], 43 = [76], 44 = [77], 45 = [78], 46 = [79], 47 = [80], 48 = [81], 49 = [82], 50 = [83].
high FL values 100% and lower FL value 36.8%. FL values were classified into four FL classes (Table 2). FL value of class one was 100% (2 species), class two 97 to 89% (18 species), class three 88 to 79% (44 species), class four 78 to 69% (31 species), class five 68 to 33% (11 species). In the present study, *Salix babylonica* and *Sonchus asper* had an FL of 100%, *Prunus armeniaca* 96.8%, and *Momordica charantia* 94.74%. Lowest values were found for *Pinus wallichiana* (44.4) and *Galium abaujense* (36.8).

**Family importance value (FIV)**
The analysis of family importance value reported to Pteridaceae has the maximum FIV (26.6%), followed by Fabaceae (22.2%), Scrophulariaceae, Thymelaeaceae and Caryophyllaceae (21.6). Lowest values were observed for Cyperaceae 7.7 (Fig. 6). These medicinal plants are explored equally by all the communities on a regular basis and the folk knowledge is constant.
Jaccard index (JI)
A comparison of medicinal uses of plants was made by analyzing 50 research papers from aligned countries (Table 2). The review of the literature showed that 106 reported medicinal plant species share similar uses fluctuated from 0% [29] to 13.2% while nonsimilar usage from 3.77 [64] to 0% [70]. The lowest degree of similarity was found in the studies reported in India and South Africa on skin diseases by [5, 49–51] (Table 3). The comparison was based on skin disease reports in several studies, presenting the usage of therapeutic plants for the cure of skin infections in local communities.

Chi-square test
The male participants reported more medicinal plants than women, and it could be stated that males possess more knowledge about the use of medicinal plants than women (Additional file 1). The chi-square on the number of species of plants reported by the two age categories showed important differences. Table 4 represents the median for a number of medicinal species reported by the participants 36–46 and > 46 years of age. Scattering of knowledge was observed in different age groups. The significantly higher average number of medicinal plants (p <
0.05) were mentioned by participants of 69 to 79 years (37.88) for men and (24.1) for women, respectively. There were no significant variations ($\chi^2 = 13.45; P > 0.05$) in the < 36 year age group. Analysis of variance ($p = 0.05$) was used to elucidate the effect of gender, age, and gender to gender interaction on the traditional knowledge of plants in society.

**Previous literature on phytochemicals, pharmacological activities, and toxicity**

A large number of plants stated in this study possess skin cure possessions and might have compound that are indirectly or directly active against parasites. These compounds are known as secondary metabolic compounds. Medicinal plants used for skin diseases were investigated for preliminary in vitro studies, essential phytochemicals and toxicity from the previous studies. Some of the plant species used for skin ailments have been reported for numerous secondary metabolites which show the significance of the plants in traditional remedies (Table 4).

Preliminary in vitro screening of some of the most mentioned plants have been mentioned to validate the findings of the present study (Table 5). In spite of the wide application of active metabolic compounds for humans; they also have a health hazardous effect because of much toxins. These substances not only hamper with the growth of parasite also have lethal effects on mammalian cells (Additional file 1: Table S1). It is, therefore, important to validate the toxic effects of medicinal plant products in relation to their anti-nutritional and other side effects.

**Comparison with other studies in neighbouring regions**

In the present study, some plants were used alone to treat the particular diseases, while in some cases plant parts were mixed to treat diseases. This present study reported 63 novel plants for skin diseases from Northern Pakistan, including *Ajuga integrifolia*, *Anaphalis chitra-lensis*, *Capparis himalayensis*, *Gnaphalium affine*, *Isodon rugosus*, *Tamarix aphylla*, *Nepeta clarkei*, *Launaea nudicaulis*, *Valeriana jatamansi* (Table 2).

**Discussion**

This study was carried out in the native groups of Northern Pakistan. People use medications for the cure of several diseases. Generally the medicinal plants are used in village parts of the area. The majority of professional healers in this study were males, this finding is similar to the literature [290]. According to an estimate, 84% of the rural population relies on herbal traditional medicinal plants [291]. Different origins of the medicinal plant knowledge were recorded. The inherited knowledge of medicinal plants is transferred through orally a cultural practice common in the rural areas in addition to the divine revelation. Most people inherit traditional knowledge from their elders that passed generation to generation [292].

The most dominant life form uses in the study was herbs. Herbs are easily available and collected from roadsides and farmlands [293–295]. Asteraceae was the most preferred family used. Previous work [3] also reported Asteraceae (6 species), Lamiaceae (6 species) and Fabaceae (5 species) with large figure of medicinal flora. There seems to be a tendency for a few families of plants to stand out in any pharmacopeia [296]. These plant families have been reported with high pharmacological,
| S. No | Study Site                  | Year | Number of plant spp. recorded in aligned areas | Plants reported for similar uses | Plants reported for dissimilar uses | Total plant spp. common in both the areas | %age of plant spp. common in both the areas | Plant species enlisted only in aligned areas | Species enlisted only in study area | %age of plant species enlisted only in the study area | %age of plant species with similar uses | %age of plant species with dissimilar uses | Jaccard index (JI) | Citation |
|-------|----------------------------|------|-----------------------------------------------|----------------------------------|------------------------------------|---------------------------------------------|---------------------------------------------|-------------------------------------------|-------------------------------------|-----------------------------------------------|------------------------------------------|------------------------------------------|-------------------|----------|
| 1     | Amman, Jordan              | 2003 | 58                                            | 6                                | 1                                  | 7                                           | 12.07                                       | 51                                         | 99                                  | 9340                                         | 5.6603774                       | 0.94                       | 4.90             | [47]     |
| 2     | Karnataka, India           | 2003 | 31                                            | 0                                | 1                                  | 1                                           | 3.23                                        | 30                                         | 105                                 | 9906                                         | 0                           | 0.94                       | 0.75             | [48]     |
| 3     | Assamese, India            | 2006 | 85                                            | 5                                | 2                                  | 7                                           | 8.24                                        | 78                                         | 99                                  | 9340                                         | 4.7169811                      | 1.89                       | 4.12             | [22]     |
| 4     | Central Kenya              | 2007 | 57                                            | 0                                | 1                                  | 1                                           | 1.75                                        | 56                                         | 105                                 | 9906                                         | 0                           | 0.94                       | 0.63             | [29]     |
| 5     | North-West Frontier Province, Pakistan | 2010 | 66                                            | 14                               | 1                                  | 15                                          | 22.73                                       | 51                                         | 91                                  | 8585                                         | 13.207547                      | 0.94                       | 11.81            | [1]      |
| 6     | Central Chaco, Argentina   | 2010 | 72                                            | 1                                | 1                                  | 2                                           | 2.78                                        | 70                                         | 104                                 | 9811                                         | 0.943962                       | 0.94                       | 11.6             | [3]      |
| 7     | South Africa               | 2014 | 117                                           | 1                                | 1                                  | 2                                           | 1.71                                        | 115                                        | 104                                 | 9811                                         | 0.943962                       | 0.94                       | 0.92             | [49]     |
| 8     | Eastern Cape, South Africa | 2014 | 106                                           | 2                                | 1                                  | 3                                           | 2.83                                        | 103                                        | 103                                 | 9717                                         | 1.8867925                      | 0.94                       | 1.48             | [50]     |
| 9     | Uttarakhand, India         | 2014 | 90                                            | 5                                | 3                                  | 8                                           | 8.89                                        | 82                                         | 98                                  | 9245                                         | 4.7169811                      | 2.83                       | 46.5             | [51]     |
| 10    | Pakistan                   | 2013 | 50                                            | 3                                | 1                                  | 4                                           | 8.00                                        | 46                                         | 102                                 | 9623                                         | 2.8301887                      | 0.94                       | 2.78             | [26]     |
| 11    | France                     | 2015 | 1                                             | 1                                | 0                                  | 1                                           | 100.00                                      | 0                                         | 105                                 | 9906                                         | 0.943962                       | 0.96                       | 0.06             | [7]      |
| 12    | Kenya                      | 2015 | 25                                            | 1                                | 0                                  | 1                                           | 4.00                                        | 24                                         | 105                                 | 9906                                         | 0.943962                       | 0.00                       | 0.78             | [27]     |
| 13    | South Africa               | 2013 | 47                                            | 0                                | 0                                  | 0                                           | 0.00                                        | 47                                         | 106                                 | 100.00                                       | 0                           | 0.00                       | 0.00             | [5]      |
| 14    | India                      | 1992 | 50                                            | 0                                | 0                                  | 0                                           | 0.00                                        | 50                                         | 106                                 | 100.00                                       | 0                           | 0.00                       | 0.00             | [52]     |
| 15    | North West Punjab, Pakistan | 2012 | 12                                            | 3                                | 0                                  | 3                                           | 25.00                                       | 9                                          | 103                                 | 9717                                         | 2.8301887                      | 0.00                       | 2.75             | [53]     |
| 16    | Saudi Arabia               | 2015 | 4                                             | 0                                | 0                                  | 0                                           | 0.00                                        | 4                                          | 106                                 | 100.00                                       | 0                           | 0.00                       | 0.00             | [54]     |
| 17    | India                      | 1995 | 2                                             | 1                                | 3                                  | 3.16                                        | 92                                          | 103                                        | 9717                                 | 1.8867925                      | 0.94                       | 1.56             | [55]     |
| 18    | Nigeria                    | 2008 | 41                                            | 1                                | 1                                  | 2                                           | 4.88                                        | 39                                         | 104                                 | 9811                                         | 0.943962                       | 0.94                       | 1.42             | [28]     |
| 19    | India                      | 2010 | 11                                            | 0                                | 0                                  | 0                                           | 0.00                                        | 11                                         | 106                                 | 100.00                                       | 0                           | 0.00                       | 0.00             | [84]     |
| 20    | South Africa               | 1999 | 9                                             | 3                                | 1                                  | 4                                           | 44.44                                       | 5                                          | 102                                 | 9623                                         | 2.8301887                      | 0.94                       | 3.88             | [57]     |
| 21    | Eastern Cape, South Africa | 2016 | 1                                             | 0                                | 0                                  | 0                                           | 0.00                                        | 1                                          | 106                                 | 100.00                                       | 0                           | 0.00                       | 0.00             | [58]     |
| 22    | Iran                       | 2014 | 18                                            | 3                                | 1                                  | 4                                           | 22.22                                       | 14                                         | 102                                 | 9623                                         | 2.8301887                      | 0.94                       | 3.57             | [59]     |
| 23    | Haran, India               | 2012 | 100                                           | 0                                | 0                                  | 0                                           | 0.00                                        | 100                                        | 106                                 | 100.00                                       | 0                           | 0.00                       | 0.00             | [60]     |
| 24    | India                      | 2012 | 1                                             | 0                                | 0                                  | 0                                           | 0.00                                        | 1                                          | 106                                 | 100.00                                       | 0                           | 0.00                       | 0.00             | [7]      |
| S. No | Study Site          | Year | Number of plant spp. recorded in aligned areas | Plants reported for similar uses | Plants reported for dissimilar uses | Total plant spp. common in both the areas | %age of plant spp. common in both the areas | Plant species enlisted only in aligned areas | %age of plant species enlisted only in the study area | %age of plant species with similar uses | %age of plant species with dissimilar uses | Jaccard index (JI) | Citation |
|------|--------------------|------|-----------------------------------------------|--------------------------------|----------------------------------|-------------------------------------------|---------------------------------------------|------------------------------------------|---------------------------------------------|--------------------------------|--------------------------------|------------------|----------|
| 25   | Thailand           | 2015 | 55                                           | 0                              | 0                                | 0.00                                      | 55                                          | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [17]     |
| 26   | Mizoram, India     | 2014 | 4                                            | 0                              | 0                                | 0.00                                      | 4                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [62]     |
| 27   | Peru, America      | 1997 | 9                                            | 0                              | 0                                | 0.00                                      | 9                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [63]     |
| 28   | Palestine, Israel  | 2000 | 165                                          | 4                              | 2                                | 6.64                                      | 159                                         | 100                                      | 94.34                                        | 3.7735849        | 1.89                                        | 2.37              | [64]     |
| 29   | Africa             | 2016 | 61                                           | 2                              | 1                                | 3.92                                      | 58                                          | 103                                      | 97.17                                        | 1.8867925        | 0.94                                        | 1.90              | [65]     |
| 30   | India              | 2004 | 23                                           | 0                              | 0                                | 0.00                                      | 23                                          | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [66]     |
| 31   | Chinese            | 2015 | 16                                           | 0                              | 0                                | 0.00                                      | 16                                          | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [67]     |
| 32   | Nigeria            | 2014 | 41                                           | 1                              | 1                                | 2.88                                      | 39                                          | 104                                      | 98.11                                        | 0.9433962        | 0.94                                        | 1.42              | [28]     |
| 33   | Pakistan           | 2011 | 47                                           | 4                              | 3                                | 7.89                                      | 40                                          | 99                                       | 93.40                                        | 3.7735849        | 2.83                                        | 5.30              | [68]     |
| 34   | Karnataka, India   | 2014 | 102                                          | 0                              | 2                                | 2.96                                      | 100                                         | 104                                      | 98.11                                        | 0                            | 1.89                                        | 0.99              | [69]     |
| 35   | Turkey             | 2012 | 1                                            | 0                              | 0                                | 0.00                                      | 1                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [30]     |
| 36   | India              | 2012 | 1                                            | 0                              | 0                                | 0.00                                      | 1                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [70]     |
| 37   | Turkey             | 2012 | 1                                            | 0                              | 0                                | 0.00                                      | 0.00                                        | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [71]     |
| 38   | India              | 2011 | 1                                            | 0                              | 0                                | 0.00                                      | 1                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [72]     |
| 39   | Turkey             | 2010 | 1                                            | 0                              | 0                                | 0.00                                      | 0.00                                        | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [73]     |
| 40   | Ethiopia           | 2006 | 5                                            | 1                              | 1                                | 2.00                                      | 3                                           | 104                                      | 98.11                                        | 0.9433962        | 0.94                                        | 1.90              | [11]     |
| 41   | India              | 2010 | 1                                            | 0                              | 0                                | 0.00                                      | 1                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [74]     |
| 42   | Nigeria            | 2010 | 1                                            | 0                              | 0                                | 0.00                                      | 1                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [75]     |
| 43   | Brazil             | 2009 | 12                                           | 0                              | 0                                | 0.00                                      | 12                                          | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [76]     |
| 44   | India              | 2007 | 51                                           | 2                              | 1                                | 3.88                                      | 48                                          | 103                                      | 97.17                                        | 1.8867925        | 0.94                                        | 2.03              | [77]     |
| 45   | Jordan             | 2007 | 5                                            | 0                              | 1                                | 0.80                                      | 4                                           | 105                                      | 99.06                                        | 0                            | 0.94                                        | 0.93              | [78]     |
| 46   | China              | 2006 | 25                                           | 0                              | 1                                | 2.00                                      | 24                                          | 105                                      | 99.06                                        | 0                            | 0.94                                        | 0.78              | [79]     |
| 47   | South Africa       | 2013 | 45                                           | 0                              | 0                                | 0.00                                      | 45                                          | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [80]     |
| 48   | Ethiopia           | 2005 | 8                                            | 0                              | 0                                | 0.00                                      | 8                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [81]     |
| 49   | Italy              | 2004 | 70                                           | 3                              | 3                                | 6.57                                      | 64                                          | 100                                      | 94.34                                        | 2.8301887        | 2.83                                        | 3.80              | [82]     |
| 50   | Jordan             | 2003 | 1                                            | 0                              | 0                                | 0.00                                      | 1                                           | 106                                      | 100.00                                      | 0                            | 0.00                                        | 0.00              | [83]     |
organoleptic and pharmaceutical properties [297]. The fewer species were observed in 37 families that are similar to previous studies [298, 299].

Among the reported plant part leaves were the most used plant part. In various studies, leaves were reported to be used as powder and paste on the affected skin

| S/No | Plant Species          | Activity                                                                 | References |
|------|------------------------|---------------------------------------------------------------------------|------------|
| 1.   | Anethum graveolens     | Antibacterial and antimicrobial activity                                  | [85, 86]   |
| 2.   | Cynodon dactylon       | Antibacterial and wound healing activity                                 | [87, 88]   |
| 3.   | Bergenia ciliata       | Antibacterial, antibiotic, anti-inflammatory and antiviral activity       | [89, 90]   |
| 4.   | Adiantum venustum      | Antibacterial, antifungal and anti-inflammatory activity                  | [91]       |
| 5.   | Gerbera gossypina      | Antimicrobial activity                                                    | [92]       |
| 6.   | Aconitum chasmanthum   | Antimicrobial activities                                                  | [93]       |
| 7.   | Trigonella foenum-graecum | Anti-inflammatory, antibacterial and antifungal activities                | [94]       |
| 8.   | Verbascum thapsus,     | Anti-inflammatory, antimicrobial, antiviral, and anti-hyperlipidemic activity | [95]       |
| 9.   | Saussurea lappa        | Anti-inflammatory activity                                                 | [96]       |
| 10.  | Rosa chinensis,        | Antimicrobial activities                                                  | [97]       |
| 11.  | Gerbera gossypina      | Antimicrobial activities                                                  | [98]       |
| 12.  | Taxus wallichiana      | Antibacterial and antifungal activites                                    | [99]       |
| 13.  | Aquilegia pubiflora    | Antimicrobial activity                                                    | [100]      |
| 14.  | Salix babylonica       | Anti-bacterial and anti-fungal activities                                 | [101]      |
| 15.  | Sonchus asper          | Antimicrobial activities                                                  | [102]      |
| 16.  | Prunus armeniaca       | Antimicrobial activity                                                    | [103]      |
| 17.  | Momordica charantia    | Antibacterial and antifungal activity                                     | [104]      |
| 18.  | Urtica dioica          | Antibacterial and antifungal activity                                     | [105, 106] |
| 19.  | Dodonaea viscosa       | Antifungal activity                                                       | [107]      |
| 20.  | Bergenia stracheyi     | Antifungal activity                                                       | [108]      |
| 21.  | Pisum sativum          | Antifungal activity                                                       | [109]      |
| 22.  | Butea monosperma       | Antifungal, antibacterial and anti-inflammatory activities                | [110]      |
| 23.  | Commelina benghalensis | Anti-inflammatory and wound healing activities                            | [111]      |
| 24.  | Polygonum nepalense    | Antimicrobial and antifungal activity                                     | [112]      |
| 25.  | Valeriana jatamansi    | Anti-inflammatory activity                                                 | [113]      |
| 26.  | Cannabis sativa        | Antimicrobial activity                                                    | [114]      |
| 27.  | Plantago major         | Antibacterial activity                                                    | [115]      |
| 28.  | Berberis lycium        | Antibacterial, antifungal and healing properties                          | [116]      |
| 29.  | Taraxacum officinale   | Antimicrobial activity                                                    | [117]      |
| 30.  | Myrsine Africana       | Antimicrobial activity                                                    | [1]        |
| 31.  | Allium sativum         | Antimicrobial and wound healing                                           | [118]      |
| 32.  | Allium cepa            | Antimicrobial activities                                                  | [119]      |
| 33.  | Pinus roxburgii        | Antibacterial activity                                                    | [120]      |
| 34.  | Senecio chrysanthemoides | Antifungal and antibacterial activities                               | [121]      |
| 35.  | Olea europaea          | Antimicrobial activity                                                    | [122]      |
| 36.  | Isodon rugosus         | Antimicrobial activities                                                  | [123]      |
| 37.  | Micromeria biflora     | Antimicrobial activities                                                  | [124]      |
| 38.  | Lawsonia inermis       | Antimicrobial and antibacterial activities                               | [125, 126] |
| 39.  | Teucrium stocksianum   | Anti-microbial activities                                                 | [127]      |
| 40.  | Delbergia sissoo       | Anti-microbial activities                                                 | [128]      |
| S/No | Family / Scientific name / coll. # | Phytochemicals | Toxicity |
|------|----------------------------------|----------------|----------|
| 1.   | Acanthaceae Justicia adhatoda L. | Alkaloids, flavonoids, and sterols [129] | Less toxicity [130] |
| 2.   | Amaryllidaceae Allium cepa L. | Alkaloids, flavonoids, cardiac glycosides, terpene, steroids and resins [131] | None |
| 3.   | Amaryllidaceae Allium sativum L. | Saponin, steroids, tannins, carbohydrates and cardiac glycosides [132] | Excessive use cause toxicity like acute toxicity, burning sensation in the mouth and gastrointestinal tract, nausea, diarrhea, vomiting [133] |
| 4.   | Apioseae Anethum graveolens L. | Essential oils, fatty oil, proteins, carbohydrates, fiber and ash [134] | Nontoxic [135] |
| 5.   | Apioseae Coriandrum sativum L. | Alkaloids, carbohydrates, volatile oil, tannins, and flavonoids [136] | Acute and sub chronic toxicity [137] |
| 6.   | Apioseae Fersula foetida (Bunge) | Terpenoids, Sulfide derivatives, volatile Oil and Phenols [138] | Little toxicity including (including lung metastasis) [139] |
| 7.   | Apioseae Pleurospermum brunonis Benth. ex C.B.Clarke | None | None |
| 8.   | Apioseae Calotrops procera (Aiton) | Cardenolides, flavonoids, and saponins [132] | Highly toxic [140] |
| 9.   | Apioseae Carissa spinarum L. | Alkaloids, tannin, glycoside, steroids and carbohydrates [141] | Acute toxicity (Shamim, 2014) |
| 10.  | Apioseae Rauwolfia serpentina L. | Phenolic acids and flavonoids [142] | None |
| 11.  | Asteraceae Anaphalis margaritacea (L.) Benth. | Flavonoids, polyacetylenes, and hydroxylactone [143] | |
| 12.  | Asteraceae Artemisia vulgaris L. | Carbohydrate, saponins, phytosterol, proteins, amino acid, tannin & phenolic compounds and flavonoids [144] | Genotoxicity [145] |
| 13.  | Asteraceae Gerbera gossypina (Royle) Beavuerd | None | Less toxicity [139] |
| 14.  | Asteraceae Graphium affine D.Don | Flavonoids, sesquiterpenes, diterpenes, Tritterpenes and phytosterols [146] | Damage oxidative compounds and produce various toxic compound that are harmful for humans [139] |
| 15.  | Asteraceae Launaea nudicaulis (L.) Hook.f. | Flavonoids, anthocynadins and flavanones [147] | Nontoxic [148] |
| 16.  | Asteraceae Saussurea lappa (Decne) | Alkaloids, glycosides, phenolics, steroids and terpenoids [149] | Acute toxicity [150] |
| 17.  | Asteraceae Senecio chrysanthemoides DC | Tritterpe, emodins,polyphenol, reducing sugar and anthcyanosides [151] | Hepatotoxicity [150] |
| 18.  | Asteraceae Sonchus asper (L.) Hill | Ascorbic acid, carotenoids and fatty acids [152] | Acute toxicity [153] |
| 19.  | Asteraceae Taraxacum officinale agg. | phenolic compounds, flavonoid glycosides [154] | Acute toxicity [155] |
| 20.  | Asteraceae Tussilago farfara L. | Terpenes, flavonoids, and alkaloids [156] | Acute toxicity [157] |
| 21.  | Balsaminaceae Impatien edgeworthii Hook. | Flavonoids, sugars, alkaloids and saponins [158] | Cytotoxicity [159] |
| 22.  | Berberidaceae Berberis lycium Royle | ß-sitosterol, 4,4-dimethylhexadeca-3-ol, Butyl-3-hydroxypropyl phthalate, Butyl-3-hydroxypropyl phthlate and 4-methyl-7-hydroxycoumarin [160] | Acute toxicity and oral toxicity [158] |
| 23.  | Boraginaceae Hackelia americana (A.Gray) | Phenols, saponins, and flavonoids [161] | Hepatotoxicity [162] |
| 24.  | Boraginaceae Onosma hispida Wall. ex G. | Flavonoid, amines, iridonoids and sesquiterpene [163] | Acute toxicity [164] |
| 25.  | Brassicaceae Brassica juncea (L.) Czern. | 2,6-dichlorophenol indophenol and HEPES 4-(2-Hydroxyethyl)-1-piperazine-ethane-sulphonic acid [165] | Poisonous [166] |
| 26.  | Buxaceae Buxus papillosa C.K. Schneid. | Cyclobuxapaline-C (IV)(+)-cyclopilosine-D (VII) and (+)-buxamine-C [167] | Nonpoisonous [168] |
| S/No | Family / Scientific name / coll. # | Phytochemicals | Toxicity |
|------|----------------------------------|----------------|----------|
| 27.  | Cannabaceae Cannabis sativa L LI 26 | Alkaloids, flavonoids, cardiac glycosides, resins, terpenes and steroids [169]. | High doses cause inhibition of hepatic drug and decreased fertilization capacity [170] |
| 28.  | Capparaceae Capparis decidua (Forsk) Edgew. LI 27 | Alkaloids, phenols, sterols and glycosides [171] | Acute toxicity [172] |
| 29.  | Caprifoliaceae Valeriana jatamansi Jones ex Roxb. LI 105 | Phenols, flavonoids and tannins [173] | Fumigant toxicity [174] |
| 30.  | Caryophyllaceae Cerastium fontanum subsp. vulgare (Hartm.) Greuter & Burdet, LI 29 | None | None |
| 31.  | Commelinaceae Commelina benghalensis L LI 32 | Terpenoids, saponins, tannins, flavonoids, steroids, phenolic compounds, alkalooids and cardiac glycosides [175] | Acute and sub-acute toxicity, male reproductive toxicity [176] |
| 32.  | Convolvulaceae Cuscuta reflexa Roxb. LI 35 | Flavonoids and tannins [177] | Oral toxicity [178] |
| 33.  | Cucurbitaceae Cucumis melo L. LI 36 | Alkaloids, terpenoids, carbohydrates, proteins, flavonoids, phytosterols [179] | Metal toxicity [180] |
| 34.  | Cucurbitaceae Lagenaria siceraria (Molina) Standl. LI 59 | Protein, carbohydrates, flavonoids and saponin [181] | Gastrointestinal toxicity [182] |
| 35.  | Cucurbitaceae Momordica charantia L. | Alkaloid, glycoside, aglycone, tannin, sterol, phenol, protein and carbohydrate [183] | Hepatotoxicity [184] |
| 36.  | Cupresaceae Juniperus communis L. LI 67 | Steroids, alkaloids, phenolics, flavonoids, tannins and terpenoids [185] | Nephrotoxicity [186] |
| 37.  | Cupresaceae Juniperus excelsa M. Bieb. LI 57 | Alkaloids, flavonoids, phenols, saponins and diterpenes [187] | Cytotoxicity [188] |
| 38.  | Cyperaceae Cyperus difformis L LI 38 | Flavonoids, coumarins, tannins and sterols [189] | Fumigent toxicity [190] (Chang et al., 2012) |
| 39.  | Elaeagnaceae Hippophae rhamnoides L. LI 53 | Phenol, Quercetin and Catechin [191] | Non toxic [192] |
| 40.  | Equisetaceae Equisetum arvense L. LI 43 | Flavonoids, alkaloids, minerals, phenolic petrosins, triterpenoids, saponins, phytosterols [193] | Acute and metal toxicity [194] |
| 41.  | Euphorbiaceae Euphorbia helioscopia L. LI 44 | Reducing sugars, terpenoids, alkaloids, steroids, tannins, flavanoids and phenolic compounds [195] | Cytotoxicity [196] |
| 42.  | Fabaceae Butea monosperma (Lam.) Kuntze LI 14 | Sterols, triterpenes, glycosides flavonoids and proteins [197]. | Acute and oral toxicity [198] |
| 43.  | Fabaceae Delbergia sissoo L. LI 41 | Proteins, phyto sterols, tannins, starch, flavonoids and tannins [199]. | Acute toxicity [200] |
| 44.  | Fabaceae Pisum sativum L. LI 77 | Tannins, terpenoids, alkaloids and flavonoids [201] | Cadmium toxicity in human [202] |
| 45.  | Fabaceae Trigonella foenum-graecum L LI 102 | Alkaloids, cardiac glycosides, and phenols [203] | Acute toxicity [204] |
| 46.  | Gentianaceae Swertia abyssinica Hochst. LI 97 | None | Hepatic toxicity [205] |
| 47.  | Lamiaceae Ajuga integrifolia Buch-Ham-ex D. Don LI 5 | Essential oil [206] | Body weakness [205] |
| 48.  | Lamiaceae Illecebrum rugosum (Wall. ex Benth.) LI 55 | Alkaloids, glycosides, flavonoids, oils, terpenoids, saponins, tannins and anthraquinones [207] | Cytotoxicity [159] |
| 49.  | Lamiaceae Micromeria biflora (Buch.-Ham. ex D.Don) Bentham LI 66 | None | Membrane toxicity of cell [184] |
| 50.  | Lamiaceae Nepeta hindostana (B.Heyne ex Roth) Haines. LI 68 | None | Mycotoxin [208] |
| S/No | Family / Scientific name / coll. # | Phytochemicals | Toxicity |
|------|----------------------------------|----------------|----------|
| 51.  | Lamiaceae *Rydingia limbata* (Benth.) Scheen & V.A. Albert LI 90 | None | Cytotoxicity [209] |
| 52.  | Lamiaceae *Salvia moorcroftiana* wall. ex Benth LI 92 | Flavonoids, diterpenoids and sterols | Nontoxic inhibitor [211] |
| 53.  | Lamiaceae *Teucrium stocksianum* Boiss. LI 101 | Alkaloids, tannins, flavonoids, saponins, steroid, reducing sugar, terpenoid, anthraquinone, phlobatannin and glycoside | Acute toxicity [213] |
| 54.  | Loranthaceae *Loranthus pulverulentus* Wall LI 62 | Triterpenoids, alkaloids, carbohydrates, flavanoids, proteins, tannins and glycosides | Low toxicity [148] |
| 55.  | Lythraceae *Lawsonia inermis* L. LI 61 | Glycosides, phytosterol, steroids, saponins, and tannins | Highly toxic [148] |
| 56.  | Malvaceae *Abelmoschus esculentus* (L.) Moench LI 1 | Carbohydrate, gums and mucilages, proteins, phytosterols, flavanoids, tannins, phenolic compounds and volatile oil (Saha et al., 2011). | No toxic effect [216] |
| 57.  | Meliaceae *Melia azadirach L.* LI 65 | Alkaloids, Tannins, Saponins, Phenols | Toxic [218] |
| 58.  | Myrsinaceae *Myrsine africana* L. LI 63/ | Saponins, tannins, flavonoids, amino acids, steroids and reducing sugar | Acute toxicity [148] |
| 59.  | Nitrariaceae *Peganum harmala* L. L 19/ | Alkaloids, flavonoids and anthraquinones | Cytotoxicity [221] |
| 60.  | Nyctaginaceae *Boerhavia diffusa* L. LI 19/ | 1,1-diphenyl picrylhydrazyl, phenolic, flavonoid and ascorbic acid | Acute toxicity [223] |
| 61.  | Oleaceae *Olea europaea* subsp. cuspidata (Wall. & G.Don) Cif LI 70 | Flavonoids, terpenes | Low toxicity [164] |
| 62.  | Papaveraceae *Corydalis govaniana* Wall. LI 34 | Alkaloids | Acute toxicity (Mukhopadhyay et al., 1987) |
| 63.  | Phytolaceae *Phytolacea letsenia* L. LI 73 | None | |
| 64.  | Pinaceae *Cedrus deodara* (Roxb. ex D.Don). LI 28 | Tannins, flavanoids, alkaloids, and terpenoids | Cytotoxicity [172] |
| 65.  | Pinaceae *Pinus roxburghii* Sarg LI 75/ | Flavonoids and terpenoids | Acute toxicity [228] |
| 66.  | Pinaceae *Pinus wallichiana* A.B. Jacks. LI 76 | Flavonoid and phenolic | Toxic [228] |
| 67.  | Plantaginaceae *Picrorhiza kurrooa* Royle. ex Benth. LI 74 | Sterols, glycosides and phenolic compounds | Cytotoxicity [231] |
| 68.  | Plantaginaceae *Plantago major* L. LI 78 | Alkaloids, flavonoids, saponins, quinones, terpenes, lignans, tannins, polysaccharides, steroidal glycoside, thiosulfimates, proanthocyanidin and proteins | Less toxicity [233] |
| 69.  | Plantaginaceae *Plantago lanceolata* L. | Anthraquinone, Glycosides and alkaloids | Not toxic [235] |
| S/No | Family / Scientific name / coll. # | Phytochemicals | Toxicity |
|------|-----------------------------------|----------------|----------|
| 70.  | Poaceae Cynodon dactylon (L.) Pers. Li 79 | Alkaloids, anthroquinone, flavonoids, saponins, steriods, tannins and triterpenoid [190] | Fungal growth, biomass toxicity [236] |
| 71.  | Polygonaceae Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer Li 45 | Protein, carbohydrates, fat and rutin [237] | Hepatotoxicity [238] |
| 72.  | Polygonaceae Polygonum nepalense Meissn. Li 81 | None | Toxic [239] |
| 73.  | Polygonaceae Rumex abyssinicus Jacq. Li 87 | Tannins, anthraquinones, amino acids flavonoids and carbohydrates [240] | Non toxic in cell [241] |
| 74.  | Polygonaceae Rumex dissectus H. Lév. Li 88 | B-carotene linoleic acid, has antioxidant activity [242] | Less toxic [243] |
| 75.  | Polygonaceae Rumex dentatus L. Li 89 | Alkaloids, terpenoids, flavonoids and tannins [244] | Toxic [174] |
| 76.  | Polygonaceae Fagopyrum tataricum (L.) Gaertn. Li 46 | Flavonoids [245] | Cytotoxicity [246] |
| 77.  | Primulaceae Androsace rotundifolia Lehm. ex Roem. & Schult. Li 9 | None | Less toxic [247] |
| 78.  | Primulaceae Adiantum venustum D. Don Li 4 | Adininaneone, adininaonol and Norhopan [248] | Nontoxic (Huxley et al., 1992) |
| 79.  | Ranunculaceae Aconitum chasmanthum Stapf ex Holmes Li 2 | Alkaloids, benzoylmecasonine and mesaconitine [249] | Some species are highly poisonous [250] |
| 80.  | Ranunculaceae Aconitum delphinfolium DC. Li 3 | Alkaloids, benzoylmecasonine and mesaconitine [249] | Slightly poisonous when used in access [250] |
| 81.  | Ranunculaceae Aquilegia pubiflora Wall. ex Royle Li 13 | None | Nontoxic [251] |
| 82.  | Ranunculaceae Caltha alba Cambess Li 25/ | Alkaloids, flavonoids, glycosides and triterpenoids [252] | Acute toxicity, cytotoxicity [216] |
| 83.  | Ranunculaceae Nigella sativa L. Li 69 | Flavonoid glycosides quercetin and kaempferol 3-glucosyl [253] | Hepatotoxicity [254] |
| 84.  | Rhamnaceae Colubrina oppositifolia Brongn. ex H. Mann Li 23 | None | None |
| 85.  | Rosaceae Malus pumila Mill. Li 64 | Triterpenoids and flavonoids [255] | Hepatotoxic [148] |
| 86.  | Rosaceae Prunus armeniaca L. Li 82 | Carbohydrates, phenolic compounds and organic acids [256] | Acute and renal toxicity [257] |
| 87.  | Rosaceae Prunus persica (L.) Batsch Li 83 | Phenolics, anthocyanins and flavonoids [258] | Toxic side effects [259] |
| 88.  | Rosaceae Rosa chinensis Jacq | None | None |
| S/No | Family / Scientific name / coll. # | Phytochemicals | Toxicity |
|------|-----------------------------------|----------------|----------|
| 89.  | Rosaceae Rubus abchaziensis Sudre Li 86 | Diterpene glycosides, phenolic glycoside and Lignan glycoside [260] | Cytotoxicity and mitochondrial toxicity [261] |
| 90.  | Rubiaceae Galium abaujense Borbás Li 48 | None | None |
| 91.  | Rubiaceae Galium aparine L. Li 49 | None | None |
| 92.  | Rutaceae Zanthoxylum armatum DC Li 11 | Limonene, linalool, neral [262] | Cytotoxic and Phytotoxic potential [263] |
| 93.  | Rutaceae Citrus medica L. Li 30 | Carbohydrates, proteins, amino acids and flavonoids [264] | Estrogenic effect [265] |
| 94.  | Rutaceae Citrus sinensis L. Li 31 | Tannin, alkaloid, saponin, flavonoid, steroid, triperterpenes [266] | Fumigant toxicity [267] |
| 95.  | Salicaceae Salix babylonica L. Li 91 | Phenolics and saponins [268] | Cytotoxicity [269] |
| 96.  | Sapindaceae Dodonaea viscosa (L.) Jacq Li 42 | Carbohydrates, flavonoids, proteins, amino acids, saponins, steroids, sterols, tannins, and triterpenoids [270] | Acute toxicity [271] |
| 97.  | Saxifragaceae Bergenia ciliata (Haw.) Stemb Li 16 | Alkaloids, carbohydrates, cardiac glycosides, saponins, phenols, flavonoids and diterpenes [272] | Acute toxicity [273] |
| 98.  | Saxifragaceae Bergenia ligulata Engl. Li 17 | Bergenia, catechin, gallicin and gallic acid [274] | Radical toxicity in renal epithelial cell [275] |
| 99.  | Saxifragaceae Bergenia stracheyi Hook.f. & Thomson Engl Li 18 | Bergenia 2. Tannic acid 3. Gallic acid 4. Stigmasterol 5. β-Sitosterol 6. catechin 7 [276] | Acute toxicity [277] |
| 100. | Scrophulariaceae Verbascum thapsus L. Li 106 | Methanolic extract has antiviral activity against the pseudorabies virus [278] | Toxic pyrrolizidine alkaloids [279] |
| 101. | Solanaceae Datura stramonium L. Li 40 | Saponins, tannins, alkaloids and glycosides [280] | Poison and hallucinogen [281] |
| 102. | Solanaceae Solanum virginianum L. Li 95 | None | Cytotoxicity [282] |
| 103. | Tamaricaceae Tamarix aphylla (L.) H. Karst. Li 98 | Flavonoids, alkaloids and tannins [283] | Less toxic [284] |
| 104. | Taxaceae Taxus wallichiana Zucc. Li 100 | Diterpenoids, lignans, flavonoids, steroids and sugar derivatives [285] | Hepatotoxicity [286] |
| 105. | Thymelaeaceae Daphne mucronata S Royle Li 39 | Coumarins, flavonoids, triterpenoids, lignin, glucosides, daphnine and umbelliferone [287] | Leaf extract is highly toxic [287] |
| 106. | Urticaceae Urtica dioica L. Li 104 | Phytosterols, saponins, flavanoids, tannins, hydrolysable tannins, phenolic compounds, proteins and amino acids [288] | Nontoxic [289] |
also described the common practices of medicinal activities. Following reports carried out in various areas ally for their phytochemical and pharmacological ac-
cure of skin infections might also be utilized addition-
days, or till the patient was completely cured.
fore breakfast or afterward dinner, for 3-7 successive
times juice extract from fresh parts of plants was
The amount of powder used to make a concoction or a combination of different parts of the same plant. The
used. Treatments were done with single plant parts or a combination of different parts of the same plant.
The drugs were usually prepared from the paste of the
plant part either with water, lime water, rose water, coconut water, milk, ghee, and butter. Sometimes juice extract from fresh parts of plants was used. Treatments were done with single plant parts or a combination of different parts of the same plant. The amount of powder used to make a concoction was defined as a half, full or a quarter of a teaspoon. In the morning, the mixtures were regularly used before breakfast or afterward dinner, for 3-7 successive days, or till the patient was completely cured.

The medicinal plants described in this study for the cure of skin infections might also be utilized additionally for their phytochemical and pharmacological activities. Following reports carried out in various areas also described the common practices of medicinal species usage against the diseases of skin [22, 29, 48].

The overall effectiveness of the mentioned plant species in the context of curing skin ailments was calculated on the basis of the computed index called used value [40]. This species was mentioned by 21 participants. Wounds and skin burns treated by *Pisum sativum* showed an increase in oxygen supply as a result of increased blood pressure flow [302]. In other studies glycoprotein extracted from *Pisum* helped the formation of epidermis tissues [303]. The highest UV for important medicinal plants like *Pisum sativum* and *Cynodon dactylon* might be ascribed to the trends of using herbal drugs for skin diseases in the area. It is also observed that plant species that are using repeatedly are more possibly to be active biologically and have good healing properties [53]. Less available in the study site parallel to small UV e-g in case of *Adiantum venustum* [304].

Relative frequency of citation is applied to choose high potential medicinal plant species for future research anti-skin diseases drug development. The medicinal species that have high RFC should be further analyzed for phytochemical compounds, to recognize their active chemical components for drug discovery [305]. These findings might be considered as of greatest importance for relating and assessing study in associated hypothetical fields for upcoming drug inventory and sustainable utilization of plant species for medicinal purposes [306].

The plant species that were cited only once by a single participant were not considered for the fidelity level study. The high value of FL indicates the choice of participants to treat the specific disease [84]. These plants can be verified as significant medicinal flora on additional estimation by the help of pharmaceutical, phytochemical and biological actions. We have found the species as more significant having 80 FL% or greater.

In [292] the maximum value of FIV was documented for Juglandaceae (45%) followed by Punicaceae (44%) whereas the lowest value was noted for Vitaceae and Rubiaceae (3%) The results of present study vary from previous literature reports due to differences in climate and vegetation of area [307]. The highest percentage of FIV demonstrates that the plants of a particular family are commonly used in curing many diseases as reported by participants.

Jaccard index is used to find out the similarity of medicinal uses with previous studies carried out on skin ailments. The maximum level of resemblance was present in findings carried out in North-West Frontier Province, Pakistan and Gilgit Baltistan Pakistan on skin diseases [1, 73]) with Jaccard index value 11.81 and 5.30, respectively. About 12% average similarity is reported among different areas and the study regions. The recent study represents a high level of novelty index with respect to the use of medicinal species in skin diseases and its significance in old traditional recipes [308] specified in his study work that the medicinal plants repeatedly cited must be utilized as herbal drug development. The comparison of similarities shows the significant authenticity of documented data. Similarly, the medicinal plants which are not cited in previous work should be assessed for pharmacological and phytochemical analysis for drug discovery development.

In this research, the use of medicinal plants against skin diseases were studied for the occurrence of various toxicity and phytochemicals stated in former literature (see Table 5, Additional file 1). Mostly all the species had been described previously for their one or more phytochemical important compound representing their importance in medicinal cures. In the study, phytochemical analysis on genus, Aconitum has directed to the identification of alkaloids, benzoyl mecasonine and mesaconitine [249]. Some species of *Aconitum* are slightly poisonous when used in the excess amount [250]. In other studies, *Bergenia ciliate* was reported to contain active compounds such as alkaloids, carbohydrates, cardiac glycosides, saponins, phenols, flavonoids and diterpenes [272]. *Allium sativum* is rich with saponins, steroids, tannins, carbohydrates, allicin and cardiac glycosides which possess essential skin diseases curing activity [132]. Alkaloids, flavonoids, phenols, saponins and diterpenes compounds of *Juniperus excels* also have reported skin properties [185]. High consumption of flavonoids and phenolics may inhibit enzyme activity and
caused oxidative damage [309]. Some alkaloids can inhibit enzyme activity, block ion channels loss of coordination, convulsions, hallucination and even death [310]. Myrsine Africana reported to have an acute toxic effect and Malus pumila cause hepatotoxicity [148], Rubus fruticosus damage cell activity that was stated by [261]. Discovery of drugs from medicinal plants links a multidisciplinary approach to joining pharmacological, botanical, ethnopharmacological and natural methods. Some natural products of plant derivatives are in the phase of the trial and are in experimental use [311]. Therefore further pharmacological, ethnopharmacological and phytochemical studies should be carried out to authenticate the use of plant species in skin diseases and to discover new drugs.

The root of Butea monosperma was reported for skin diseases in the present study while it is reported as a blood purifier and skin diseases in the work of [312]. Coriandrum sativum was used to control hypertension, joint pain, stomach complaints, and Gastrointestinal tract problems [313], but in the present study, it is reported to treat pimples and skin problems. Fruits of Lagenaria siceraria were reported to treat severe body pain [314], while our study revealed that fruits and seeds can be used for skin problems. The leaves of Justicia adhatoda have been used for muscular pains in a study of [315], but this study documented that the leaves can be used for wound healing. Leaves of Myrsine africana were reported for stomach problems in the previous studies of [313], these results are in accord with the present study. The flowers and leaves of Verbascum thapsus were used for wounds [314], while the current study found that aerial parts of plant’s may be utilized for the cure of blemishes and several skin related problems.

Launaea nudicaulis and Gnaphalium affine were used often for skin ailments. Asteraceae are generally rich in flavonoids, sesquiterpenes, diterpenes, triterpenes, phytosterols [146]. Nepeta clarkei, Ajuga integrifolia, and Isodon rugosus were used for curing of boils, wound healing and skin problems, respectively. Capparis himalayensis was used for wound healing in areas of Northern Pakistan. The medicinal use of species related to wound healing was not reported earlier. Euphorbia helioscopia was reported for the treatment of cholera, jaundice, respiratory diseases, cancer [46], but the present study reported it for wound healing. Brassica juncea was found to treat some skin problems while the literature suggested it for the treatment of ulcers [316]. In this study, Cucumis melo was used to treat skin burn while in a previous study it was used to treat liver diseases [314]. This study showed that Rheum emodi can be used for skin ailments, while in literature it is mostly reported for the treatment of cancer [317]. Our research also found that Svertia alata, as used for skin diseases, while the previous study reported it only as used for rheumatic disorders [314]. Onosma hispida was documented to treat skin burns, compared to use as skin tonic [318]. Verbascum thapsus also served for curing skin ailments, while traditionally it was reported for stomach diseases [319]. Melia azedarach was found as a treatment for pimples and wound healing, but literature reported this species for sexual problems and as skin tonics [320]. The present work therefore suggest that public sector administrator in study area should make policies in order to protect people from health problems and use of medicinal plants by local people for treatment of diseases.

Conclusions
This is the first quantitative ethnopharmacological study that provides information about the use of 106 species that belonging to 90 genera and 56 families for the treatment of skin diseases in Northern Pakistan. Key findings of the study revealed leaves to be the most used plant parts (58%), herb to be dominant life form (63%) and powder to be the most frequent method of administration (22%). The highest skin disease category was recorded for wound healing (40%). RFC ranged from 0.07 to 0.25%, highest use-value reported for Pisum sativum (0.143 UV), highest FIV was observed for Pteridaceae (26.6 FIV) while FL values ranged from 100% to 36.8. The medicinal information documented in this study could be explored in the future for phytochemical and pharmacological investigations which may lead to plant-based nano-medicine drug discovery and development.

Additional file

Additional file 1: Table S1. Chi-square test $\chi^2$ test for gender wise distribution. Figure S1. Schematic representation of medicinal plant parts used prepared by NVivo software for skin diseases in Northern Pakistan. Figure S2. Systematic representation of mode of utilization for skin diseases in Northern Pakistan. (DOCX 615 kb)

Abbreviations
FC: Frequency of citation; FL: Fidelity Level; CBE: Institutional Bio-ethics Committee; ISL: Islamabad; JI: Jaccard index; Pak: Pakistan; RFC: Relative Frequency of citation; THPs: Traditional Health Practitioners; Quaid-i-Azam uni

Acknowledgments
The authors are thankful to all key medicinal plant practitioners and participants for sharing their valuable knowledge on medicinal flora.

Authors’ contributions
KM carried out field surveys and data collection. MZ, SS NR, SNS, helped in analysis of data while MA critically revised the manuscript to its present form. RU, HMM, L and BP helped in revision of the manuscript and helps in checking the consistency of data. All authors read the final manuscript and agreed to its submission.
Funding
The authors extend their appreciation to the Deanship of the scientific Research at King Saud University for funding through research group no (RG-1440-100).

Availability of data and materials
Not Applicable.

Ethics approval and consent to participate
Verbal consent was taken from participants before carrying out the study as most if the participants were illiterate. Present study was carefully designed with strict compliance of bio-ethics and approved by the Institutional Bio-ethics Committee (IBC) of Quaid-i-Azam University, Islamabad, Pakistan under the approval No PT-5695.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Received: 25 September 2018 Accepted: 19 July 2019

Published online: 13 August 2019

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