Research Article

Traditional Herbal Knowledge among the Inhabitants: A Case Study in Urgam Valley of Chamoli Garhwal, Uttarakhand, India

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The Indian Himalaya is rich in plant species, including many medicinal plants, greatly valued by local inhabitants for health care needs. The study in Urgam Valley of Uttarakhand, India, is to identify and document traditional knowledge of medicinal plants. The study revealed high consensus on medicinal plant usage, with 51 species belonging to 31 families used for local health care. Number of species and uses known increases with age, and elders and specialist healers retain higher levels of traditional medicinal plant knowledge, having unique knowledge of medicinal plants and their uses as well as preparation.

1. Introduction

India is rich in floral diversity, with more than 17,000 angiosperm species, 64 gymnosperms, 1,200 pteridophytes, 2,850 bryophytes, and 2,021 lichens [1]. Out of the total, 7,500 species have been reported to have medicinal uses [2]. Diverse topography and climatic conditions provide the Indian Himalaya with an especially rich medicinal plants, whereby alpine areas being the major source of important medicinal plants.

Inhabitants of rural and remote areas still rely on plants as a major component of their health care systems. Indigenous medicines provide considerable economic benefits to local people [3]. The World Health Organization (WHO) mentioned that about 25% of modern medicines are developed from plant sources used traditionally; and research on traditional herbal plants leads to discovery of 75% of herbal drugs [3, 4].

Locals acquire knowledge of the economic values and medicinal properties of many plants through need, observation, trial and error, and the transmitted experiences of elders. Often, knowledge is concentrated in specialist healers. Most diseases cured by local herbalist are common problems such as respiratory diseases, aches and pains, wounds, and musculoskeletal ailments. Inhabitants often use local medicinal plants without prior advice of local traditional healers because they are using these plants since generations [5]. This knowledge may be passed secretly from one generation to the next through word of mouth [6] or inherited via medico-spiritual manuscripts [7]. Although knowledge of these valuable plants is often restricted within lineages or in other ways, ensuring that the younger generations in these areas acquire this knowledge is essential to its continuity in use and sustainability. Medicinal plant richness of the Indian Himalaya is exemplified in Garhwal Himalaya, within northwestern India. This study focused on traditional herbal medicines of Urgam, a mountain valley in the Garhwal Himalaya rich in medicinal plants which are still used by local inhabitants and specialist healers.

2. Materials and Methods

2.1. The Study Area. Urgam Valley (30°30'20.93" to 30°34'12.35"N and 79°26'14.02" to 79°30'17.26" E) is located in north-eastern Chamoli district in Uttarakhnad, India.
(Figure 1). The valley joins the Kalp Ganga Valley at 1,300 m asl to the surrounding mountain tops above 3,000 m asl. Crops consist mainly of three types, namely, Rabi, Kharif, and Zaid. The main Rabi crops of the region are Wheat and Mustard and Kharif crop are Rice, Maize, Finger millet, Barnyard grasses, and Amaranthus. Zaid crops include Beans, Cucumber, and pumpkin. Among the fruits are Apple, Peach, Cherry, and Walnut. Annual rainfall ranges from 2000 to 2500 mm while temperature ranges from 15 to 35°C during summer and -2 to 15°C in winter. Urgam Valley spans over a wide spread of topographic and climatic conditions, namely, alpine, subalpine, and temperate zones provide a range of plant habitats.

2.2. Field Survey and Data Collection. Local surveys including uses of medicinal plants of Urgam Valley were done between August 2015 and July 2016. Ninety-six informants were randomly selected in 11 villages. After giving prior informed consent, informants answered questionnaires (see the Appendix) in the local language (Garhwali), with photos of 110 medicinal plants as references. Answers were elicited based on plant species (“what do you know about [plants name]?”) and based on disease condition (“which plants you use when suffering from [disease name]?”). The questionnaires were then compiled detailed information for each plant on local name, life form, local uses, method of use or drug preparation, and amount of use (dose). Apart from the general population survey of villagers and shepherds, local male (Vaidyas) and female specialists (Daai) were also sought to compare their knowledge to that of the general population.

2.3. Plant Collection and Identification. Voucher specimens were prepared for the traditionally used plants documented in this study. Specimens were identified using Flora of District Garhwal [8] and Flora of Chamoli [9] and in comparison with the specimens of Garhwal University Herbarium, Srinagar Garhwal (GUH). Plant specimens were mounted on herbarium sheets and preserved in HAPPRC Herbarium. Plant names reported here were matched using The Plant List [10].
2.4. Data Analysis

2.4.1. Comparing Consensus in Plant Use across Categories of Use. An informant consensus factor (ICF) was used to measure the consensus in plant use for a given illness treatment in the study area. To develop this consensus, all treated diseases were grouped into nine categories: (a) gastrointestinal disorders, (b) fever and aches, (c) diseases of the skin, (d) remove weakness, immunomodulator, anaemia, (e) ophthalmologic complaints, (f) poisonous bite, (g) dental problems, (h) ear ache, and (i) hearing problems. Within these categories, ICF was calculated according to the following formula [11]:

\[
ICF = \frac{Nur - N_{taxa}}{(Nur - 1)},
\]

where Nur refers to the number of use-reports for a particular ailment category and N_{taxa} refers to the number of taxa used for a particular ailment category by all informants. ICF value ranges from 0 to 1. A high ICF value (close to 1.0) indicates “consensus” indicating relatively few taxa is reported by a large proportion of informants for an ailment category.

2.4.2. Comparing Plants and Uses across Informants. To test whether the traditional medicinal plant knowledge varied with age, the total plants or total uses reported by each informant (excluding healers) were summed up and ran linear regressions and natural spline regressions, using the package splines [12] in the R statistical framework (Version 3.3.0).

To test whether healers reported a different set of plants and uses altogether, the 89 informants who had reported more than 10 species were compared. A matrix with plants as columns and informants as rows, calculated Bray-Curtis distances among each pair of informants based on how similar their answers were, and used nonmetric multidimensional scaling to plot informants based on these distances. To calculate the significance of specialist healer status, the fit of this factor on the location of informants in the ordination space was compared to that of 999 randomized shuffles using the R package vegan [13].

3. Results

3.1. Demographic Features of Informants. A total of 96 people were interviewed consisting of seven local healers from both female (Daai) and male (Vaidyas) healers. Most (48 participants or 50%) were 41-60 years old with 27 informants or 28.1% were 40 years old and younger. Seventeen were illiterate, while 4 young practitioners held a tertiary education (degree/diploma) (Table 1).

3.2. Traditional Medicinal Plants Diversity. Fifty-one species representing 31 families are used by local inhabitants of Urgam Valley in Chamoli Garhwal for local health care (see Table 2). Out of 31 families, most (21 families) were dicotyledons, 9 were monocotyledons, and 1 was gymnosperm. The most represented families were asteraceae (7 species), followed by lamiaceae, amaryllidaceae, and apiaceae (3 species each) (Figure 2). Most species (39 species, 77%) were herbaceous plants, though trees (7 species, 14%), climbers (3 species, 6%), and shrubs (2 species, 4%) were also included.

3.3. Plant Part Use and Drug Preparation. Plant parts used were mostly roots (18 species, 32%) and leaves (13 species, 23%). Also recorded were aerial parts (7 species, 13%), seeds (4 species, 7%), fruits, rhizome, bark, and whole plants each two species (5%) (Figure 3).

The different type of formulations prepared by local inhabitants of Urgam recorded during the study was primarily plant powder (42% of formulations). Other preparations are paste (23%), extract/juice (17%), decoction and raw (7%), and herbal tea (2%) (Figure 4). All formulations are prepared by local practitioner (Vaidyas), elders, or those with more experience in herbal medicines.

3.4. Informant Consensus Factor. The highest consensus among informants (ICF) is found for Aconitum balfourii Stapf for poisonous bite (PB) followed by Berberis aristata DC. and Berberis lycium Royle for ophthalmologic complaints (OP), and Potentilla lineata Trevor for dental problems (DP) (0.99) (Table 3).

3.5. Comparing Plants and Uses across Informants. Inhabitants of Urgam Valley have a generally strong knowledge of medicinal plants, with informants reporting on average 18 plant species and 13 uses. This knowledge increases with age: linear regressions on age significantly increase for uses (y=0.18*age+5.5, p<0.01, r-squared = 0.39) and for plant species (y=0.24*age+5.5, p<0.01, r-squared = 0.37). The natural spline regressions show that this effect is less steep at higher ages (significantly nonlinear): that is, there is less increase in knowledge after about age 50 (Figure 6(a)).
| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|-----------------------------------------------|------------|------------|------------|---------------------|--------------------------|------------------|----|--------------------------|
| 1    | *Aconitum balfourii* Stapf. Syn. *Aconitum lethale* Griff Ranunculaceae HAPPRCASR 4103 Figure 5(a) | Meetha/Bhngwa | Herb | Root | Decoction (in cow urine), Paste | 1/2 drop once a day | Snake bite | 11 | Diaphoretic, diuretic, analgesic, febrifuge, anti-inflammatory, anti-rheumatic, anti-pyretic, vermilflag, powerful sedative, narcotic and poison [14, 15] |
| 2    | *Aconitum heterophyllum* Wall.ex Royle Ranunculaceae HAPPRCASR 4104 Figure 5(b) | Atees | Herb | Root | Juice, Powder | 1/2 teaspoon with lukewarm water | Stomach ache, fever | 69 | Anti-inflammatory, antipyretic, Antibacterial, Immunomodulatory, Anthelmintic, Antihyperlipidemic, analgesic [14, 16–19] |
| 3    | *Ajuga parviflora* Benth. Lamiaceae HAPPRCASR 4168 | Neelkanthi | Herb | Whole plant | Powder or decoction | 1/2-1 teaspoon 3 times a day with water | Stomach ache, fever | 29 | Hypertension, malaria, pneumonia, edema, as anthelmintic, antifungal, hypoglycemic, anti-inflammatory, antitussive, expectorant, antitusmor and antimicrobial agents [20, 21] |
| 4    | *Allium cepa* L. Amaryllidaceae HAPPRCASR 4120 | Pyaj | Herb | Bulb | Juice | 1-3 drops | Ear ache | 48 | Antitumor, antidiabetic, antioxidant, antibacterial, anti-allergic and molluscsidal activity [22, 23] |
| 5    | *Allium sativum* L. Amaryllidaceae HAPPRCASR 4121 | Lehsun | Herb | Whole plants | Paste | 1/2 teaspoon | Burnt, Cut | 23 | Antibacterial, antiviral, antifungal, anti-parasitic, cardiovascular [24] |
| 6    | *Allium wallichii* Kunth. Amaryllidaceae HAPPRCASR 4125 | Lainka | Herb | Leaves | Powder | 1/2 -1 teaspoon with water | Gastric | 12 | Anti-microbial, anti-oxidant, and anti-cancer [25] |
| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|---------------------------------------------|------------|------------|------------|---------------------|--------------------------|------------------|----|------------------------|
| 7    | *Angelicaglaucaw* Edgew Apiaceae HAPPRCASR 4146 | Choru      | Herb       | Root       | Powder              | 1/2 teaspoon with water  | Gastric         | 9  | Antioxidant, antimicrobial, and phytotoxic [26] |
| 8    | *Artemisianilagirica*(C.B Clarke) Pamp. Asteraceae HAPPRCASR 4146 | Kunja      | Herb       | Leaves     | Juice               | 1 teaspoon               | Cut and wounds  | 24 | Antimicrobial, antifungal, antibacterial, antifilarial, insecticidal, antiulcer, anticancer, antioxidant and anti-asthmatic [27] |
| 9    | *Asparagus filicinus* Buch.-Ham. ex. D.Don Asparagaceae HAPPRCASR 4126 | Jhirna     | Herb       | Root       | Powder              | 1/2 -1 teaspoon with cow milk | Remove weakness | 13 | Hypolipidemic [28] |
| 10   | *Berberis aristata* DC. Berberidaceae HAPPRCASR 4163 | Kingod     | Shrub      | Root       | Decoction           | 1-2 drop                 | Eye ailments     | 87 | Antimicrobial, antidepressant, diabetes mellitus, hepatoprotective, immunomodulatory [29] |
| 11   | *Berberis lycium* Royle Berberidaceae HAPPRCASR 4164 | Chotru     | Herb       | Bark       | Decoction           | 1 teaspoon thrice a day  | Diabetes, eye ailments | 92 | Antidiabetic, hepatoprotective, antiyperlipidemic, Antimicrobial, antimutagenic, pesticidal, wound healing [30] |
| 12   | *Bergenia ciliata* (Haw.) Sternb. Saxifragaceae HAPPRCASR 4112 | Syalphadi  | Herb       | Root       | Decoction           | 1 teaspoon once a day with lukewarm water | Stone           | 45 | Anti-tussive, antiulcer, anti-neoplastic, antioxidant, antibacterial, hypoglycaemic [31, 32] |
| 13   | *Bergenia stracheyi* (Hook.F.& Thomson) Engl Figure 5(c). Saxifragaceae HAPPRCASR 4113 | Pashanbhed | Herb       | Root       | Decoction           | 1 teaspoon once a day with lukewarm water | Stone           | 61 | Anti-arthritis, antimicrobial, [32] |
| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|-----------------------------------------------|------------|------------|------------|---------------------|-------------------------|-----------------|----|-------------------------|
| 14   | *Centella asiatica* (L.) Urb. Apiaceae HAPPRCASR4174 | Brahmi     | Herb       | Leaves     | Juice, Powder       | 1/2 -1 teaspoon with water | Coolant 26     |    | Stimulatory-nervine tonic, rejuvenant, sedative, tranquilizer and intelligence promoting property, antiepileptic, leprosy, antinociceptive and anti-inflammatory [33–35] |
| 15   | *Cinnamomum tamala* (Buch.-Ham.) T'Nees & Eberm. Lauraceae HAPPRCASR4169 | Tejpat     | Tree       | Leaves, bark | Powder             | 1/2 -1 teaspoon with water | Control blood pressure 49 | Antidiabetic, antibacterial, anti-ulcer, antimicrobial [36] |
| 16   | *Cirsium wallichii* DC. Asteraceae HAPPRCASR4138 | Kanjelu    | Herb       | Root       | Powder, Juice      | 1/2-1 teaspoon thrice a day with water | Fever 2 | Antimicrobial and Antioxidant [37] |
| 17   | *Cucumis sativus* L. Cucurbitaceae HAPPRCASR4153 | Kakdi      | Climber    | Seeds      | Powder             | 1/2 teaspoon with water | Diuretic 40 |    | Antimicrobial, Antioxidant, Hypo cholesterolimic [38] |
| 18   | *Curcuma longa* L. Zingiberaceae HAPPRCASR4165 | Haldu      | Herb       | Rhizome    | Paste              | 1/2 teaspoon twice a day | Cut and wounds 86 |    | Anti-HIV, antioxidant, anti-inflammatory, anti-tumor [39] |
| 19   | *Dactylorhiza hatagirea* (D.Don) Soo Orchidaceae HAPPRCASR4162 Figure 5(d) | Hathajadi  | Herb       | Root       | Paste, Powder      | 1/2 teaspoon | Cut and wounds, fever, stomach ache 39 |    | Antibacterial, aphrodisiac, antipyretic [14] |
| 20   | *Dioscorea bulbifera* L. Dioscoreaceae HAPPRCASR4139 | Tairu      | Climber    | Tuber      | Powder             | 1/2 teaspoon with water | Coolant 3 |    | Anthyperlipidemic, antitumor, antioxidant, anorexiant, analgesic, anti-inflammatory, plasmid curing, anti-diabetic and antihyperglycemic[40] |
| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|---------------------------------------------|------------|------------|------------|-------------------|-------------------------|-------------------|----|-------------------------|
| 21   | Eupatorium adenophorum Sprengel Asteraceae HAPPRCASR 4157 | Basya | Herb | Leaves | Juice | 1/2 - 1 teaspoon | Cut and wound | 29 | Analgesic, antifungal [41, 42] |
| 22   | Girardinia diversifolia (Link) Friis Urticaceae HAPPRCASR 4118 | Kandali | Herb | Root | Powder | 1/2-1 teaspoon twice a day with water | Fever | 1 | Antibacterial, antifungal [43] |
| 23   | Hippophae salicifolia D.Don Elaeagnaceae HAPPRCASR 4140 Figure 5(e) | Amesh | Tree | Fruits | Juice | 5-10 teaspoon in 1 glass water | Coolant | 6 | Antibacterial, antifungal, anticancer, anti-inflammatory, immunomodulatory, radio-protective, adaptogenic, anti-atherosclerosis, and anti-sterility [44] |
| 24   | Juglans regia L. Juglandaceae HAPPRCASR 4150 | Akhrot | Tree | Fruit peel | Paste | 1/2 teaspoon | Skin diseases | 56 | Antioxidant, antimicrobial, anti-atherogenic, anti-inflammatory and antimutagenic properties [45–47] |
| 25   | Jurinea macrocephala DC. Asteraceae HAPPRCASR 4116 | Bishkandara | Herb | Root | Powder | 1/2 teaspoon thrice a day | Fever | 2 | Antioxidant and Antibacterial [48] |
| 26   | Macrotyloma uniflorum (Lam.) Verdc. Fabaceae HAPPRCASR 4114 | Gahat | Herb | Seeds | Boiled soup | 1 bowl thrice a day | Stone | 96 | Hepatoprotective, anti-obesity, anticalcifying, antidiabetic, antimicrobial [49–53] |
| 27   | Megacarpcea polyandra Benth ex Madden Brassicaceae HAPPRCASR 4111 Figure 5(f) | Barmolu | Herb | Root | Powder | 1/2 -1 teaspoon twice a day with lukewarm water | Gastric | 4 | Not reported |
| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|---------------------------------------------|------------|------------|------------|---------------------|--------------------------|------------------|----|--------------------------|
| 28   | *Mentha piperita* L. Lamiaceae HAPPRCASR 4148 | Pudina     | Herb      | Leaves    | Paste              | 1/2 -1 teaspoon water    | Coolant         | 9  | Antimicrobial [54]       |
| 29   | *Mirabilis jalapa* L. Nyctaginaceae HAPPRCASR 4117 | Herb      | Leaves    | Paste      | -                  | Cut and wounds           |                  |    | Antimicrobial [55]       |
| 30   | *Nardostachys jatamansi* (D.Don) DC Caprifoliaceae HAPPRCASR 4156 | Maasi   | Herb      | Rhizome    | Powder             | 1/2 teaspoon thrice a day with luke warm water | Jaundice       | 1  | Tonic, laxative, diuretic, spasmodic hepatoprotective, cardio protective [56–58] |
| 31   | *Ocimum tenuiflorum* L. Lamiaceae HAPPRCASR 4115 | Tulsi      | Herb      | Leaves    | Powder or raw      | 3-5 leaves with water    | Fever, cough and cold | 75 | Antimicrobial, radio-protective, ant diabetic, anti-carcinogenic [59, 60] |
| 32   | *Oxalis corniculata* L. Oxalidaceae HAPPRCASR 4133 | Almodu     | Herb      | Aerial part | Paste             | 1/2 teaspoon             | Boils           | 26 | Anti-inflammatory, refrigerant and antiscorbutic, hypoglycemic, antihypertensive, antipsychotic, stimulant, chronotropic & inotropic effect [61–63] |
| 33   | *Paeonia emodi* Royle | Chandra   | Herb      | Leaves    | Juice             | 1 teaspoon thrice a day with water | Fever           | 87 | Backache, dropsy, epilepsy, tonic, emetic, cathartic, blood purifier and colic, purgative [64] |
| 34   | *Picrorhiza kurrooa* Royle ex Benth. Plantaginaceae HAPPRCASR 4105 Figure 5(h) | Kadwi     | Herb      | Root      | Powder             | 1/2 teaspoon thrice a day with water | Fever           | 96 | Immunomodulatory, cardiotonic, antipyretic, anthelmintic, laxative and anti-asthmatic, hepatoprotective, anticholestatic, anti-ulcerogenic, anti-asthmatic and immune-regulatory functions [65, 66] |
| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|---------------------------------------------|------------|------------|------------|---------------------|--------------------------|------------------|----|-------------------------|
| 35   | *Polygonatum verticillatum* (L.) All. Asparagaceae HAPPRC ASR 4127 | Mahamaida/Salampanja | Herb | Rhizome | Powder | 1/2-1 teaspoon thrice a day with water | Fever | 3 | Anti-inflammatory, antimalarial, antipyretic, insecticidal, antibacterial, antifungal, antidiarrheal [67–70] |
| 36   | *Potentilla lineata* Trevir. Syn. *Potentilla fulgens* L. Rosaceae HAPPRC ASR 4173 | Bajrdanti | Herb | Root | Powder | 1/2 teaspoon | Cleansing teeth | 26 | Anthelmintic [71] |
| 37   | *Prunus persica* (L.) Batsch Rosaceae HAPPRC ASR 4177 | Aaru | Tree | Seeds pericarp | Paste | 1/2 teaspoon | Infection after breakage of hair (Baaltod) | 2 | Anthelmintic, insecticidal, sedative, diuretic, demulcent, expectorant, vermifugal and are used in leucoderma and in piles [72] |
| 38   | *Punica graminatum* L. Lythraceae HAPPRC ASR 4142 | Anar | Tree | Fruits | Raw | 1 fruit | Anemia | 8 | Antimicrobial, anti-inflammatory, anti-diabetic, anti cancer [73, 74] |
| 39   | *Rheum moorcroftianum* Royle Polygonaceae HAPPRC ASR 4160 Figure 5(i) | Dolu | Herb | Root | Powder, paste | 1/2 teaspoon | Internal injury, cut and wounds | 24 | Purgative, antimicrobial, anti-inflammatory [14, 75] |
| 40   | *Rhododendron campanulatum* D. Don Ericaceae HAPPRC ASR 4178 | Syamru | Tree | Leaves | Paste with oil | 1/2-1 teaspoon | Skin disease | 6 | Analgesic, anti-inflammatory [76] |
| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|---------------------------------------------|------------|------------|------------|---------------------|-------------------------|------------------|----|-------------------------|
| 41   | *Rumex nepalensis* Spreng. Polygonaceae HAPPRCASR 4167 | Khuldyā | Herb | Root | Powder, paste | 1/2 -1 teaspoon thrice a day with lukewarm water | Pneumonia, Cut and wounds | 1 | Antioxidant, antitumour, anti-inflammatory, purgative, [77–79] |
| 42   | *Saussurea costus* (Falc.) Lipsch. Asteraceae HAPPRCASR 4109 | Kuth | Herb | Root and leaves | Paste | - | Cut and wounds | 27 | Anti-inflammatory, anticancer, hepatoprotective, antimicrobial [80, 81] |
| 43   | *Saussurea obvallata* (DC) Edgew. Asteraceae HAPPRCASR 4110 Figure 5(k) | Kaunl | Herb | Aerial part | Raw | - | To keep at home for increasing immunity | 29 | Antioxidant, antimicrobial [82] |
| 44   | *Selenium vaginatum* (Edgew.) C.B.Clarke Apiaceae HAPPRCASR 4144 | Bhutkesh | Herb | Root | Powder | 1/2 teaspoon with water | Coolant | 2 | Antibacterial [83] |
| 45   | *Swertia chirayita* (Roxb.) Buch.-Ham. ex C.B.Clarke Gentianaceae HAPPRCASR 4154 Figure 5(l) | Chiraitu | Herb | Whole plant | Powder | 1/2-1 teaspoon thrice a day with water | Fever, stomach ache | 78 | Antibacterial, antifungal, antileishmanial, antimalaria, anti-inflammatory, antidiabetic, hepatoprotective, antiviral [84–88] |
| 46   | *Swertia ciliata* (D.Don ex G.Don) B.L.Burtt Gentianaceae HAPPRCASR 4166 | Chirata | Herb | Aerial part | Powder | 1/2 teaspoon with water | Fever, stomach ache | 12 | Antifungal [89] |
Table 2: Continued.

| S.N. | Scientific name, Family and collection number | Local name | Life forms | Parts used | Mode of preparation | Doses and administration | Diseases treated | UR | Pharmacological activity |
|------|---------------------------------------------|------------|------------|------------|---------------------|--------------------------|-----------------|----|--------------------------|
| 47   | *Tagetes erecta* L. Asteraceae HAPPRCASR4147 | Gainda     | Herb       | Leaves     | Juice               | 1-2 drops                | Ear ache        | 1  | Antipyretic, analgesic and anti-inflammatory [90] |
| 48   | *Taxus wallichiana* Zucc. Taxaceae HAPPRCASR4151 | Thuner     | Tree       | Bark       | Tea                 | 1 cup once a day         | High blood pressure | 25 | Immunomodulatory, anti-bacterial, anti-fungal, analgesic, anti-pyretic and anti-convulsion activities, anti-cancer [91, 92] |
| 49   | *Tinospora sinensis* (Lour.) Merr. Syn. *Tinospora cordifolia* (Willd.) Miers Menispermaceae HAPPRCASR4132 | Giloe      | Climber    | Aerial part | Juice               | 1 teaspoon with water   | Fever, Stomach ache | 87 | Anti-cancer, immunomodulatory, anti-diabetic, anti-toxicity [93–95] |
| 50   | *Urtica dioica* L. Urticaceae HAPPRCASR4130 | Kandali    | Herb       | Aerial part | Raw/vegetable       | -                        | Anaemia, remove weakness | 81 | Antidiabetic, hepatoprotective, antiviral, antimicrobial, anticancer, immunomodulatory [96–101] |
| 51   | *Zanthoxylum armatum* DC. Rutaceae HAPPRCASR4107 | Timru      | Shrub      | Seeds, stem or aerial part | Powder               | 1/2 teaspoon             | Cleansing teeth and tooth ache | 95 | Anti-inflammatory, antibacterial, antifungal [102–104] |

S.N.: serial number, Syn.: synonym, UR: use reports.
Healers, who were excluded from this analysis, report more plants and more uses than the average predicted value for their age (Figure 6(b)). Elders also tend more to report learning from their parents as a source of knowledge and tend to easily identify plants and their localities and characters, while some younger informants struggled to give information.

Ordinations show similarity between informants by plotting those who reported more similar lists of plants or more similar lists of species are closer together (Figure 7). Although there is a great deal of overlap, specialist healers do report a significantly different set of plants (p=0.01, r-squared=0.06) and uses (p<0.01, r-squared=0.07) than non-specialists. For instance, Dioscorea bulbifera, Polygonatum verticillatum, Jurinea macrocephala, and Prunus persica were only reported by healers; Bergenia ciliata, Allium cepa, and Cinnamomum tamala were more widely reported, but most frequently by healers (all healers reported these plants, compared to only <50% of nonhealers). Likewise, infection after breakage of hair in body “Baaltod” was only reported by healers, and Control blood pressure’ and “Ear ache” were reported more widely, but much more frequently by healers (all healers reported these uses, compared to <50% of nonhealers).

**4. Discussion**

Medicinal plants are globally used in local health care by ethnic communities of the world and the knowledge of folk medicine is being documented throughout the world. Our results show strong consensus on plant uses in Urgam Valley, with high informant consensus values across all categories. Further, we show that knowledge of traditional
Figure 5: (a) Aconitum balfourii; (b) Aconitum heterophyllum; (c) Bergenia stracheyi; (d) Dactylorhiza hatagirea; (e) Hippophae salicifolia; (f) Megacarpaea polyandra; (g) Paeonia emodi; (h) Picrorhiza kurrooa; (i) Polygonatum verticillatum; (j) Rheum moorcroftianum; (k) Saussurea obvallata; (l) Swertia chirayita.
Table 3: Informants consensus factor for different ailment categories.

| Ailment category                                      | Number of use reports (Nur) | % of use reports | Number of taxa (Nt) | % of taxa | Informants consensus factor (ICF) |
|------------------------------------------------------|----------------------------|------------------|---------------------|----------|----------------------------------|
| Gastrointestinal disorders                           | 271                        | 14.46            | 11                  | 21.56    | 0.96                             |
| Fever and aches                                      | 580                        | 30.94            | 13                  | 25.49    | 0.97                             |
| Diseases of the skin                                 | 318                        | 16.96            | 10                  | 19.60    | 0.97                             |
| Remove weakness, immunomodulator, anaemia            | 131                        | 6.99             | 4                   | 7.84     | 0.97                             |
| Ophthalmologic complaints                            | 179                        | 9.55             | 2                   | 3.92     | 0.99                             |
| Poisonous bite                                       | 11                         | 0.58             | 1                   | 1.96     | 1                                |
| Dental problems                                      | 121                        | 6.45             | 2                   | 3.92     | 0.99                             |
| Ear ache                                             | 49                         | 2.61             | 2                   | 3.92     | 0.97                             |
| Hearing problems                                     | 74                         | 3.94             | 2                   | 3.92     | 0.98                             |
| Others                                               | 140                        | 7.47             | 4                   | 7.84     | 0.97                             |
| Total                                                | 1874                       |                  |                     |          |                                  |

Figure 6: Species and uses reported by the general populace (red) increase with age (a) and are greatest for specialist healers (blue, b). The line indicates a natural spline regression in which the increase in knowledge with age flattens above age 50.
uses and of medicinal plants is higher in elders (bujurg), who learnt this knowledge from their parents or forefathers and associated plant medicine with positive attitudes, but also with regular practice of identifying and using plants to treat different ailments. We also showed that specialists tend to report different and unique species and were associated with some species that were widely reported, but most consistently reported by specialist. For instance, *Bergenia ciliata* (Haworth) Sternberg was reported here used for stones by every healer. This is a widely used plant, with similar use citations reported locally [8, 105] but also across the greater Himalayan region for a variety of uses [106]

Most commonly mentioned plants across the general population have also been reported previously for similar uses from the region. For instance, *Picrorhiza kurrooa* Benth., which was reported by nearly every informant, is used for fever similar to Bhat et al. [107], where it was reported for fever and stomach ache. *Zanthoxylum armatum* DC., reported by 95 informants for cleaning teeth and toothache, was reported for similar uses locally [108] and more distantly by Abbasi et al. [109]. *Berberis lycium* Royle DC., reported by 92 informants for conjunctivitis, was also reported by Gaur [8] for ophthalmia and Bhat et al. [107] for eye irritation. *Aconitum heterophyllum* Wall.ex Royle root powder, reported by 69 informants for stomach ache and fever, was also reported elsewhere [107, 108] for the same uses. More distantly, the species is also reported for dysentery [106] in Northern Pakistan. *Juglans regia* L., reported by 56 for cleaning teeth and treatment of skin diseases, was also reported for similar uses from Northern Pakistan [106, 110] while, in Uttarakhand, Gaur [8] reported its use as fishery, dye, fungicide, and insecticide. *Dactylorhiza hatagirea* (Don.) Soo., reported by 39 for cut and wounds and stomach ache, was also reported for similar uses locally [107]. *Aconitum balfourii* Stapt., which was uncommonly reported for snake bites in this study, was reported previously for similar uses: use in poisonous skin diseases [107], as antidote of snake and scorpion sting, and for rheumatism, arthritis and paralysis from Nanda Devi Biosphere reserve [111], and leprosy [108].

5. Conclusion

The study suggests that while there remains a rich knowledge of medicinal plants in Urgam Valley, most knowledge is held by elders (bujurg) and specialist healers (vaidyas and daai). Knowledge of medicinal plants is important and frequently used by local inhabitants to support their health care. Pharmacological activity on most of the plants is yet unknown so medicinal plants use in Urgam might be helpful in new drug discovery and pharmacological properties. Most of the highly useful plants of Himalaya are threatened with overexploitation and irregular harvesting and now limited to few pockets. *Ex situ* and *in situ* conservation should be implemented to conserve biodiversity and these valuable medicinal plants. Cultivation, rather than wild-harvest, of threatened valuable medicinal plants may support the traditional uses documented here, while also protecting wild populations.

Appendix

Questionnaires

Informants’ Details

(1) What is your name?

   Gender: Male/Female

(2) How old are you?
(3) What is your Education?: Illiterate/5th/High school/ Intermediates/graduation

(4) What is your occupation?

(5) Location/residence

(6) Altitude

(7) Do you know about medicinal plants? Yes/no
   If yes

(8) Which plants do you know?
   (8.1) Plant (Local name)
   (8.2) Habit (Tree/ Herb/ Shrub/Climber)
   (8.3) Number/name of disease (s) treated?
   (8.4) How you identify particular disease: Symptoms?
   (8.5) Plant part used (Root/leaves/ stem/ flowers/ fruit/ aerial part/whole plants)
   (8.6) Method of crude drug preparation and administration?
   (8.7) Dosage
   (8.8) How you collect and stored medicinal herbs and their preparation?
   (8.9) How much time we can use these stored preparation? (About expiry date )
   (8.10) Have you ever used this or just you knowledge from forefather or elsewhere?
   (8.11) Other importance?
   (8.12) Cultivated/ Wild
   (8.13) Wild availability:Common/scattered/ rare/ very rare
   (8.14) Natural location: High altitude/ middle altitude/ lower altitude/ every where
   (8.15) Natural pockets where you seen or collected? (Place name)
   (8.16) Availability of particular medicinal plants increases or decreases?
      If increases/decreases
   (8.17) What is your opinion for why increase or decrease?
   (8.18) Conservation required? Yes/No
      If yes
   (8.19) How can we conserve these important species?

Remarks

Plants identified as ............................................ (Botanical name and family)

Signature of Researcher

Informants’ Consent

I..................................................... (Informants name) declare that information given by me is true, complete and accurate and I am fully consent for it.

| S.No | Disease (Local name) | Disease (English name) |
|------|----------------------|------------------------|
| 1    | Anidra               | Insomnia               |
| 2    | Ankh ki bimariyan    | Eye problems           |
| 3    | Aankh aana           | Eye flue               |
| 4    | Apach                | Indigestion            |
| 5    | Baal jhadna          | Hair fall              |
| 6    | Baaltod              | Boils after breakage of hair |
| 7    | Bukhar               | Fever                  |
| 8    | Daant dard           | Tooth ache             |
| 9    | Diabetes             | Diabetes               |
| 10   | Gum chot             | Wounds                 |
| 11   | Haddi tootna         | Bone fracture           |
| 12   | Jilna                | Burnt                  |
| 13   | Jodo ka dard         | Joint pain             |
| 14   | Jukam                | Cold                   |
| 15   | Kaan dard            | Ear ache               |
| 16   | Kamjori              | Nutritive              |
| 17   | Katna/Katyon         | Cuts                   |
| 18   | Khasi                | Cough                  |
| 19   | Makra/Daad           | Herpes                 |
| 20   | Patchis              | Dysentery              |
| 21   | Pathri               | Stone                  |
| 22   | Peelia               | Jaundice               |
| 23   | Pet dard             | Stomach ache           |
| 24   | Pet ke keede         | Stomach worms          |
| 25   | Phati Biwain         | Feet crack             |
| 26   | Phode, funsi         | Boils                  |
| 27   | Pradar               | Leukorrhea             |
| 28   | Sar dard             | Head ache              |
| 29   | Syalbai              | Kind of fever          |
| 30   | T.B                  | Tuberculosis           |

Date........................................... (Signature/Thumb impression of Informant)

(i) Photographic base survey (N=110)

(9) To show one by one photograph to informants and ask have ever saw this plants?
   If informants know about plants (Repeat from (8.1) to (8.19))

(ii) List of medicinal plants with local name

(10) What do you know about... plants? (Local name)
   If informants know about plants (Repeat from (8.1) to (8.19))

(iii) Disease base information

(11) What do you know about...(diseases name)?
   If they know and use some medicinal plant for particular diseases

The diseases list used to collect information is shown in Table 4. (Repeat (8.1) to (8.19))
### Table 5

| No. | Botanical name                        | + | =Yes | - | =No |
|-----|---------------------------------------|---|------|---|-----|
| 1   | Aconitum balfouri syn. Aconitum lethal Griff. |   |      |   |     |
| 2   | Aconitum heterophyllum Wall. ex Royle |   |      |   |     |
| 3   | Aconitum violaceum Jacq. em. ex Stapf |   |      |   |     |
| 4   | Aconogonon ruminicifolium syn. Pleurotropyrum ruminifolium (Royle ex Bab.) Munshi & Javeid |   |      |   |     |
| 5   | Acorus calamus L.                      |   |      |   |     |
| 6   | Aesculus indica (Wall. ex Cambess.) Hook. |   |      |   |     |
| 7   | Ajuga parviflora Benth.               |   |      |   |     |
| 8   | Allium cepa L.                        |   |      |   |     |
| 9   | Allium sativum L.                     |   |      |   |     |
| 10  | Allium stracheyi Baker                |   |      |   |     |
| 11  | Allium wallichii Kunth                |   |      |   |     |
| 12  | Angelica archangelica L.              |   |      |   |     |
| 13  | Angelica gialca Edgew.               |   |      |   |     |
| 14  | Arisaema tortuosum (Wall.) Schott     |   |      |   |     |
| 15  | Arnebia benthamii (Wall. ex G.Don) L.M. Johnst. |   |      |   |     |
| 16  | Asparagus filicinus Buch.-Ham. ex D.Don |   |      |   |     |
| 17  | Barleria cristata L.                  |   |      |   |     |
| 18  | Berberis aristata DC.                 |   |      |   |     |
| 19  | Berberis chinensis Buch.-Ham. ex Lindl. |   |      |   |     |
| 20  | Bergenia ciliata (Haw.) Sternb.       |   |      |   |     |
| 21  | Bergenia stracheyi (Hook. & Thomson) Engl. |   |      |   |     |
| 22  | Betula utilis D. Don                  |   |      |   |     |
| 23  | Boehmeria rugulosa Wedd.             |   |      |   |     |
| 24  | Cedrus deodara (Roxb. ex D.Don) G.Don |   |      |   |     |
| 25  | Centella asiatica (L.) Urb.           |   |      |   |     |
| 26  | Cinnamomum tamala (Buch.-Ham.) T.Nees & Eberm. |   |      |   |     |
| 27  | Cirsium wallichii DC.                 |   |      |   |     |
| 28  | Citrus aurantifolia (Christm.) Swingle |   |      |   |     |
| 29  | Cucumis sativus L.                    |   |      |   |     |
| 30  | Carcuma longa L.                      |   |      |   |     |
| 31  | Cynodon dactylon (L.) Pers.           |   |      |   |     |
| 32  | Dactylorhiza hatagirea (D.Don) Sow |   |      |   |     |
| 33  | Delphinium vestitum Wall. ex Royle    |   |      |   |     |
| 34  | Dioscorea bulbifera L.                |   |      |   |     |
| 35  | Drymaria cordata (L.) Willd. ex Schult. |   |      |   |     |
| 36  | Duchesnea indica (Jacks.) Focke       |   |      |   |     |
| 37  | Echinocloa frumentacea Link           |   |      |   |     |
| 38  | Eleusine coracana (L.) Gaertn.        |   |      |   |     |
| 39  | Eupatorium adenophorum Spreng. Syn. Ageratina adenophora (Spreng.) R.M.King & H.Rob. |   |      |   |     |
| 40  | Ficus palmata Forssk.                 |   |      |   |     |
| 41  | Fritillaria roylei Syn. Fritillaria cirrhosa D.Don |   |      |   |     |
| 42  | Geranium wallichianum D.Don ex Sweet. |   |      |   |     |
| 43  | Girardinia diversifolia (Link) Fries  |   |      |   |     |
| 44  | Habenaria intermedia D.Don            |   |      |   |     |
| 45  | Hedera nepalensis K.Koch              |   |      |   |     |
| 46  | Hedychium spicatum Sm.                |   |      |   |     |
| 47  | Hippophae salicifolia D.Don           |   |      |   |     |
| 48  | Juglans regia L.                      |   |      |   |     |
| 49  | Jurinea macrocephala DC.              |   |      |   |     |
| 50  | Lyonia ovalifolia (Wall.) Drude       |   |      |   |     |
| 51  | Macrotyloma uniflorum (Lam.) Verdc.   |   |      |   |     |
| 52  | Malaxis muscifera (Lindl.) Kuntze     |   |      |   |     |
| 53  | Megacarpaea polyedra Benth. ex Madden |   |      |   |     |
| 54  | Mentha × piperita L.                  |   |      |   |     |
| 55  | Morina longifolia Wall. ex DC.        |   |      |   |     |
| 56  | Nardostachys jatamansi (D.Don) DC.    |   |      |   |     |
| 57  | Nicandra physalodes (L.) Gaertn.      |   |      |   |     |
| 58  | Ocimum tenuiflorum L.                 |   |      |   |     |
| 59  | Oxalis corniculata L.                 |   |      |   |     |
| 60  | Paeonia emodi Royle                   |   |      |   |     |
| 61  | Paris polypylla Sm.                   |   |      |   |     |
| 62  | Persicaria capitata (Buch.-Ham. ex D.Don) H.Gross |   |      |   |     |
| 63  | Picrorhiza kurrooa Royle ex Benth.    |   |      |   |     |
| 64  | Podophyllum hexandrum Syn. Sinopodophyllum hexandrum (Royle) T.S.Ying |   |      |   |     |
| 65  | Polygonatum verticillatum (L.) All.   |   |      |   |     |
| 66  | Potentilla fulgens L. Syn. Potentilla lineata Trevir. |   |      |   |     |
| 67  | Pouzolzia hirta Blume ex Hassk.       |   |      |   |     |
| 68  | Primula denticulata Sm.               |   |      |   |     |
| 69  | Prunus cerasoides Buch.-Ham. ex D.Don |   |      |   |     |
| 70  | Prunus persica (L.) Batsch             |   |      |   |     |
| 71  | Punica granatum L.                    |   |      |   |     |
| 72  | Quercus leucotrichophora A.Camus Syn. Quercus oblongata D.Don |   |      |   |     |
| 73  | Rheum austral D. Don                  |   |      |   |     |
| 74  | Rheum moorcroftianum Royle            |   |      |   |     |
| 75  | Rhododendron campanulatum D. Don      |   |      |   |     |
| 76  | Roscoea alpina Royle                  |   |      |   |     |
| 77  | Rubia cordifolia L.                   |   |      |   |     |
| 78  | Rubus ellipticus Sm.                  |   |      |   |     |
| 79  | Rumex hastatus D.Don                  |   |      |   |     |
| 80  | Rumex nepalensis Spreng.              |   |      |   |     |
| 81  | Satyrium nepalense D.Don              |   |      |   |     |
| 82  | Saussurea costus (Falc.) Lipsch.      |   |      |   |     |
| 83  | Saussurea gossypiphora D.Don           |   |      |   |     |
| 84  | Saussurea obvallata (DC.) Edgew.      |   |      |   |     |
| 85  | Selinum vaginatum (D.C.) Clarke       |   |      |   |     |
| 86  | Skinneria laeucola Franch.            |   |      |   |     |
| 87  | Solanum americanum Mill.              |   |      |   |     |
| 88  | Solanum khasianum C.B. Clarke         |   |      |   |     |
| 89  | Solanum nigrum L. Syn.                |   |      |   |     |
| 90  | Stellaria media (L.) Vill.            |   |      |   |     |
| 91  | Swertia chirayita (Roxb.) Buch.-Ham. ex C.B.Clarke |   |      |   |     |
| 92  | Swertia chirayita (D. Don ex G. Don) B.L. Burtt |   |      |   |     |
| 93  | Swertia chirayita (Wall. ex G. Don) C.B. Clarke |   |      |   |     |
| 94  | Tagetes erecta L.                     |   |      |   |     |
| 95  | Tanacetum longifolium Syn. Athanasia linifolia Burm.F |   |      |   |     |
| 96  | Taraxacum officinale Syn. T. campylodes G.E.Haglund |   |      |   |     |
Table 5: Continued.

| No. | Botanical name                  |
|-----|--------------------------------|
| 97  | Taxus wallichiana Zucc.         |
| 98  | Terminalia bellirica (Gaertn.) Roxb. |
| 99  | Terminalia chebula Retz.       |
| 100 | Thalictrum foliolosum DC.      |
| 101 | Tinospora sinensis (Lour.) Merr. |
| 102 | Trichosanthes tricuspidata Lour. |
| 103 | Trillium govanianum Wall. ex D.Don |
| 104 | Urtica ardens Link             |
| 105 | Urtica dioica L.               |
| 106 | Valeriana wallichii DC. Syn. Valeriana jatamansi Jones |
| 107 | Vanda cristata Wall. ex Lindl.  |
| 108 | Viola canescens Wall.          |
| 109 | Zanthoxylum armatum DC.         |
| 110 | Zingiber officinale Roscooe    |

Plant list (see Table 5)

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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