# An ethnobotanical survey for the determination of informant consensus factor to demystify traditional herb *Teliya-kanda* in Indian medicinal system

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*Teliya-kanda* is among one of the miraculous plants which has been described in ancient Ayurvedic text for veritable medicinal uses. However, the taxonomic identification of *Teliya-kanda* plant is yet ambiguous. Following a semi-structured survey methodology, we carried out questionnaire based interviews with 250 native tribals and traditional healers/ *vaidyas* of villages in the Himalayan foothills of Uttarakhand (22 remote villages). The participants involve in the study were consulted about their knowledge towards the target plant species *Teliya-kanda*, its medicinal applications, features, drug formulations, drug administration route, dosage *etc*. The survey was conglomerated with ancient texts of *Ayurveda* (published/ unpublished), thereby possibly revealing the most accurate botanical source of *Teliya-kanda*. The ethnobotanical information was evaluated by various quantitative metrics as use value (UV), use frequency (FU), informant consensus factor ($F_{IC}$), citation relative frequency ($R_{FC}$), popularity relative level ($R_{PL}$), and rank priority ($R_P$). In the present study, data collected from the survey participants included the information of about 09 taxa belonging to 05 botanical families. The interviewed informants alluded that the highest level of fidelity, popularity, and priority was found for *Sauromatum venosum* (Dryand. ex Aiton) Kunth ($R_{PL}$ ~ 0.417; $R_{FC}$ ~ 0.232; $R_P$ ~ 0.0969), thereby indicating it to be the most probable botanical source of *Teliya-kanda*. Based on this ethnobotanical survey, the name *Teliya-kanda* can be associated with *S. venosum* (Dryand. ex Aiton) Kunth, however, further detailed molecular and phytochemical analyses yet need to be unveiled.

**Keywords**: *Ayurveda,* Ethnomedicine, Informant consensus factor, *Teliya-kanda*, Traditional knowledge

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*Ayurveda* is the oldest medical science prevailing in the Indian subcontinent, wherein, its literal meaning is 'the knowledge or science for longevity'[1,2]. Atharva-veda is said to be the oldest veda, originated nearly around 2000 BC, comprising Ayurveda as an upaveda[3-5]. All these vedas and upavedas are the cradle of augmented traditional knowledge passed down to next generations through scriptures, which were written as per *Shruti* (Hearing) and *Smriti* (Memory)[3]. All these traditional scriptures account for India being the earliest in the world to have an organized cosmopolitan structure of institutionally-based medical provisions[6,7]. In the Indian traditional medicinal system, plants of varied botanical sources have been circumscribed under one common name, thereby raising controversies regarding the actual identity of the plant. Secondly, the issues of common vernacular names of different species have arisen due to the scarce availability of the plant in a particular region, which has forced the traditional healers to substitute the rare plant with a nearly similar plant possessing identical pharmacological or therapeutic activities[8,9]. Another discrepancy in the ancient Vedic medicinal system is the dearth of any bifurcations between magic, medicine, and religion, which enables the prescription of certain plants with ambiguous names and indeterminate properties[9]. One such plant mentioned in ancient Indian texts is *Teliya-kanda*[10].

This study aims to solve the mystery of the ancient name *Teliya-kanda*, together with information obtained from ethnobotanical research and ancient Ayurvedic texts. Our studies will also possibly reveal the most accurate botanical source of *Teliya-kanda* matched with the characteristic morphological

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features and medicinal properties. The ensuing sections provide the methodology adopted for the conduction of the ethnobotanical survey, presented along with the detailed data analysis.

## Methodology

Interviews were conducted with native tribals and traditional healers/ *vaidya*. All the plants practiced under the name *Teliya-kanda* were collected and identified with the help of the floristic treatises as well as through comparison with identified specimens in the repository of the herbarium of Patanjali Research Institute [Patanjali Research Foundation Herbarium (PRFH), Haridwar, India, in collaboration with 'The Royal Botanic Garden, Edinburgh' (https://data. rbge.org.uk/ search/herbarium/). The information regarding morphology & medicinal utilities of plant samples given by the senior *vaidyas* were crosschecked with the modern botanical literature and ancient handwritten Sanskrit manuscripts collected[11-13].

### Study area

The research area of this ethnomedical study was chosen as Uttarakhand, which is located between $28^o$ 44' and $31^o$ 28' North latitudes and $77^o$ 35' and $81^o$ 01' East longitudes. Several season wise field survey were conducted during 2017 to 2021 for plant collection and ethnomedicinal lore from geographically nomadic communities *viz.,* Raji, Bhoxa, Tharu, Jaunsari, *etc*. These indigenous communities belongs to Pauri-garhwal, Thiri-garhwal Nainital, Chamoli, Haridwar, Dehradun, and Uttarkashi districts of Sub Himalayan regions of Uttarakhand. Due to the remoteness of the study area, there were only a few primary healthcare centers in all the above-mentioned regions and the local people mostly relied upon the *vaidyas* for primary health related needs. Henceforth, *vaidyas* or the traditional local healers were generally considered as the subjects/informants for the study[14].

### Data collection

Seven ethnobotanical surveys took place from July 2017 to February 2021, wherein 70 volunteers, aged between 22 and 65 years, actively participated as data collectors. These data-collecting volunteers comprised botanists, medicinal compilers, and Ayurvedic doctors. Several interviews were conducted with *vaidyas*/ traditional healers, who were using *Teliya-kanda*, either in formulation or as a whole. They were confabulated as per a previously drawn questionary for *Teliya-kanda* with sections such as

'literature referred, plant species/ plant part used, preparation method, solvent used, drug administration route, dosage, number of patients with drug exposure and their after effect, other use (Edible, Magical, Commercial, *etc*.)'.

These interviews were conducted as per the method described by Cook, 1995, during field trips for plant collection and after pursuing oral consent from informants, respective specimens (plant/ plant parts) and manuscripts (if available) were collected, and submitted to the repository of Patanjali Research Institute and Library of Patanjali Research Institute, Haridwar, India[14,15].

### Data analysis

The collected information was then compared with the properties given in ancient Ayurvedic text collected from the traditional healers and web resources/ Patanjali Research Institute library. The plant specimens were then alphabetically indexed by their respective scientific name, family, voucher number, and frequency of use. The statistical observation frequencies of the plants were evaluated as the summation of all the uses mentioned in the questionary provided to the traditional healers. The taxonomic identity of all the collected plants were authenticated using the MPNS - Medicinal Plant Names Services (https://mpns.science.kew.org), IPNI - International Plant Name Index (http://www.ipni.org) and GRIN - Germplasm Resources Information Network taxonomy site (http://www.ars-grin.gov/cgi-bin/npgs/html/queries.pl), while the authenticity of the families was validated using Angiosperm Phylogeny Group - A.P.G. system[16]. The life forms of the plants were categorized as grass, herb, shrub, or tree (annual/ biennial/ perennial), according to Raunkiaer and Brown[17-19]. The ethnobotanical data was evaluated using several quantitative indicators such as Frequency of use (FU), Informant Consensus Factor ($F_{IC}$), Relative frequency citation ($R_{FC}$), Use value ($U_V$), Relative level of popularity ($R_{PL}$), and Rank order priority ($R_P$). The results from the data were reported in form of proportions and percentages[20-23].

### Use frequency (FU)

This study predominantly incorporates descriptive statistics, for evaluation of botanical and medicinal information of various plants species utilized as *Teliya-kanda* as collected from the healers[20]. The frequency of use (FU) of the plant species employed as Teliya-kanda was evaluated using the following formula:

$$FU = \frac{1}{4} \frac{[N_{PS}]}{T_{NS}} \qquad \qquad \text{... Eq.1}$$

where,

FU = Frequency of use.

$N_{PS}$ = Number of times a particular species was mentioned.

$T_{NS}$ = Total number of times all the species were mentioned.

***Informant consensus factor ($F_{IC}$)***

The $F_{IC}$ value shows the informant consensus, based on the medicinal consumption of the plant, and calculates its variability in the mode of plant consumption against number of disease reported. These ailments are usually categorized into diverse categories before calculating $F_{IC}$ value[23].

$$F_{IC} = T_{NU} - \frac{N_T}{T_{NU}} - 1 \qquad \qquad \text{... Eq.2}$$

where,

$T_{NU}$ = Total number of medicinal uses reported for each species.

$N_T$ = Number of species used in foresaid category.

***Use value ($U_V$)***

Use value ($U_V$) was determined to assess the relative significance of use of the plant species[22]. It was evaluated by the given formula:

$$U_v = \sum \frac{U_i}{N} \qquad \qquad \text{... Eq.3}$$

where,

$U_V$ = Use value of individual species.

$U_i$ = Number of use recoded for specific species.

N = Number of informants proclaimed that species.

***Relative citation frequency ($R_{FC}$)***

Relative citation frequency ($R_{FC}$) was determined to signify the regional significance of each species mentioned by the traditional healers in the study area[22,24]. It was calculated using the formula as described below:

$$R_{FC} = \frac{F_c}{N} \qquad \qquad \text{... Eq.4}$$

where,

$F_C$ = Number of informants citing the species.

N = Total number of informants in the survey.

***Popularity relative level ($R_{PL}$)***

It is the ratio of the number of diseases treated by a specific plant species to the total number of informants. However, the therapeutic potential of plants with comparable/ similar $F_L$ may differ[22]. The popularity relative level of the plants were evaluated and categorized as popular or unpopular.

***Rank priority ($R_P$)***

Rank priority represents correction factor, employed for appropriate ranking of the plant with diverse $R_{FC}$ and $R_{PL}$ values[25]. The $R_P$ is derived by multiplying $R_{PL}$ and $R_{FC}$ values as given below:

$$R_P = R_{FC} \times R_{PL} \qquad \qquad \text{... Eq.5}$$

## Results and Discussion

### Demographic characteristics of informants

The study area covered six districts of Uttarakhand, including Chamoli, Dehradun, Haridwar, Pauri Garhwal, Nainital, and Tehri Garhwal, as shown in Figure 1. Out of 102 villages covered within the study, 22 villages having traditional healers/ *vaidyas,* were identified for performing the ethnomedicinal survey on *Teliya-kanda* (Table 1). A total of 250 local medicinal practitioners were found prescribing various plant species such as *Teliya-kanda,* among which 12% were women, and 88% were men who belonged mainly to the Bhoxa, Jaunsari, Raji, and Gujjar communities. All these traditional healers have been residing in the study area for a decade and are engaged in the aforesaid field genealogically for at least two generations. They have been prescribing the drug named *Teliya-kanda* for several ailments, as listed in Table 2. However, the botanical identity of *Teliya-kanda* varies for each practitioner, thereby raising confusion regarding the actual botanical source of the herb. These disparities were commenced due to the fact that traditional healers might be using alternative forms of a given species or a different species under a common vernacular name. Moreover, eliciting the ethnomedicinal data was extremely challenging as the number of traditional healers is incredibly scarce nowadays. Beluwakhan (~ 40 *vaidyas*) and Daluwala Kalan village (~ 30 *vaidyas*) had the maximum numbers of people who involved in the survey. The paintings of the herbals identified as probable sources of *Teliya-kanda* have been given in Figure 2.

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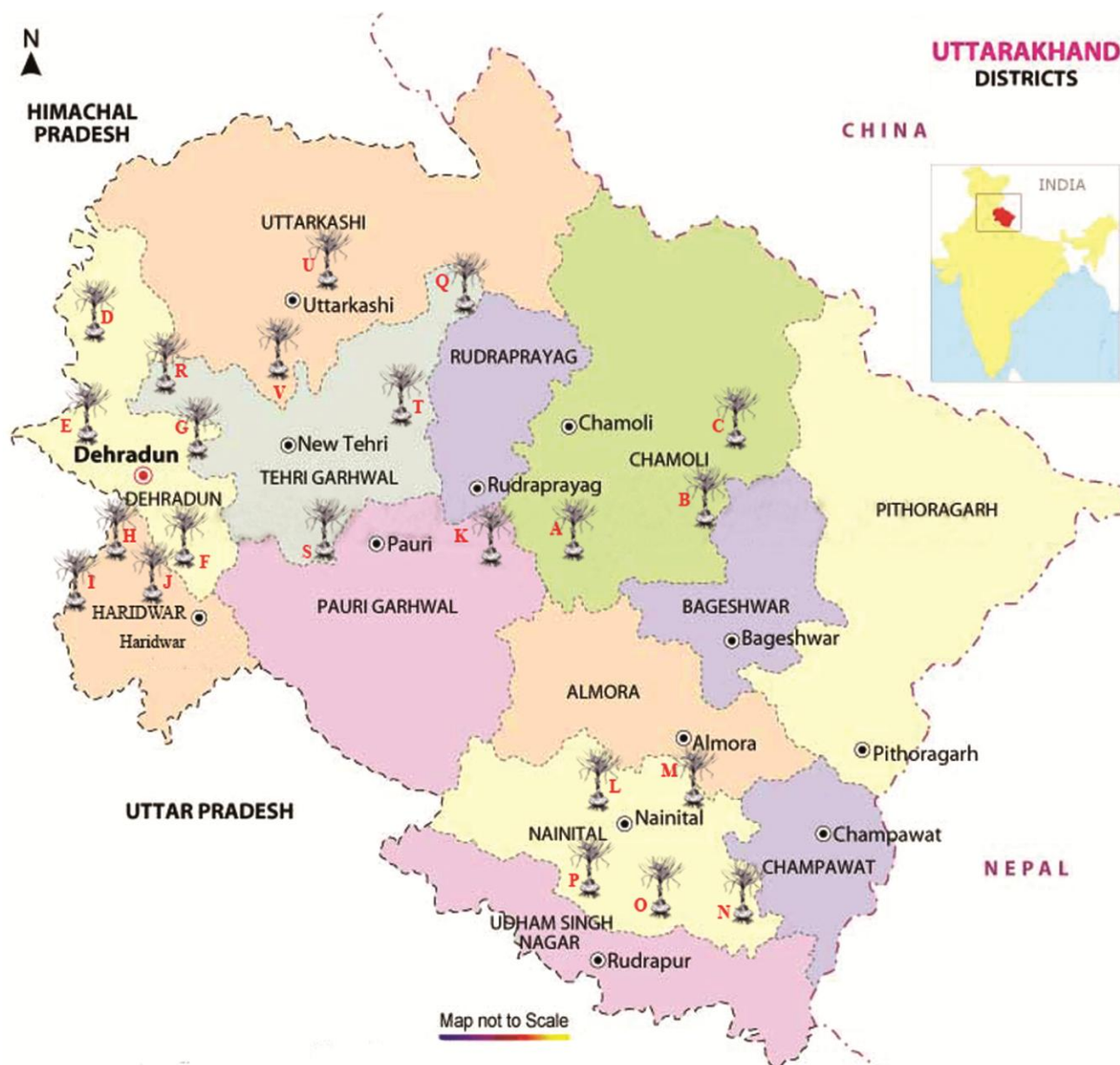IDENTIFICATION OF MEDICINAL PLANT *TELIYA-KANDA*

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Fig. 1 — Location of the studied areas in Uttarakhand, including Chamoli [Purna (a), Dewaldhar (b), Bhadakoti (c)], Dehradun [Samog (d), Siribarkoti (e), Indroli (f), Sujau (g)], Haridwar [Daluwala Kalan (h), Gajiwali (i), Sanghipur (j)], Pauri Garhwal [Mala Gaon (k)], Nainital [Beluwakhan (l), Sonkhamari (m), Sirori (n), Gajaari (o), Simli Malli (p)], Tehri Garhwal [Pokhari (q), Chilamu (r), Kyari (s), Kirgani (t)] and Uttarkashi [Kamad (u), Dunda (v)]. The given map is not to be scaled; Adapted and modified from Maps of India (https://www.mapsofindia.com)

**Different plant species recorded as *Teliya-kanda* and its botanical identity**

The ethnomedicinal survey revealed that about 9 species of 5 different families of herbs are being used as *Teliya-kanda* in the selected region of study. Traditional *vaidyas* also provided several valuable hand written manuscripts, such as *Raja-nighantu*. These ancient Sanskrit texts have presented varied views about the botanical identification of *Teliya-kanda*. Our study revealed that the name *Teliya-kanda* with its medicinal properties and vernacular names has been mentioned in ancient Sanskrit manuscripts as *Raja-nighantu*, *Nighantu-bhusana*, *Rasendra-chudamani*, *Shaligrama-nighantu*, *Shabdakalpadruma* and *Vachaspatyam*[25-27] as presented in Table 3. Out of these, *Raja-nighantu* was found to be used as medicinal reference by most of the local healers.
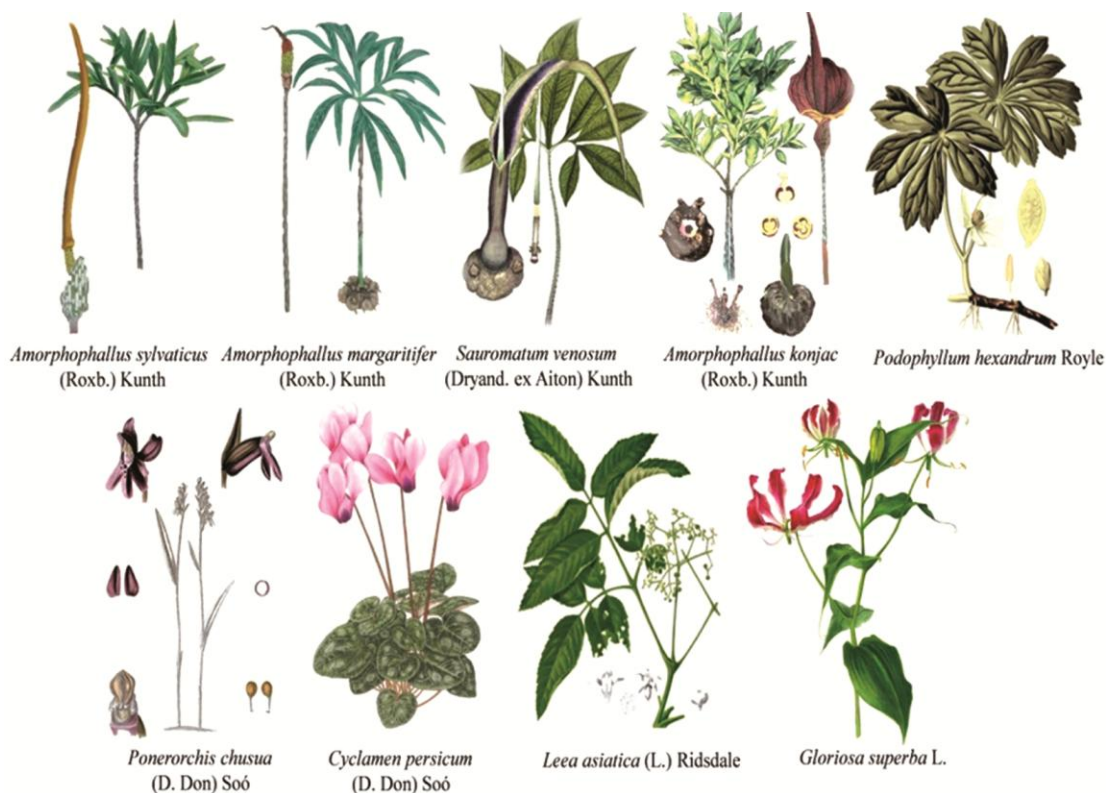
Fig. 2 — Paintings/ illustrations of probable sources of *Teliya-kanda*, namely, *Amorphophallus sylvaticus* (Roxb.) Kunth, *Amorphophallus margaritifer* (Roxb.) Kunth, *Sauromatum venosum* (Dryand. ex Aiton) Kunth, *Amorphophallus konjac* K. Koch, *Podophyllum hexandrum* Royle, *Ponerorchis chusua* (D. Don) Soó, *Cyclamen persicum* (D. Don) Soó, *Leea asiatica* (L.) Ridsdale and *Gloriosa superba* L.

| S. No. | Region | District | Geographical area (In hectares)[†] | Population[†] | Traditional Healers/ *Vaidyas* |
|---|---|---|---|---|---|
| | | Table 1 — Demographic characteristics of the informants residing in the remote regions selected for the study | | | |
| 1 | Purna | Chamoli | 40.98 | 92 | 03 |
| 2 | Dewaldhar | Chamoli | 309.72 | 769 | 09 |
| 3 | Bhadakoti | Chamoli | 88.01 | 240 | 08 |
| 4 | Samog | Dehradun | 634.12 | 387 | 10 |
| 5 | Siribarkoti | Dehradun | 219.03 | 690 | 15 |
| 6 | Indroli | Dehradun | 221.63 | 431 | 11 |
| 7 | Sujau | Dehradun | 101.13 | 314 | 08 |
| 8 | Mala Gaon | Pauri Garhwal | 89.56 | 438 | 10 |
| 9 | Daluwala Kalan | Haridwar | 297.92 | 1779 | 30 |
| 10 | Gajiwali | Haridwar | 172 | 2107 | 20 |
| 11 | Sanghipur | Haridwar | 174.89 | 3912 | 15 |
| 12 | Beluwakhan | Nainital | 136.56 | 3687 | 40 |
| 13 | Sonkhamari | Nainital | 36.00 | 90 | 05 |
| 14 | Sirori | Nainital | 100.00 | 120 | 04 |
| 15 | Gajaari | Nainital | 24.99 | 66 | 03 |
| 16 | Simli Malli | Nainital | 58.9 | 52 | 03 |
| 17 | Pokhari | Tehri Garhwal | 42.73 | 63 | 05 |
| 18 | Chilamu | Tehri Garhwal | 23.85 | 41 | 06 |
| 19 | Kyari | Tehri Garhwal | 139.48 | 781 | 08 |
| 20 | Kirgani | Tehri Garhwal | 183.96 | 629 | 10 |
| 21 | Dunda | Uttarkashi | 36.12 | 1869 | 15 |
| 22 | Kamad | Uttarkashi | 11.66 | 1162 | 12 |

Legend: †All the survey data is based on the census report obtained from the 'Office of Registrar General & Census Commissioner, Ministry of Home Affairs, Government of India, 2015 (census india.gov.in)' – An Open Government Data Platform, published under National Data Sharing and Accessibility Policy (NDSAP). © Office of the Registrar General & Census Commissioner, India (http://censusindia.gov.in/)

Table 2 — List of plant species and families, which have been probably used under the name *Teliya-kanda*

| Scientific name of species | Family | Other Common Name | Native (as per POWO)[†] | Status | Ethnic medicinal use |
|---|---|---|---|---|---|
| *Amorphophallus sylvaticus* (Roxb.) Kunth | *Araceae* | Vajraprokta, Vajra kanda | South India and Sri Lanka | Least Concern | Ache (Tooth), Adenopathy, Bruise, Tumour |
| *Amorphophallus margaritifer* (Roxb.) Kunth | *Araceae* | Had tikta, Vajra kanda bhed | India to Myanmar | Least Concern | Bruise, Antidote |
| *Sauromatum venosum* (Dryand. ex Aiton) Kunth | *Araceae* | Bhasm kand | Upland areas of Asia and Africa | Least Concern | Cancer, Lupus erythromatosus, Antidote, Ulcer, Sialogogue, Sore, Polydipsia |
| *Amorphophallus konjac* K. Koch | *Araceae* | Oal, Gandira, Jangli suran, madana masta | China | Least Concern | Stimulant, Antidote |
| *Podophyllum hexandrum* Royle | *Berberidaceae* | Ban-kakari, Papra, Paatvel | East Afghanistan to Central China | Endangered | Alterative, Cholagogue, Condyloma, Emetic, Antidote, Mitogenic, Purgative, Stimulant (Hepatic), Tonic, Tumour, Wart |
| *Ponerorchis chusua* (D. Don) Soó | *Orchidaceae* | Chusua Orchis | Siberia to Himalaya | Endangered | Dysentery, Diarrhoea, Fever |
| *Cyclamen persicum* (D. Don) Soó | *Orchidaceae* | Bakhur-e-miryam | Mongolia to Himalaya | Vulnerable | Skin infection, Sclerosis, Tumour |
| *Leea asiatica* (L.) Ridsdale | *Vitaceae* | Semal musli, Nagasya, Guvaii | Indian Subcontinent to China and Indo-China | Least Concern | Ache (Head), Anodyne, Boil, Colic, Dermatosis, Diarrhoea, Dysentery, Eye diseases, Sting (Caterpillar), Sudorific, Vertigo, Wart |
| *Gloriosa superb* L. | *Colchicaceae* | Langli, Kalihari, Nadal bhada | Tropical and southern Africa and in tropical Asia | Least Concern | Abortifacient, Alterative, Anodyne, Bactericide, Bile, Bite (Snake), Cancer, Canicide, Cholagogue, Colic, Erysipelas, Gonorrhoea, Homicide, Labour, Laxative, Leprosy, Malaria, Mitogen, Neuralgia, Parasiticide, Parturition, Pediculicide, Piles, Antidote, Scabies, Skin diseases, Sore, Splenitis, Stomachic, Syphilis, Tonic, Tumour, Vermifuge |

**Legend**: † POWO stands for Plants of the World Online (http://www.plantsoftheworldonline.org/), wherein it is used to validate the taxonomic status of the plant species.

**Data analysis**

The ethnomedicinal survey included 22 villages and a total of 250 local traditional healers of Uttarakhand district. About 9 species were identified as the probable botanical sources of *Teliya-kanda*. Distribution details of these species in different villages have been provided in Table 4. Uttarakhand was selected as the area of study because this sub-Himalayan region is a heterogeneous reservoir of biodiversity including enormous species of plants and wildlife[27]. Use frequency (FU) was assessed by calculating the number of times a particular species was mentioned, out of all the total number of times the species were mentioned. The maximum FU was found for *Sauromatum venosum* (Dryand. ex Aiton) Kunth ($\frac{FU}{100\%} \sim 36$), followed by *Gloriosa superba* L. ($\frac{FU}{100\%} \sim 23.2$) and *Cyclamen persicum* Mill. ($\frac{FU}{100\%} \sim 21.6$). A greater use frequency is indicative of the maximum utility of a species in the selected study regions, thereby indicating a higher medicinal significance[20], as presented in Table 5.

Secondly, informant consensus factor ($F_{IC}$) was measured to study the total usage of individual plant species according to culture applicability, where in a maximum score of 1 was observed for

Table 3 — Ancient Scriptures mentioning *Teliya-kanda* as a medicinal herb

| S. No. | Ancient Manuscript | *Shloka*/ Hymn[†] | Explanation of *Shloka*/ Hymn |
|---|---|---|---|
| 1 | *Raja-nighantu* (*Misrakadi varga*: *Shloka* 37; *Mulkadi varga*: *Shloka* 110-112) | तैलकन्द सुधाकन्द क्रोडकन्दो रुदन्तिका। सर्पनेत्रयुताः पञ्चसिद्धौषधिकसञ्जकाः।। Tailkanda sudhakanda krodkando rudantika, Sarpanetrayuktah panch-siddhaushdhika sangyakaha. | (i) *Taila kanda*, *Sudha kanda*, *Krod kanda*, *Rudantika* having Snake like spots are *panch siddha aushadhi* or five herbals used for processing purposes. |
| | | तैलकन्द उक्तो द्रावककन्दस्तिलाङ्कितदलश्च। करवीरकन्दसञ्जो ज्ञेयस्तिलचित्रको बाणैः।। Tailkanda ukto dravak-kanda tilankitdalascha, Karvirkandasangyo gyeyastilchitrako baaneha. | (ii) *Taila kanda*, *Dravaka kanda*, *Tilankitadala*, *Karvira kanda* and *Tila citraka* are its five names. |
| | | लोहद्रावी तैलकन्द कटूष्णो वातापस्मारापहारी विषारि। शोफघ्न स्याद् बन्धकारी रसस्यद्रागेवासौ देहसिद्धि विधत्ते।। Lohdraavi tailkand katushno vata apasmarahari vishaari, Shophaghna syaad bandhkaari rasasya draagevaaso dehasiddhi vidyate. | (iii) It is pungent in taste, hot in potency and used for the processing of Iron and related minerals. It is employed to treat *vata roga*, *apasmara* (hysteria), *visavikara* (poisoning) and *shopha* (inflammatory ailments). Its juice is also employed for processing of mercury and aids in body rejuvenation. It has *Ashwari* (*Nerium oleander* L.) like leaves, *Til* (*Sesamum indicum* seeds) like spots, oily and occurs under earth as a culm. |
| 2 | *Vachaspatyam* (Vol. 4, Pg. 3351) | तिलस्यायम् अण् तैलः तिलसम्बन्धो कन्द द्रव कंदोऽस्य। तिलचित्रपत्रके वृक्षभेदे "तैलकंदः कटूष्णश्च लौहद्रावकरोमतः। Tilasyayam ann tailah tilsambandho, kanda drava, kandosya Tilchitra patrake, vrikshbhede tailkandah, katushnaksh, lohdraavaka karomataha. | (i) *Til* like spotted leaf, shrub like. Tail kand contains pungent taste and has iron degrading capabilities. |
| | | मारुतापस्मार विषशोफनाशकरश्च सः। रसस्य बन्धकारी च देहशुद्धिकरस्तथा' राजनिघण्टुः। Marutaapasmara visha shopha naashakascha sah, Rasasya bandhkaari ch deha shuddhi karastatha'' Raja-nighantuha. | (ii) This herb is used for a variety of medicinal purposes such as *vata roga*, *apasmara* (hysteria), *visavikara* (poisoning) and *shopha* (inflammatory ailments), as coinciding with the concept mentioned in *Raja-nighantu*. |
| 3 | *Shabdakalpadruma* (Part 2, Pg. 649) | तैलकन्द पु. (तैलप्रधानः कन्दः) । कन्दविशेषः। तत्पर्यायः। द्रावककन्दः। तिलाङ्कितदलः। करवीरकन्द संज्ञः। तिलचित्रपत्रकः। Tailkanda (taila pradhan kandah), Kandavisheshah, tatparyayaha, draavaka kandah, tilankitdalah, karvirkanda sangyaha, tilchitra patrakaha. | (i) Synonyms of *Teliya-kanda* are *Tail kanda*, *Dravaka kanda*, *Tilankit dala*, *Karvir kanda bhed*, comprising *Til* spotted leaves. |
| | | अस्य गुणाः। लोहद्रावित्वम्। कटुत्वम्। उष्णत्वम्। वातापस्मारविषशोफनाशित्वम्। रसस्य बन्धकारित्वम्। स्नेहसिद्धिकारित्वञ्च। इति राजनिघण्टुः। Asya gunah, lohdraavitvam, katutvam, ushnatvam, vataparasmar, visha shopha naashitvam, rasasya bandhkaaritvam. Snehasiddhikaaritvascha, iti Raja-nighantuha. | (ii) It is Iron degrading, pungent in taste (*katu*), hot in potency and is used to treat *vata* disorder, epilepsy, poisoning and inflammation. It increases oiliness and its latex is used for the processing/ purification of Mercury. |

(*Contd.*)

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Table 3 — Ancient Scriptures mentioning *Teliya-kanda* as a medicinal herb

| S. No. | Ancient Manuscript | *Shloka*/ Hymn† | Explanation of *Shloka*/ Hymn |
|---|---|---|---|
| 4 | *Shaligram nighantu bhusaṇa* (*Shaka varga - Kanda shaka*, Pg. 708) | अथ तैलकन्द उक्तो द्रावककंदस्तिलांकितदलश्र। करवीरकंद संझोंज्ञेयस्तिलचित्रपत्र को बाणै:।। Adha tailkanda ukto draavak kanda tilankitdalascha, Karvirkanda sangyogyeyastil chitrapatra ko baaneha. | (i) This *Taila kanda*, *Dravaka kanda*, *Tilankitadala*, *Karvira kanda* and *Tila citraka* are its five names. |
| 5 | *Rasendra chudamani* (Chapter 6, *Shloka* 54) | तिलकन्देति व्याख्याता तिलवत्फलपत्रिणी। लता क्षीरवती सुत निबंधनात्यातपे खरे।। Tilkandeti vyakhyata tilvatphalapatrini, Lata kshiravati suta nibandhanatyatape khare. | (i) *Teliya-kanda* is a climber having *til* like spots in its fruits and leaves, producing white latex as milk, when crushed. Its latex is employed to process mercury under extreme sunny conditions. |

**Legend**: †This table enlists the *shloka*/ hymns exemplifying the name *Teliya-kanda* along with its medicinal significance, as mentioned in ancient Ayurvedic scriptures, namely, *Raja-nighantu*, *Vachaspatyam*, *Shabdakalpadruma*, *Shaligram nighantu bhusana* and *Rasendra chudamani*.

Table 4 — Distribution details of probable botanical sources of *Teliya-kanda* in Uttarakhand

| Name of species / Name of Area [Altitude (in m)] | *Amorphophallus sylvaticus* (Roxb.) Kunth [800-2400 m] | *Amorphophallus margaritifer* (Roxb.) Kunth [800-2400 m] | *Amorphophallus konjac* K. Koch [800-2400 m] | *Sauromatum venosum* (Dryand. ex Aiton) Kunth [0-3900 m] | *Podophyllum hexandrum* Royle [1013-2883 m] | *Ponerorchis chusua* (D. Don) Soó [2400-4900 m] | *Cyclamen persicum* (D. Don) Soó [0-1200 m] | *Leea asiatica* (L.) Ridsdale [500-1800 m] | *Gloriosa superb* L. [0-2500 m] | Total No. of Informants† |
|---|---|---|---|---|---|---|---|---|---|---|
| Purna [384 m] | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 03 |
| Dewaldhar [520 m] | 0 | 0 | 0 | 3 | 0 | 0 | 4 | 0 | 2 | 09 |
| Bhadakoti [800 m] | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 08 |
| Samog [1880 m] | 2 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 10 |
| Siribarkoti [648 m] | 0 | 0 | 0 | 4 | 0 | 0 | 3 | 4 | 4 | 15 |
| Indroli [181 m] | 0 | 0 | 0 | 3 | 0 | 0 | 5 | 0 | 3 | 11 |
| Sujau [648 m] | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 4 | 08 |
| Mala Gaon [355 m] | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 4 | 10 |
| Daluwala Kalan [271 m] | 0 | 0 | 0 | 10 | 0 | 0 | 7 | 0 | 13 | 30 |
| Gajiwali [271 m] | 0 | 0 | 0 | 4 | 0 | 0 | 5 | 0 | 11 | 20 |
| Sanghipur [271 m] | 0 | 0 | 0 | 5 | 0 | 0 | 3 | 0 | 7 | 15 |
| Beluwakhan [520 m] | 0 | 0 | 0 | 7 | 0 | 0 | 10 | 8 | 15 | 40 |
| Sonkhamari [594 m] | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 2 | 05 |
| Sirori [170 m] | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 04 |
| Gajaari [345 m] | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 03 |
| Simli Malli [369 m] | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 03 |
| Pokhari [2890 m] | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 05 |
| Chilamu [1880 m] | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 06 |
| Kyari [345 m] | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 3 | 08 |
| Kirgani [1550 m] | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 4 | 10 |
| Dunda [648 m] | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 2 | 7 | 15 |
| Kamad [1639 m] | 2 | 3 | 2 | 1 | 1 | 0 | 1 | 1 | 1 | 12 |

Legend: †This table provides the number of informants suggesting the probable botanical source of *Teliya-kanda* in different areas, where in a total of 09 botanical names were suggested within the study area comprising of 22 districts of Uttarakhand

*Amorphophallus konjac* K. Koch ($F_{IC} \sim 1$), *Cyclamen persicum* Mill. ($F_{IC} \sim 1$) and *Ponerorchis chusua* (D. Don) Soó ($F_{IC} \sim 1$). Such a high informant consensus factor was indicative of a unanimous usage and hence allowed a more objective selection of the species for the ethnomedicinal study to validate traditional knowledge[27].

Furthermore, Use value ($U_V$) was assessed to identify the maximum number of uses suggested by traditional healers for a given species, wherein it was found that *Ponerorchis chusua* (D. Don) Soó ($U_V \sim 1$) had the maximum utility as assessed in the survey conducted. Consequently, relative citation frequency ($R_{FC}$) was represented as the ratio of number of informants citing a species and the total number of informants. This ratio is also indicative of the relative utility of a particular species with respect to all the test species of this survey. *Gloriosa superba* L. ($R_{FC} \sim 0.36$) and *Sauromatum venosum* (Dryand. ex Aiton) Kunth ($R_{FC} \sim 0.232$) were found to be the species with maximum usage. Ultimately, the popularity relative level ($R_{PL}$) and rank priority ($R_P$) were calculated to assess the level of fidelity of the test species as suggested by the traditional healers in the study area. The popularity relative level ($R_{PL}$) assumes a value between 0 and 1, wherein '1' signifies an absolute measure of popularity of a given

Table 5 — Frequency of use of probable botanical sources of *Teliya-kanda* as mentioned by traditional healers of rural regions of Uttarakhand

| Name of species / Name of Area [Altitude (in m)] | Amorphophallus sylvaticus (Roxb.) Kunth | Amorphophallus margaritifer (Roxb.) Kunth | Amorphophallus konjac K. Koch | Sauromatum venosum (Dryand ex Aiton) Kunth | Podophyllum hexandrum Royl | Ponerorchis chusua (D. Don) So | Cyclamen persicum (D. Don) So | Leea asiatica (L.) Ridsdale | Gloriosa superba L. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Frequency of Use (FU)/100% | | | | | |
| Purna | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0 | 0.4 |
| Dewaldhar | 0 | 0 | 0 | 1.2 | 0 | 0 | 1.6 | 0 | 0.8 |
| Bhadakoti | 1.2 | 0.8 | 0.4 | 0 | 0 | 0 | 0 | 0.8 | 0 |
| Samog | 0.8 | 1.2 | 0.4 | 0.4 | 0.4 | 0 | 0 | 0 | 0.8 |
| Siribarkoti | 0 | 0 | 0 | 1.6 | 0 | 0 | 1.2 | 1.6 | 1.6 |
| Indroli | 0 | 0 | 0 | 1.2 | 0 | 0 | 2.0 | 0 | 1.2 |
| Sujau | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0.8 | 1.6 |
| Mala Gaon | 0 | 0 | 0 | 1.6 | 0 | 0 | 0.8 | 0 | 1.6 |
| Daluwala Kalan | 0 | 0 | 0 | 4.0 | 0 | 0 | 2.8 | 0 | 5.2 |
| Gajiwali | 0 | 0 | 0 | 1.6 | 0 | 0 | 2.0 | 0 | 4.4 |
| Sanghipur | 0 | 0 | 0 | 2.0 | 0 | 0 | 1.2 | 0 | 2.8 |
| Beluwakhan | 0 | 0 | 0 | 2.8 | 0 | 0 | 4.0 | 3.2 | 6.0 |
| Sonkhamari | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0.4 | 0.8 |
| Sirori | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0 | 0.8 |
| Gajaari | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0 | 0.4 |
| Simli Malli | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0 | 0.4 |
| Pokhari | 0 | 0 | 0 | 0 | 0 | 1.2 | 0 | 0 | 0.8 |
| Chilamu | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0 | 0 | 0 | 0.4 |
| Kyari | 0 | 0 | 0 | 1.2 | 0 | 0 | 0.8 | 0 | 1.2 |
| Kirgani | 0 | 0 | 0 | 1.2 | 0 | 0 | 1.2 | 0 | 1.6 |
| Dunda | 0 | 0 | 0 | 1.2 | 0 | 0 | 1.2 | 0.8 | 2.8 |
| Kamad | 0.8 | 1.2 | 0.8 | 0.4 | 0.4 | 0 | 0.4 | 0.4 | 0.4 |
| Total Score | 3.2 | 3.6 | 2.0 | 23.2 | 1.2 | 1.2 | 21.6 | 8.0 | 36.0 |

Legend: † Frequency of Use (FU) of 09 probable botanical sources of *Teliya-kanda* has been provided within the study area (22 districts of Uttarakhand) and is expressed as FU/100%.

Table 6 — Informant consensus factor ($F_{IC}$), Use value ($U_V$), Popularity relative level ($R_{PL}$), Relative citation frequency ($R_{FC}$) and Rank priority ($R_P$) of probable botanical sources of *Teliya-kanda*

| S. No. | Name of Plant species | Number of medicinal uses suggested/ reported | Number of informants suggesting its ethno-medicinal uses | Informant Consensus Factor ($F_{IC}$) | Use value ($U_V$) | Relative Popularity Level ($R_{PL}$) | Relative frequency of citation ($R_{FC}$) | Rank order priority ($R_P = R_{FC} \times R_{PL}$) | Deduced Rank† |
|---|---|---|---|---|---|---|---|---|---|
| 1 | *Amorphophallus sylvaticus* (Roxb.) Kunth | 4 | 8 | 0.33 | 0.50 | 0.05063 | 0.032 | 0.00162 | 6 |
| 2 | *Amorphophallus margaritifer* (Roxb.) Kunth | 3 | 9 | 0 | 0.33 | 0.03797 | 0.036 | 0.001367 | 7 |
| 3 | *Amorphophallus konjac* K. Koch | 2 | 5 | 1 | 0.40 | 0.02531 | 0.020 | 0.000506 | 8 |
| 4 | *Sauromatum venosum* (Dryand. ex Aiton) Kunth | 33 | 58 | 0.68 | 0.56 | 0.41772 | 0.232 | 0.096912 | 1 |
| 5 | *Podophyllum hexandrum* Royle | 14 | 3 | 0.69 | 4.6 | 0.17721 | 0.012 | 0.002127 | 5 |
| 6 | *Ponerorchis chusua* (D. Don) Soó | 3 | 3 | 1 | 1 | 0.03797 | 0.012 | 0.000456 | 9 |
| 7 | *Cyclamen persicum* (D. Don) Soó | 3 | 54 | 1 | 0.05 | 0.03797 | 0.216 | 0.008203 | 4 |
| 8 | *Leea asiatica* (L.) Ridsdale | 12 | 20 | 0.72 | 0.6 | 0.15189 | 0.08 | 0.012152 | 3 |
| 9 | *Gloriosa superba* L. | 7 | 90 | 0.67 | 0.70 | 0.08860 | 0.36 | 0.031899 | 2 |

Legend: † Deduced rank has been assigned to each plant species on the basis of the Rank priority ($R_P$), following the unitary method, wherein, *Sauromatum venosum* (Dryand. ex Aiton) Kunth attains the first rank, followed by *Gloriosa superba* L. (Rank 2) and *Leea asiatica* (L.) Ridsdale (Rank 3)

plant species with respect to major ailments, and '0' signifies a complete absence of utility of a plant species with respect to major ailments. Henceforth, for a popular plant species, the $R_{PL}$ value is rationally equal to unity (*i.e.*, equal to 1), while $R_{PL}$ value is less than 1 for unpopular plant species[22,23]. The maximum $R_{PL}$ value in our study has been designated for *Sauromatum venosum* (Dryand. ex Aiton) Kunth ($R_{PL} \sim 0.417$) thereby indicating it as the most utilized species with a higher fidelity and popularity level. It also indicates that the said species could most probably be the botanical source of *Teliya-kanda*. Rank priority ($R_P$) was also found to be in accordance with the popularity relative level, wherein *Sauromatum venosum* (Dryand. ex Aiton) Kunth ($R_P \sim 0.0969$; Deduced rank $\sim 1$) was ranked as the most probable botanical source of *Teliya-kanda* with maximum significance of medicinal utility (Table 6).

## Conclusion

The ethnobotanical survey conducted in the Uttarakhand district suggested that *Sauromatum venosum* (Dryand. ex Aiton) Kunth ($R_{PL} \sim 0.417$; $R_{FC} \sim 0.232$; $R_P \sim 0.0969$; Deduced Rank $\sim 1$) is the probable botanical source of the miraculous herb *Teliya-kanda*.

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Botanical features and therapeutic claims mentioned in the ancient ayurvedic scriptures were also indicative of *Sauromatum venosum* (Dryand. ex Aiton) Kunth as *Teliya-kanda*. Further investigations are still being conducted in the laboratory of the Drug Discovery and Development Division, Patanjali Research Institute, Haridwar, to find novel phytochemical and therapeutic associated with all the above-mentioned species. Such detailed analyses will ultimately aid in the correct identification of the botanical source of *Teliya-kanda*.

## Conflict of Interest

All the authors declare that there is no conflict of interest in publishing this manuscript.

## Author Contributions

AB coordinated the study. PT and SS participated in the design of the research and discussion of results. RM, PT and SS also participated in the data collection. All authors read and approved the final manuscript.

## Prior Informed Consent

Prior consent from traditional healers/ *vaidyas* has been taken as required.

## Data Availability

The data used is available at Mendeley Data, V1, doi: 10.17632/22dgn92nr4.1

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