Distribution pattern and ethnomedicinal uses of plants in Kanchanpur district, Far-Western Nepal

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Databased and Inventories

Abstract

Background: The Far Western Region of Nepal boasts a large inventory of floral diversity including medicinal plants. In order to conserve medicinal plants in Nepal, it is necessary to better identify and assess their distribution, population, uses and interactions with culture. Medicinal plant species are main element in traditional system of healing in Nepal, which have been an integral part in history and cultural practices. In the present study, we aimed to document medicinal plant species and their indigenous uses in Bhimdatt-18, Far Western Nepal. It deals with the study of relationship of people with plants and the documentation of indigenous knowledge on how local plant resources are utilized by local people to cure different diseases.

Methods: Fieldwork was carried out in two distinct sites for studying both distribution pattern and folk medicinal uses of plants. A total of ten quadrats in each site (N=20) were used to calculate phytosociological characteristics (frequency, density and Important Value Index). In order to assess the distribution of plant use knowledge, semi-structured questionnaire was used for interview and supplementary information was collected during informal group discussions. The use reports were categorized into medicinal and non-medicinal. Medicinal uses were further analyzed using the relative frequency citation (RFC).

Results: We recorded 74 species of flowering plants at Bhimdatt-18, (Katan) Kanchanpur district, of which 35 species were recorded from agriculture farmlands (site 1) and the large number (66) from a conserved area (site 2). The recorded plants belonged to 29 families in which highest number of species was associated with families: Poaceae (16), Cyperaceae (12), Leguminosae (5), Asteraceae (4) and Malvaceae (4). On the basis of Importance Value Index, *Imperata cylindrica* (L.) Raeusch. (Poaceae), *Ageratum conyzoides* L. (Asteraceae), *Desmodium triflorum* (L.) DC. (Leguminosae) were placed as top three species, respectively. Of the recorded 74 species, 56 species of medicinal plants were used to cure different diseases.

Conclusions: Dominant species, *Centella asiatica* (L.) Urban., *Eclipta prostrata* L. and *Euphorbia hirta* L. are popular medicinal plants, used in folklore of Kanchanpur district, Nepal. Of ten dominant plant species, nine are being used in ethnomedicine. Dominant plant species are frequently used in ethnomedicine in Kanchanpur district hinted that ecological and ethnobotanical accounts are interrelated. This study concluded that documentation and preservation of biodiversity and its associated knowledge is necessary which could generate further research activities and will help upcoming generations conserve ethnobotanical knowledge for the benefit of ecology and ethnobotany.

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Background

Nepal is divided into seven physiographical regions which occur in the order from south to north: Terai, Siwaliks, Mahabharat, Mid-hills, Mountains, Inner Himalayas and the Tibetan marginal mountain range (Hagen 1998). The great range of bioclimatic variation associated with tropical to alpine zones and lowland Terai to snow-capped Himalayas brings richness in useful medicinal plants (Bhatt 2019). The country is rich in terms of floral diversity because of its physiography and size (NBSAP 2014). Catalogues have recorded over 2500 useful medicinal and aromatic plants in Nepal (Baral & Kurmi 2006, Ghimire *et al.* 2008, Rokaya *et al.* 2010; Kunwar *et al.* 2020), reporting their importance in alleviating human suffering because they have long been used for subsistence, home remedies, and traditional therapies (Manandhar 2002, Kunwar *et al.* 2009). These plants and their products are important for local livelihoods (Adhikari *et al.* 2019) and income generation (Olsen 1998), contributing local and national economy (Bhatt 2019).

In order to conserve medicinal plants in Nepal, it is necessary to better identify the species, assess their distribution, population, uses and current management and develop sustainable strategies. Despite the huge potential, the exploration, diversity analysis, ethnomedicinal study and utilization patterns of plants in Western Terai lowlands areas are limited, urged frequent and periodic ecological and ethnobotanical studies which is also important for future critical studies leading to sustainable utilization of natural resource and to lead the new discovery of phytochemicals (Dhami 2008, Singh *et al.* 2012). In the Far Western Region of Nepal, most of the scientific endeavors have been concentrated on the medicinal values of plants but the study on distribution pattern and ecological survey of plant species is missing. Therefore, the present study was carried out to analyze the inventory of distribution pattern of plant species among study areas and document indigenous knowledge of the different ethnic groups on the use of medicinal plants in Kanchanpur district, Far western Nepal.

Materials and Methods

Study area

The study area, Bheemdatt-18 (Katan), selected for this study, lies in the central part of Kanchanpur district, Far-Western Nepal and stretches between 80°11′3″ East Longitude and 28°57′30″ North Latitude. It ranges from 76 m to 300 m elevation above mean sea level and covers an area of 171.36 sq km with human population of over 13,000 (Fig. 1). Approximately 15274 ha land of the district lies in southern low-land flat plains, which is equipped with irrigation. Due to the lowland type feature and poor drainage, water logging in the fields is a major problem, promoting weeds.

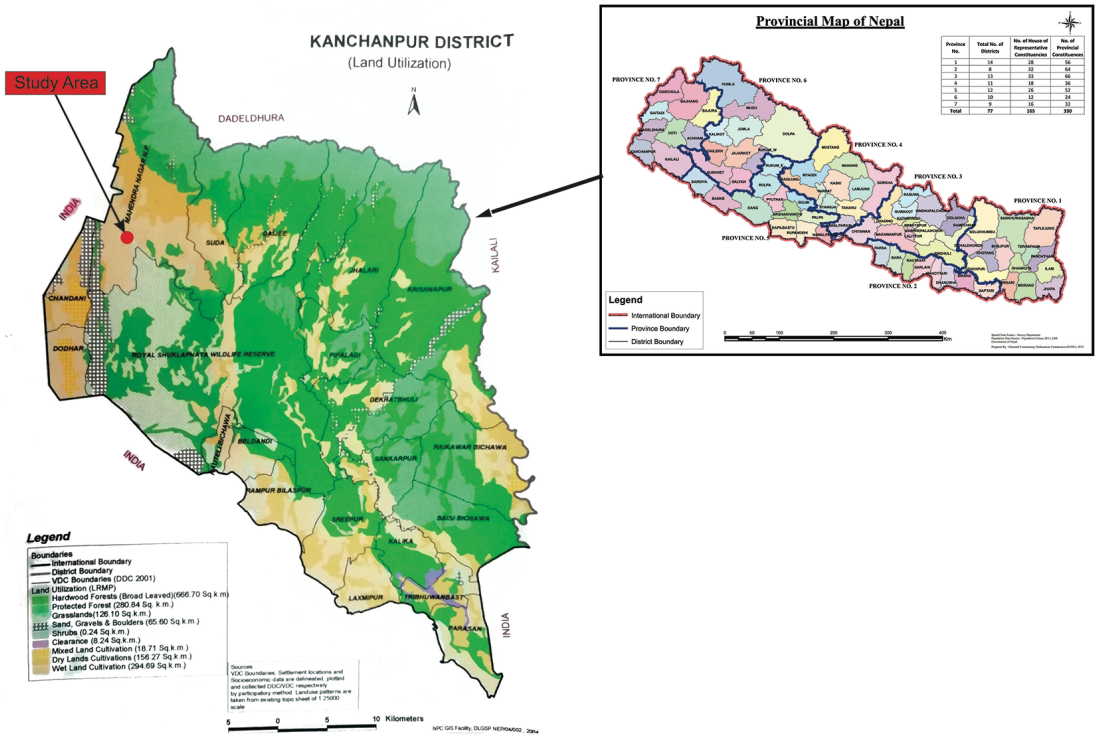

Fig. 1. Map of the study area

Because of the forest litter and alluvial soil, Katan area is more arable and mixed type of cropping system is persistent. Settlement, agriculture and built up areas are major land use types of the site. Katan literally means the area flooded and scoured by Mahakali river. The area is generally lowland type. It was densely forested until 1978 but with the increase in human population, immigration and their associated disturbances, it was degraded and converted into agricultural land. Immigration from upland districts Baitadi, Darchula, Dadeldhura, Bajhang, Achham and Doti is rife. The study area is characterized by the following major ethnic groups: Tharu, Chhetri, Brahmin, Kami, Thakuri, Magar, Damai, Sarki, Muslim, Lohar, etc. The former is indigenous to lowland Terai (Bhattarai *et al.* 2019). Tharu, Chhetri and Brahmin cover 70 percent of the population of the area.

The study area experiences humid tropical climate with three distinct seasons in a year; *viz.* monsoon (mid-June to October), winter (November to February) and summer (March to mid-June). The area is situated in tropical climatic zone having an average 1575 mm annual rainfall with maximum temperature 42^{o}C during summer and minimum temperature 6^{o}C during winter (Bhatt *et al.* 2007). The relative humidity is in the range of 84-87% (DDC Kanchanpur 2008). The land use of the area covers agro-land 36.8%, forests 34% area, and protected zone (Shuklaphanta National Park) 18.8%. Similarly, built-up area, sandy area and water bodies occupy 5.7%, 3.0% and 1.6% of land area, respectively. Due to fertile land with alluvial soil, warm temperatures and comparatively easy access of transportation, irrigation and agricultural inputs, the area boasts two or more crops a year (LRMP 1886). Similarly, there are eco-parks such as Campus Park, Bhimdatta Pant memorial park, Forests; agricultural lands that boast wide range of plant species. The dominant plant species of the area are *Alternanthera sessilis*, *Cynodon dactylon, Cyperus brevifolius, Cyperus rotundus*, *Desmodium triflorum*, *Eriocolon cinerum*, *Eclipta prostrata*, *Imperata cylindrica*, *Murdania nudiflora*, *Oplismenus burmanii*, *Phyllanthus urinaria, Senna tora, Saccharum spontaneum, Hemigraphis hirta, Sida cordata, Parthenium hysterophorus* (Rao 1983; Bhatt *et al*. 2007; Moody 1989; Malik and Moorthy 1996).

Two distinct sites (Site 1: agriculture-settlement zone and Site 2: conserved zone) of study area (Katan) were selected for this study, and the distribution, uses and conservation of useful plants of the area were studied with the help of field inventory, ethnobotanical survey and discussions. The former site is exploited for human uses whereas the latter is conserved for biodiversity purposes. Site 1 is located nearly 10 km south of Mahendranagar, the largest city of Kanchanpur district. Site 2 is nearly 3 km away from the Mahendranagar and characteristically upland type with mixed vegetation and relict stumps of trees. It is conserved site as a protected area in the form of Eco-park, Bhimdatt park, and Campus park, etc. to maintain the greenery of the area and biodiversity. The site is comparatively smaller with land area (1.8 ha). It is upland type and water logging is relatively not a problem. Vegetation cover predominates the site characterized by both indigenous and plantation species. The site is a conserved secondary forest.

Field visits and ecological study

Fieldwork for primary qualitative and quantitative data collection was carried out twice between July 2017 and July 2018. The first field visit was made in August 2017 and the second in July-August, 2018. Each field work was lasted between 20-25 days. During the field visits, the data and information regarding composition of plant species, natural habitat, growth form, phenology, indigenous uses and local conservation measures were collected. Plant samples were collected for morphological and ethno-ecological studies. Diversity Index was calculated by using Shannon-Weiner index (Shannon-Weiner 1949) and Index of Similarity (IS) of plants between two sites was calculated as per Sorenson (1948). Quadrats measuring 1×1 m size were laid randomly in both the study sites, as per the procedure given by Misra (1968) for quantitative analyses of plant species in each sampling plot, and sites. A total of 10 quadrats in each site (N=20) were used to calculate frequency, density and Important Value Index (IVI) (Curtis & McIntosh 1951, Zobel *et al.* 1987).

Collection and Identification

The plant species referred to be useful by respondents were collected, pressed, dried, mounted and preserved based on standard methods as given by (Forman & Bridson 1989). Before preservation all the collected vouchers were examined and identified with the help literature (Hooker 1872, Hara *et al*. 1978, 1982, Hara & Williams 1979, Grierson & Long 1983, Press *et al.* 2000). Furthermore, the species were confirmed by comparing with herbarium specimens deposited at KATH (National Herbarium and Plant Laboratories, Godawori, Lalitpur, Nepal), TUCH (Tribhuvan University Herbarium, Department of Botany, Kirtipur, Kathmandu), and Department of Botanty, Siddhanath Science Campus, Mahendranagar. All voucher specimens were deposited at Department of Botany, Siddhanath Science Campus, Mahendranagar. Scientific name of plants and their families were verified with referring to the plant list

(http://www.theplantlist.org/).

Ethnobotanical survey and data analyses

In order to assess the distribution of plant use knowledge, a total of 30 respondents (N = 30) of the study sites including 20 men and 10 women age ranged between 45 years and 75 years were randomly selected and interviewed following Kunwar *et al.* (2019). They suggested 25 or greater number of respondents is required to attain the sampling asymptote for ethnobotanical study. The name of useful species and their uses, along with the mode of application was sought in questionnaire survey (Supplementary File 1). A semi-structured questionnaire was used for interview and supplementary information was collected through informal meetings during staying in the village with communities, walking in the trails, and having morning tea at tea-vendors (Putnam 1975). While pursuing informal meeting and questionnaire surveys, vernacular names and medicinal uses as well as other supplementary information were collected. The collected information was compared with the published literatures (Baral and Kurmi 2006, Bhattarai and Ghimire 2006, Dhami 2008, Kunwar *et al.* 2010, Rokaya *et al*. 2010, Shakya 2014, Singh 2014, Bhatt and Shakya 2015).

The reports were categorized into medicinal and non-medicinal according to their use. Medicinal uses were quantitatively enumerated using the relative frequency citation (RFC) following Tardío and Pardo-De-Santayana (2008). RFC was evaluated by dividing the number of informants who mentioned the use of the species (n) by the total number of informants participating in the survey (N). The RFC index ranges from "0" when nobody referred to a plant as useful to "1" when all informants referred to a plant as useful. RFC = n/N.

Results

Distribution pattern and composition of plant species

Of the total 74 species of plants recorded in study area of Kanchanpur district, 35 species were recorded from site 1 (agriculture-farmlands) and 66 species from site 2 (conserved area) (Supplementary File 2). These species belonged to 29 families: Poaceae (16), Cyperaceae (12), Leguminosae (5), Asteraceae (4), Malvaceae (4), Scrophulariaceae (3), Amaranthaceae (2),Commelianaceae (2), Lamiaceae (2), Verbenaceae (2), Piperaceae (2), Pteridaceae (2), Phyllanthaceae (2) and one species each belong to Rhamnaceae, Myrtaceae, Rosaceae, Oxalidaceae, Molluginaceae, Meliaceae, Marsilaceae, Acanthaceae, Rubiaceae, Convolvulaceae, Euphorbiaceae, Eriocaulaceae, Equisetaceae, Onagraceae, Araceae and Apiaceae (Fig. 2 & Supplementary File 2). Twenty-seven species were recorded at both sites. Species richness (diversity) was found to be higher (66) in site 2 than in site 1 (35). The Shannon-Wiener index was 3.6 at site 1 and 4.0 at site 2. The percentage similarity between the sites was 51.5%, indicating a moderate degree of similarity of species between the two sites (Fig. 2).

The maximum density was contributed by *Imperata cylindrica* (40.11 individuals m^{-2}) followed by *A. conyzoides* (26.02) and *D. triflorum* (14.99). In the present study, the maximum and minimum IVI was occupied by *Imperata cylindrica* (69.35 individuals m^{-2}) and *Equisetum hyemale and Saraca indica* (10.01 individuals m^{-2}) species, respectively (Supplementary File 2).

On the basis of Importance Value Index (IVI > 28), 10 plant species predominate the site. The highest IVI was recorded by *Imperata cylindrica* (69.35) and lowest by *Cynodon dactylon* (28.23) (Table 1), both were common in study area. Both represent Poaceae, and Poaceae has the highest family IVI. Of the 10 dominant species, *Cyperus millifolius,* used as forage was found only in Site 1 (agricultural site) whereas the *Achyranthes aspera*, a medicinal plant used in diarrhea and lower abdominal pain in women throughout the district was found only in Site 2 (conservation site). Of the 10 dominant species, nine were ethnomedicinal.

Plant use values

Out of the total 74 plant species, 56 (75.68%) species were used in different medicinal purposes and the other 18 (24.32%) species were used as forage/fodder (Fig. 4 a). Out of 56 ethnomedicinal plants, the use reports for 41 species were matched with Dhami (2008) and 32 species with (Singh 2014). The highest number of common useful species, 62 between Bhatt and Shakya (2015) and present study was attributed by the fact that both studies carried out in the central part of Kanchanpur district. (Table 2).

Whole plant parts were found utilized by local people for ethno-medicinal purposes. Local people have been using different plant parts through various modes of application to cure different ailments such as dysentery, diarrhea, cough, inflammation, urinary diseases, jaundice and dermatological complaints (Fig. 4 b & c). The empirical ethnomedicinal knowledge is constrained to limited persons and has become restricted with the introduction of modern medicine for decades. We recorded that the usage of ethnomedicinal started declining in our study area once the biomedicine as a form of immunization invaded Kanchanpur four decades ago.

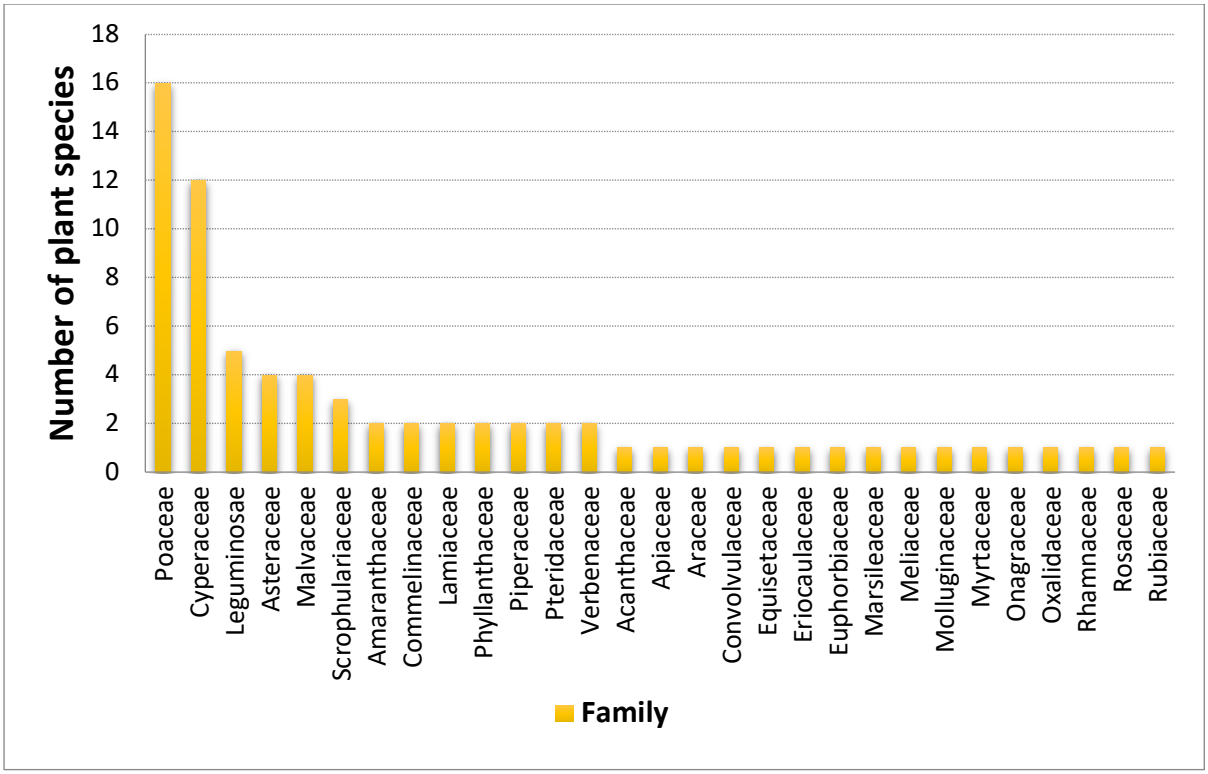

Figure 2. Number of species belonging to the different families

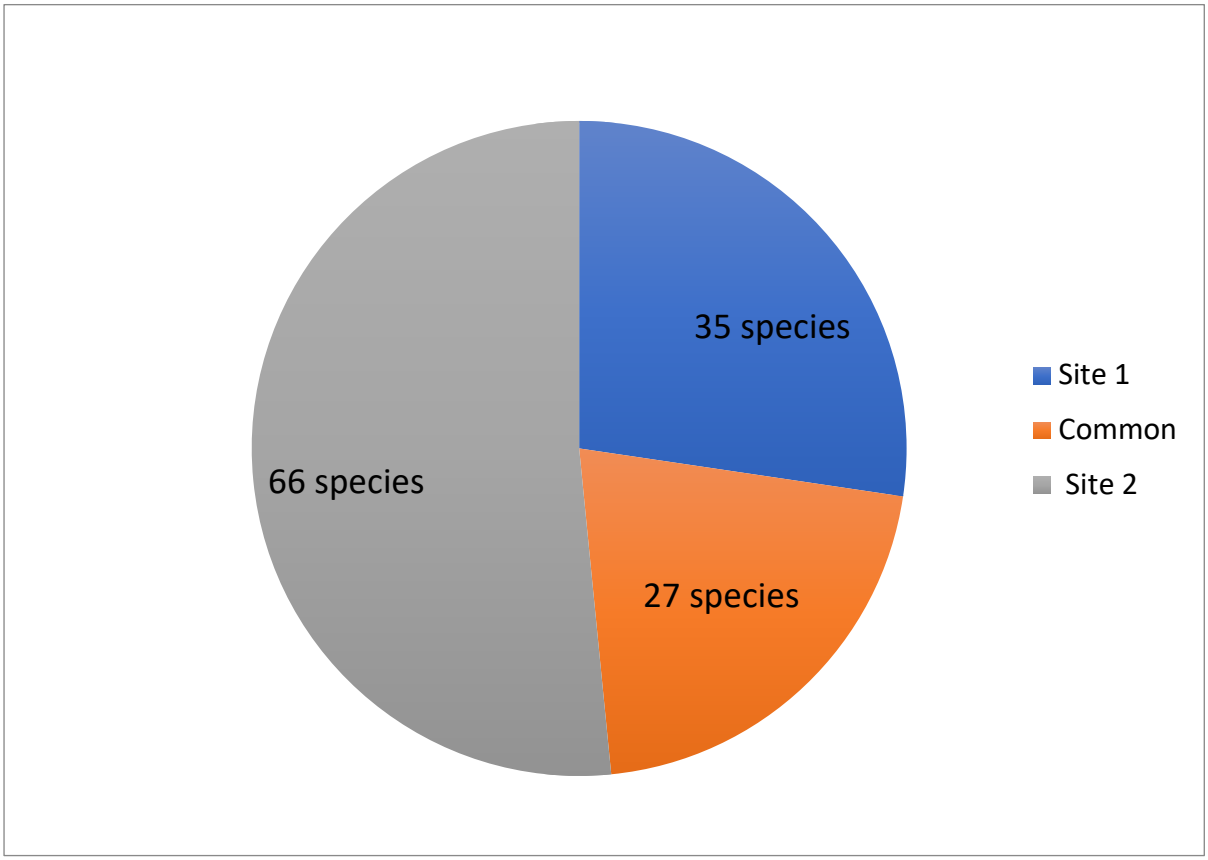

Figure 3. Species richness and similarity between two sites.

Table 1. Top ten dominant plant species among the study sites in Far western Nepal.

Dominant plant family	Family Importance Value Index (IVI)	Dominant plant species and family	Importance Value Index (IVI)	Present at study sites
Poaceae	335.52	*Imperata cylindrica* (Poaceae)	69.35	1, 2
Cyperaceae	214.31	*Ageratum conyzoides* (Asteraceae)	57.55	1, 2
Asteraceae	138.52	*Desmodium triflorum* (Leguminosae)	47.23	1, 2
Leguminosae	113.16	*Eclipta prostrata* (Asteraceae)	38.46	1, 2
Scrophulariaceae	71.49	*Cyperus miliifolius* (Poaceae)	37.20	1
Malvaceae	65.61	*Eriocaulon cinerum* (Eriocaulaceae)	33.12	1, 2
Amaranthaceae	57.74	*Cyperus rotundus* (Poaceae)	32.39	1, 2
Lamiaceae	51.26	*Lindernia procumbens* (Scrophulariaceae)	32.13	1, 2
Eriocaulaceae	33.12	*Achyranthes aspara* (Asteraceae)	30.83	2
Commelinaceae	31.79	*Cynodon dactylon* (Poaceae)	28.23	1, 2

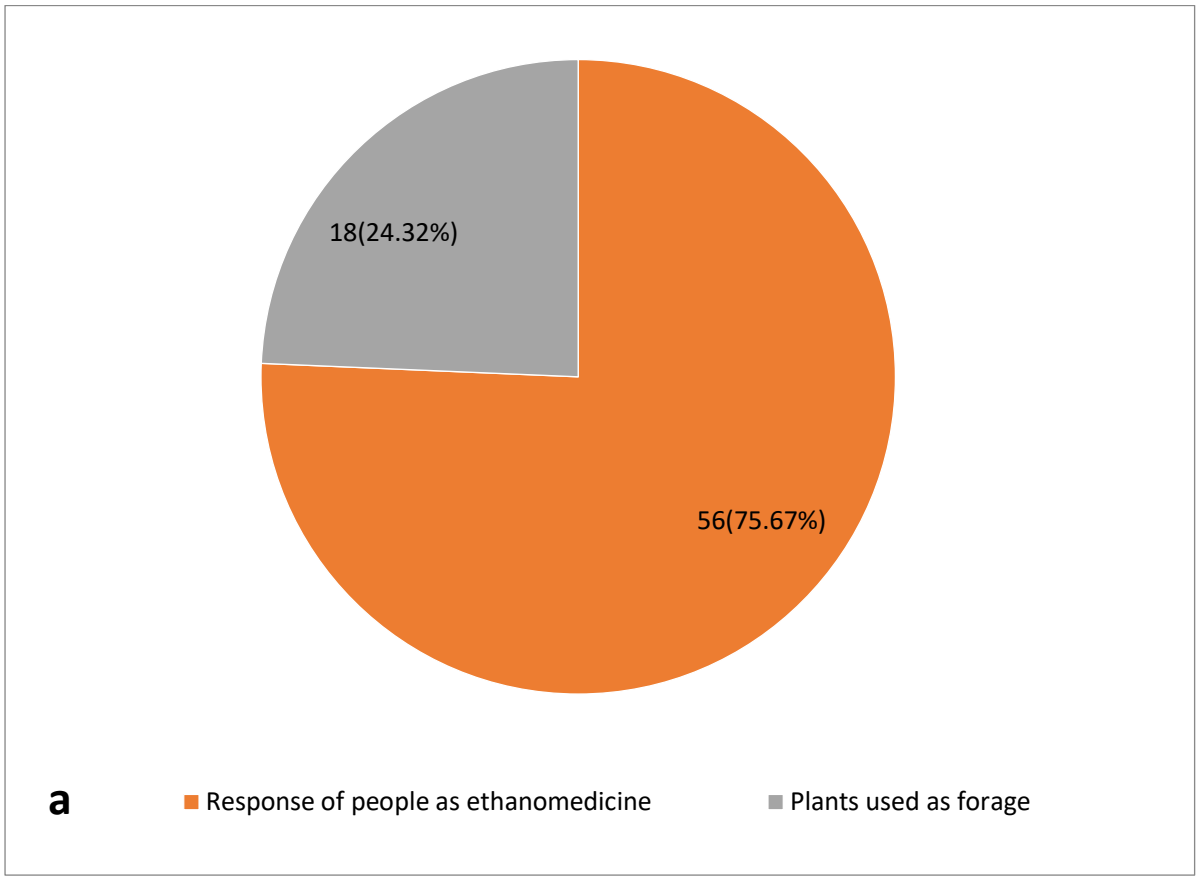

Figure 4a. Distribution of plants according to their use

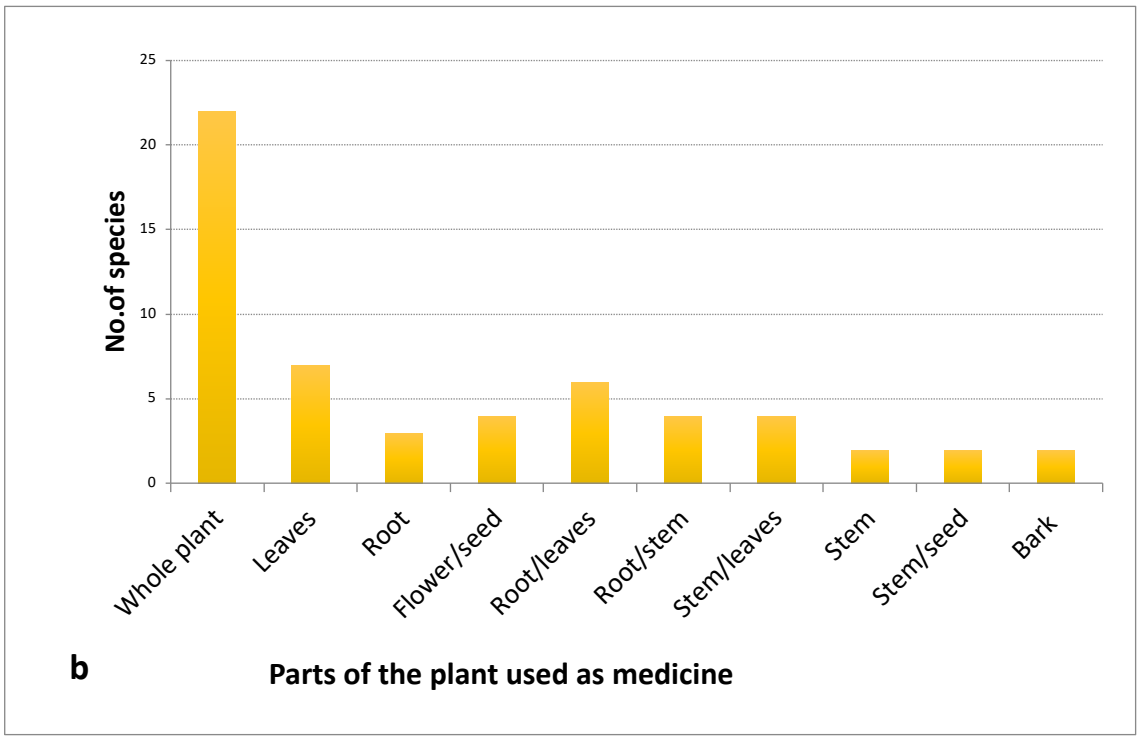

Figure 4b. Parts of the plants used as medicine

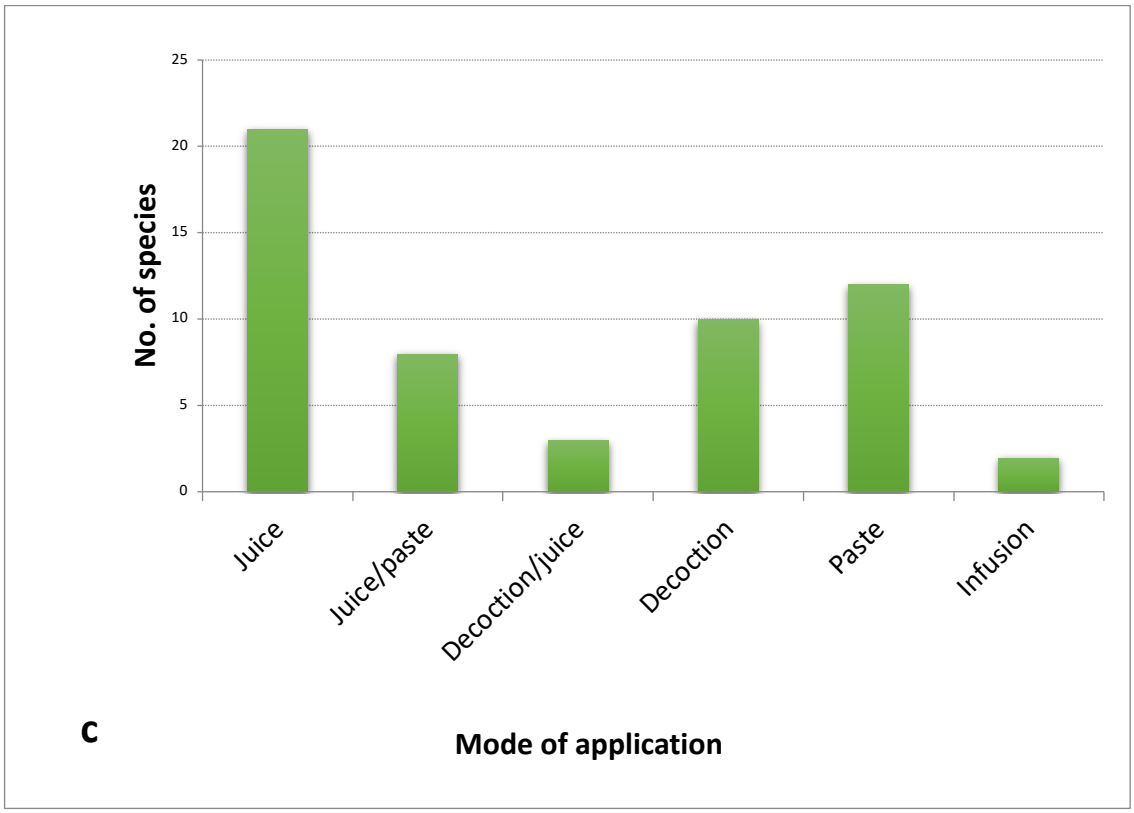

Figure 4c. Different mode of application of plants for medicinal purpose.

Table 2. Ethnomedicinal value of plant species in the study area.

Scientific name	Family	Vernacular names	Plant part used	Mentioned uses	RFC	Herbarium voucher number	Plant use in study area	Uses in earlier references
Hemigraphis hirta (Vahl)T. Anderson *	Acanthaceae	Ban pan	Whole plant	9	0.30	SNSC 043	Headache, ulcer of the mouth and gums and for passing of semen in urine.	Headache, ulcer of the mouth (Dhami 2008, Singh 2014, Bhatt & Shakya 2015).
Achyranthes aspera L.*	Amaranthaceae	Datiwan	Whole plant	23	0.76	SNSC 001	Root paste and juice given in diarrhea, lower abdominal pain in women, urinary disorders.	Root paste and juice given in diarrhea, pain in lower abdomen, snake bite and scorpion sting (Dhami 2008, Singh 2014).
Alternanthera sessilis (L.) DC*	Amaranthaceae	Bhiringi jhar	Whole plant	25	0.83	SNSC 004	Plant paste is used in wounds, venereal disease, and menstrual disorder.	Plant paste is used in wounds, venereal disease, menstrual disorder and dysentery (Dhami 2008, Singh 2014).
Centella asiatica (L.) Urban.*	Apiaceae	Ghoddtapre	Leaves	28	0.93	SNSC 008	Plant juice is considered a tonic and used in urinary troubles, skin diseases and headache.	Plant juice is considered a tonic and used in urinary troubles (Dhami 2008).
Colocasia esculenta (L.) Schott.*	Araceae	Pidalu	Tuber	12	0.40	SNSC 014	Juice of tuber is laxative demulcent.	Tuber is useful in stomalgia, alopecia, stimulant in internal hemorrhages (Bhatt & Shakya 2015).
*Ageratum conyzoides*L.*	Asteraceae	Ganaune jhar	Whole plant	25	0.83	SNSC 002	Plant juice is applied in cuts, wounds to stop bleeding and as antiseptic.	Plant juice is applied in cuts, wounds to stop bleeding (Dhami 2008, Singh 2014).
Eclipta prostrata L.*	Asteraceae	Bhringraj	Whole plant	28	0.93	SNSC 033	Plant paste is used in cut wounds, skin diseases and pimples. Juice is given in night blindness and jaundice.	Decoction of leaf is liver tonic and is given in jaundice (Dhami 2008, Bhatt & Shakya 2015).
Parthenium hysterophorus L.*	Asteraceae	Bahudal ghas	Whole plant	20	0.66	SNSC 058	The Whole plant is bitter and strong-scented, reckoned tonic, stimulating and anti-hysteric.	Root decoction is useful in dysentery, antitumor activity (Bhatt & Shakya 2015).

Spilanthes calva DC.*	Asteraceae	Jhun jhun	Leaves Flower	9	0.30	SNSC 072	The decoction of the plant is used to dress wounds, toothache and affections of the gums.	The decoction of the plant is used to treat throat, gums, tongue problems (Bhatt &Shakya 2015).
Commelina benghalensis (L.)*	Commelinaceae	Kaane jhar	Whole plant	14	0.46	SNSC 015	lant is bitter, useful in leprosy, paste of plant is applied to treat burns	Juice of root is used in indigestion (Bhatt & Shakya 2015).
Murdannia nudiflora (L.) Brenan.*	Commelinaceae	Masino	Stem Leaves	5	0.16	SNSC 055	It is used often as an external poultice for wounds, sores and burns.	It is used often as an external poultice for wounds and sore throat (Bhatt & Shakya 2015).
Evolvulus nummularuis (L.) L.*	Convolvulaceae	Balu jhar	Stem Leaves	8	0.26	SNSC 039	It is used as brain tonic, astringent, anti-dysenteric.	Leaf as anti-asthmatic. Used in epilepsy and duodenal ulcers (Shakya 2014, Bhatt & Shakya 2015).
Cyperus brevifolius Rottb.#	Cyperaceae	Mothe	Whole plant			SNSC 018	Used as forage.	
Cyperus compressus L.#	Cyperaceae	Mothe	Whole plant			SNSC 019	Used as forage.	
Cyperus corymbosus Rottb.#	Cyperaceae	Mothe	Whole plant			SNSC 020	Used as forage.	
Cyperus difformis L.#	Cyperaceae	Mothe	Whole plant			SNSC 021	Used as forage.	
Cyperus flavescens L.#	Cyperaceae	Mothe	Whole plant			SNSC 022	Used as forage.	
Cyperus haspen L. #	Cyperaceae	Mothe	Whole plant			SNSC 023	Used as forage.	
Cyperus iria L.#	Cyperaceae	Mothe	Whole plant			SNSC 024	Used as forage.	
Cyperus miliifolius Peopp.& Kunth#	Cyperaceae	Mothe	Whole plant			SNSC 025	Used as forage.	
Cyperus rotundus L.*	Cyperaceae	Mothe	Tuber/ Root	20	0.66	SNSC 026	Infusion of tuber and roots is given in indigestion, diarrhea, dysentery, vomiting, fever, cholera and stomachache.	Infusion of tuber and roots is given in indigestion, diarrhea, dysentery (Dhami 2008, Bhatt & Shakya 2015).
Cyperus squarrosus L.#	Cyperaceae	Mothe	Whole plant			SNSC 027	Used as forage.	

Fimbristylis dichotoma (L.) Vahl.*	Cyperaceae	Mothe	Rhizome Stem	4	0.13	SNSC 040	The culms are used to make inferior matting and encourage hair growth.	The culms are used to boost hair growth (Bhatt & Shakya 2015).
Fimbristylis miliacea (L.) Vahl. #	Cyperaceae	Mothe	Whole plant			SNSC 041	Used as forage.	
Equisetum hyemale L.*	Equisetaceae	Nali jhar	Root	16	0.53	SNSC 035	Root juice given in fever and urinary troubles.	Plant ash used to treat burns, scabies and skin disease (HMG 1976, Dhami 2008).
Eriocaulon cinereum R. Br.*	Eriocaulaceae	Sano mothe	Leaves	5	0.16	SNSC 037	Paste of the plant is used is usedas diuretic, febrifuge and juice is used for ophthalmia.	Paste of the plant is used as diuretic, febrifuge (Shakya 2014).
Euphorbia hirta L.*	Euphorbiaceae	Dudhay jhar	Whole plant	28	0.93	SNSC 038	Milky juice is applied in cut wounds, skin diseases and boils.	Plant extract given in diarrhea, dysentery, bronchial problems, fever, earache, and snakebites (Dhami 2008, Singh 2014, Bhatt & Shakya 2015).
Ajuga integrifolia Buch.-Ham. *	Lamiaceae	Amile jhar	Leaves	12	0.40	SNSC 003	A bitter astringent given in fevers. It is credited as astringent, stimulant and tonic.	It is credited with astringent, stimulant, tonic, diuretic and depurative properties and to treat rheumatism, amenorrhea. It is used also to kill lice (Shakya 2014, Bhatt & Shakya 2015).
Clerodendrum viscosum Vent.*	Lamiaceae	Bhant	Leaves Root	11	0.36	SNSC 013	Root and leaf paste used in skin disease.	Root and leaf paste used in skin disease (Dhami 2008).
Alysicarpus vaginalis (L.) DC.*	Leguminosae	Chandre ghans	Whole plant	10	0.33	SNSC 005	A decoction of the roots is used as a treatment against coughs.	The Whole plant is used medicinally for treating sword wounds and bone fractures (Bhatt & Shakya 2015).
Desmodium trifolium (L.) DC.*	Leguminosae	Chaupate	Whole plant	16	0.53	SNSC 029	The plant is antipyretic, antiseptic, expectorant.	A decoction is commonly used to treat diarrhea and dysentery; and to cure wounds, ulcers, and for skin problems (Bhatt & Shakya 2015).
*Mimosa pudica*L.*	Leguminosae	Lajjawati	Roots Leaves	14	0.46	SNSC 053	Juice of the plant is used in jaundice, fever and diarrhea.	Juice of the plant is diarrhea, asthma, and dysentery (Dhami

								2008, Singh 2014, Bhatt & Shakya 2015).
Saraca indica L.*	Leguminosae	Asoka	Stem Seeds	16	0.53	SNSC 066	Used as analgesic, astringent, anthelmintic, blood purifier, anti-pyretic, cooling effect.	Used as analgesic, astringent, blood purifier, anti-pyretic, cooling effect (Bhatt & Shakya 2015).
Senna tora (L.) Roxb.*	Leguminosae	Chakramarda	Seed	20	0.66	SNSC 067	Seed paste is used in the treatment of ringworm and itching.	Seed paste is used in the treatment of ringworm (Bhatt & Shakya 2015).
Corchorus tridens L.*	Malvaceae	Koshe jhar	Leaves	4	0.13	SNSC 016	The cooked leaves are mucilaginous and used to soothe irritated tissues.	Leaves are mucilaginous (Bhatt & Shakya 2015).
Sida acuta Burm. f.*	Malvaceae	Balu jhar	Root Stem	9	0.30	SNSC 069	Root and stem paste is applied externally to take out pus from boils.	Root and stem paste is applied externally to take out pus from boils (Singh 2014, Bhatt & Shakya 2015).
Sida cordifolia L.*	Malvaceae	Balujhar	Whole plant	6	0.20	SNSC 070	Root and stem paste is applied externally to take out pus from boils.	Root and stem paste is applied externally to take out pus from boils (Singh 2014, Bhatt & Shakya 2015).
Sida rhombifolia L*	Malvaceae	Balu jhar	Whole plant	4	0.13	SNSC 071	Roots used in rheumatism.	Stem is used in emollient, infusion of petals is used in fever (Singh 2014, Bhatt & Shakya 2015).
Marsilea quadrifolia L.*	Marsileaceae	Chaupatay	Leaves	14	0.46	SNSC 050	Juice of leaves is diuretic and febrifuge and used to treat snakebite,	Anti-inflammatory and refrigerant (Dhami 2008, Bhatt & Shakya 2015).
Melia azedarach L.*	Meliaceae	Bakaino	Bark	20	0.66	SNSC 052	Bark juice is anthelmintic and also used in body pain, headache. Plant extract anthelmintic.	Plant extract anthelmintic (Dhami 2008, Singh 2014, Bhatt & Shakya 2015).
Mollugo pentaphylla L.*	Molluginaceae	Trayaman	Whole plant	6	0.20	SNSC 054	The plant is antipyretic, antiseptic, appetizer, laxative and stomachic.	A decoction of the roots is used to treat eye diseases (Bhatt & Shakya 2015).

Syzygium cumini (L.) Skeels*	Myrtaceae	Jamun	Leaves Fruits	23	0.76	SNSC 073	Bark juice used in diarrhea, dysentery, cut wounds. Fruits are edible and good for indigestion and constipation.	Fruit and decoction of leaves are given in diarrhea and dysentery (Dhami 2008).
Ludwigia perennis L.*	Onagraceae	Lwang jhar	Leaves Roots	10	0.33	SNSC 049	Decoction and juice of the plant is used as therapeutic.	Decoction and juice of the plant is used as therapeutic (HMG 1976).
Oxalis corniculata L.*	Oxalidaceae	Chari amilo	Stem Leaves	20	0.66	SNSC 057	Plant juice used in pimples, cut wounds, diarrhea and dysentery.	Plant juice used in pimples, cut wounds (Dhami 2008).
Phyllanthus niruri L.*	Phyllanthaceae	Bhui amala	Leaves	16	0.53	SNSC 061	Excellent diuretic, juice of leaves is an appetizer.	Plant is an excellent diuretic (Bhatt & Shakya 2015).
Phyllanthus urinaria L.*	Phyllanthaceae	Bhui amala	Whole plant	14	0.46	SNSC 062	Excellent diuretic, juice of leaves is an appetizer.	Diuretic and appetizer (Dhami 2008, Bhatt & Shakya 2015).
Peperomia pellucida (L.) Kunth.*	Piperaceae	Latpatey	Whole plant	16	0.53	SNSC 060	Plant is used as anti-inflammatory and analgesic properties.	Plant is used as anti-inflammatory (Dhami 2008, Bhatt & Shakya 2015).
Piper longum L.*	Piperaceae	Pipala	Fruit	23	0.76	SNSC 063	Decoction of fruit is taken in cough cold and bronchitis, fruit juice is used as necrotic and appetizer.	Decoction of fruit is taken in cough cold and bronchitis (Dhami 2008, Singh 2014, Bhatt & Shakya 2015).
Brachiaria mutica (Forssk.) Stapf.#	Poaceae	Banso	Whole plant			SNSC 006	Used as forage.	
Brachiaria ramosa (L.) Stapf.#	Poaceae	Likhe	Whole plant			SNSC 007	Used as forage.	
Chloris radiata (L.) Sw.#	Poaceae	Finger	Whole plant			SNSC 011	Used as forage.	
Chrysopogan aciculatus (Retz.) Trin.*	Poaceae	Kuro	Root	4	0.13	SNSC 012	Decoction of root is used for diarrhea, diuretic.	Decoction of root is used for diarrhea, diuretic(Shakya 2014).
Cynodon dactylon (L.) Pers.*	Poaceae	Dubo	Leaves Roots	23	0.76	SNSC 017	Paste of Whole plant is applied in fracture; juice is applied in cuts and wounds.	Paste of Whole plant is applied in fracture, juice and root infusion is taken orally in bleeding, and piles (Dhami 2008, Singh 2014, Bhatt & Shakya 2015).
Dactyloctenium aegypticum (L.) P. Beauv.#	Poaceae	Makure	Whole plant			SNSC 028	Used as forage.	

Digitaria sanguinalis (L.) Scop. *	Poaceae	Sano	Roots Bark	8	0.26	SNSC 030	A decoction of the plant is used in the treatment of gonorrhea.	A folk remedy for cataracts and debility (Shakya 2014, Bhatt & Shakya 2015).
Echinochloa colona (L.) Link*	Poaceae	Sawa	Whole plant	8	0.26	SNSC 031	Traditionally used in spleen and hemorrhage problems.	It has wound healing, antioxidant and antimicrobial property (Shakya 2014, Bhatt & Shakya 2015).
Echinochloa glabrescens Munro ex Hook.f. *	Poaceae	Gaure	Stem Roots	4	0.13	SNSC 032	Reported to be preventative and tonic, remedy for treating carbuncles, hemorrhages.	Sores, spleen trouble and wounds. The shoots and roots are applied as a styptic to wounds (Bhatt & Shakya 2015).
Eleusine indica (L.) Gaertn.*	Poaceae	Kode jhar	Whole plant	4	0.13	SNSC 034	Used as anthelmintic, antidiabetic, antioxidant.	Plant as diuretic, diaphoretic, inflammatory, febrifuge (Shakya 2014).
Eragrostis tenella (Retz.) Stapf#	Poaceae	Chari dana	Whole plant			SNSC 036	Used as forage.	
Imperata cylindrica (L.) P. Raeusch.*	Poaceae	Siru	Root	25	0.83	SNSC 044	Root juice used in body pain, diarrhea, dysentery, fever and indigestion.	Root paste anti-helminthic and also used in boils (Dhami 2008, Bhatt & Shakya 2015).
Oplismenus burmanni (Retz.) Beauv. #	Poaceae	Gobre ghans	Whole plant			SNSC 056	Used as forage.	
Paspalum conjugatum P.J. Bergius*	Poaceae	Janai ghas	Leaves	8	0.26	SNSC 059	A decoction of the leaves is used in the treatment of wounds, fever and cuts.	Leaf decoction is used for debility, stomach troubles, wounds and cuts (Shakya 2014).
Rottboelia exaltata L.f.#	Poaceae	Tundya	Whole plant			SNSC 065	Used as forage.	
Setaria pumila (Poir.) Roem. &Schult. #	Poaceae	Bhaale banso	Whole plant			SNSC 068	Used as forage.	
Ceratopteris thalictroides (L.) Brongn.*	Pteridaceae	Unui	Roots Leaves	8	0.26	SNSC 009	Both the leaves and the roots are used as a poultice against skin complaints.	Leaves and roots are used as a styptic to stop bleeding (Singh 2014, Bhatt & Shakya 2015).

Cheilanthes tenuifolia (Burm.f.) Sw.*	Pteridaceae	Fern	Rhizome Roots	5	0.16	SNSC 010	The rhizome and roots are used as general tonic, anti-helminthic for asthma.	Rhizome and roots are used as tonic, anti-helminthic (Bhatt & Shakya 2015).
Zizyphus mauritiana Lam.*	Rhamnaceae	Bayar	Seeds	23	0.76	SNSC 074	Ripe fruits are edible and good for indigestion, constipation and stomach problems.	Ripe fruits are edible (Dhami 2008, Bhatt & Shakya 2015).
Rosa alba L.*	Rosaceae	Gulab	Flower	20	0.66	SNSC 064	Flower used as cooling medicine in fever and in palpitation of heart.	Flower used in fever and heart problem (HMG 1976).
Hedyotis corymbosa (L.) Lam.*	Rubiaceae	Majithe jhar	Leaves	6	0.20	SNSC 042	Used in gastric irritability, nervous depression, liver complaints and fever.	Used in gastric irritability, nervous depression (Bhatt & Shakya 2015).
Lindernia oppositifolia (L.) Mukerjee.*	Scrophulariaceae	Koshe jhar	Whole plant	9	0.30	SNSC 046	Used as to treat dysentery and intestinal problems.	Decoction of the leaves is given after childbirth and the aerial parts are used in poultices for relieving boils, sores and itches (Bhatt & Shakya 2015).
Lindernia procumbens (Krock.) Borbas*	Scrophulariaceae	Pitamari	Stem Leaves	10	0.33	SNSC 047	It is used as a remedy for gonorrhea and the juice is given to children who pass green-colored stools, dysentery, intestinal problems.	Gonorrhea, dysentery, intestinal problems (Bhatt & Shakya 2015).
Mecardonia procumbens (Mill.) Small*	Scrophulariaceae	Malati jhar	Whole plant	10	0.33	SNSC 051	The plant is used to heal all kinds of wounds.	Cuts and wounds (Bhatt & Shakya 2015).
Lantana camara var. *aculeata* (L.) Mol.*	Verbenaceae	Sitayiphul	Whole plant	11	0.36	SNSC 045	Plant is vulnerary, diaphoretic, carminative, antispasmodic and tonic.	Decoction of the plant is used as rheumatism and anti-malaria (Dhami 2008, Bhatt & Shakya 2015).
Lippia nodiflora (L.) Michx.*	Verbenaceae	Bukkan	Leaves Root	12	0.40	SNSC 048	The plant is antibacterial, astringent and diuretic.	Plant is useful in the treatment of menorrhoea, constipation and pain in the knees. The juice of the root is used in the treatment of gastric troubles. (HMG 1976).

*indicates plant species used for medicinal purpose and #indicates plant species used as fodder/forage at the study area

Discussion

Plant species diversity and richness

Of the total 74 species of flowering plants recorded in two study sites of Kanchanpur district, 35 species were recorded from site 1 (agricultural zone) and 66 species at site 2 (conserved zone) shows that the selected sites are quite heterogeneous though they were from the same small area. The result was attributed by the different land use types. Site 1 is characterized with settlement area, farmlands and flat parcels of agriculture whereas the Site 2 is relatively conserved, close to agriculture land and human-disturbance free. Agricultural ecosystem is quite different from the natural environment ecosystem. In the agricultural ecosystem at site 1 the density of plant species is minimized due to tradition of weeding and regular use of weedicides. Also most of the plant species are collected as fodder, which has resulted in decrease of the density and diversity of plant species. In recent years, application of agrochemicals and pesticides change the cropping system and cultivation methods have modified vegetation distribution.

The recorded plant species belonged to 29 families in which highest number was associated with families: Poaceae (16), Cyperaceae (12), Leguminosae (5), Asteraceae (4) and Malvaceae (4). On the basis of Importance Value Index, *Imperata cylindrica* (L.) Raeusch. (Poaceae), *Ageratum conyzoides* L. (Asteraceae) and *Desmodium triflorum* (L.) DC. (Leguminosae) were placed as top three species, respectively. The dominance of family Poaceae, Cyperaceae, Asteraceae, Leguminosae and Malvaceae was contributed by their family IVI values as well as the soil seed bank of the species. The contribution of the seed bank to the regeneration process mainly depends on the management history and structural and compositional development of aboveground vegetation (López-Mariño *et al*. 2000, Bhatt & Singh 2007). Since site 2 (conserved zone) has better conservation management, it has higher species richness. All four tree-shrub species (*Melia azedarach, Syzygium cumini, Saraca indica*, and *Zizyphus mauritiana*) were recorded indigenous and native to Nepal, were recorded only from site 2. The number of native species is higher in restored site (Baral *et al.* 2017).

Plant density echoed the plant species richness, i.e. plant density is higher in site 2. The maximum density was contributed by *Imperata cylindrica* (69.35 individuals m^{-2}) and minimum by *Equisetum hyemale* (0.02 individuals m^{-2}) and *Saraca indica* (0.02 individuals m^{-2}). Both *Imperata* and *Equisetum* prefer disturbed site (Moreno-Dominguez *et al.* 2016). Dominance of *Imperata* was already reported in crop fields of Chitwan (Dangol 2002) and natural vegetation in Arun valley (Chaudhary and Kunwar 2002). This study corroborated the earlier findings made by Bhatt (2019). Of the reported 10 dominant plant species, 5 species such as *Ageratum conyzoides, Cyperus rotundus, Cynodon dactylon, Imperata cylindrica* and *Eclipta prostrata* were reported as being the most important and dominant species as in the world (Holm *et al.*1991). Of 10 dominant species, nine are being used in folklore in Katan, Kanchanpur district, revealed that apparent plants are frequently used in ethnomedicine and supported the association of ecology and ethnobotany.

Species richness, Shannon-Wiener index and degree of similarity were not much differentiated with that of a study carried out in 2007 (Bhatt *et al.* 2007), hinted that the study area (Katan) is not under severe land use change in the last decade. However, Kanchanpur has severe land use change in its eastern parts (Rimal *et al.* 2020). The lowland Terai including study area has massive deforestation since 1970's when the commercial cotton cultivation and its extensive pesticides application coupled with migration from hills was taken place (Gurung 1989, Sharma *et al.* 2013). However, Shannon-Wiener diversity index values (3.6 at site 1 & 4 at site 2) indicate that site 2 is highly diverse because of rejuvenation of earlier species and plantation of new species in parks.

Medicinal plants and their uses

People of Kanchanpur district use different plants and their parts in various purposes for their daily life. The use of plants and their products for the different purposes such as food, fodder, wood, medicine, oil, fibre, aroma and ornamental value could be traced back to centuries. Despite the historic and extensive uses of plants for local livelihood, these resources have neither been adequately documented nor evaluated for their potential. There are a large number of under-utilized species in Nepal, could contribute food security situation of the area (Kunwar *et al.* 2012). We reported 56 plant species as medicinal, which was about 75% of the total recorded flora of the site. Dhami (2008) reported 105 ethnomedicinal plant species in Kanchanpur district. Our findings revealed that elderly people, healers, and *Vaidyas (or Guruwas)* have been using a large number of plant species to cure various diseases although they were less conscious about the documentation of ethnomedicinal folklore and conservation of medicinal plants. While the youngsters of both Tharu and migrant society from different hilly districts such as Baitadi, Darchula, Dadeldhura, Bajhang, Achham and Doti were less interested and aware about the use of ethnomedicine. Traditional medical knowledge is at

risk of being lost in the study area because youth are less interested on traditional medicines (Dhami 2008, Subedi 2019) and the sharing of traditional ethnomedicinal knowledge through restrained oral process and informal learning such as apprenticeship.

Of the reported 56 medicinal plant species, medicinal plants as a whole plant were used mostly (22 species), followed by leaves (7 species), root and leaves (6 species), stem and leaves (4 species), root and stem (4 species), flower and seed (4 species), root (3 species), stem (2 species), stem and seeds (2 species) and bark (2 species). Among the reported medicinal plant species, 21 plant species were used in the form of juice, followed by paste (12 species), decoction (10 species), juice and paste (8 species), decoction and juice (3 species) and infusion (2 species) (Table 2 & Fig. 4). From the mentioned data highest percentage of plant species were used as juice 37.5%, followed by paste 21.4% and decoction 17.8%. As per the responds of the people at the study area, *Centella asiatica, Eclipta prostrata* and *Euphorbia hirta* (93.3%) were most common traditionally used plant species to cure urinary troubles, muscular pain, skin diseases, cut wounds, headache, earache, diarrhea, dysentery, bronchial problems, fever, snake bite, night blindness and liver tonic in the form of juice and paste.

In the present study, RFC values ranged from 0.13 to 0.93. The highest RFC was recorded for *Centella asiatica, Eclipta prostrata* and *Euphorbia hirta* each with 0.93. The ethnomedicinal plants species having high RFC values indicated their frequent uses and widespread knowledge among the local communities. High RFC values for a large number of species hinted that the reliance and belief on plant therapies is persistent in study area despite the modern medicine is imposed. The use of *Centella asiatica* as a tonic and urinary complaints was consistent to the findings of Dhami (2008) from the same district. Application of *Eclipta prostrata* in jaundice is common in Kanchanpur district (Dhami 2008, Present survey). Out of 56, the use reports for 41 species were matched with Dhami (2008) and 32 species with (Singh 2014). The highest number of common useful species, 62 between Bhatt and Shakya (2015) and present study was attributed by the studies carried out from the central part of Kanchanpur district. Plant based therapies are persistent in western Nepal for primary and local health care (Dhami 2008, Singh *et al.* 2012, Shakya 2014; Bhatt & Shakya 2015, Kunwar *et al.* 2016).

The ethnic people residing in different geographical belts of Nepal depend on wild plants to meet their basic requirements and all the ethnic communities have their own pool of secret ethnomedicinal and ethnopharmacological knowledge about the use of plants available in their surroundings, which has been serving rural people with its superiority. Despite the little development of rural health services, people of Kanchanpur district still use medicinal herbs to a large extent for the treatment of different diseases. Further, herbal medicines have shown lesser side effects, locally available and economically viable (Panthi & Singh 2013). To sum up, there is an urgent need of detailed investigation and documentation of indigenous knowledge about medicinal plants and therapies, which were being passed through oral process and apprenticeships.

Conclusions

Centella asiatica, *Eclipta prostrata* and *Euphorbia hirta* were popular medicinal plant species used in folklore of the study area. The knowledge on use of medicinal plants should be preserved and promoted to maintain an ecological balance within the environment. Similarly, documentation and preservation of biodiversity is necessary which could generate further research activities and help the upcoming generations in pursuing ethnobotanical knowledge.

Declarations

List of Abbreviation: Not applicable

Ethics approval and consent to participate: Permission for data collection was obtained from the chairperson of Bheemdatt -18 and oral agreements were obtained from local informants about the aims and objectives of the study prior to interviews and all field data were collected through their oral consents. No further ethics approval was required.

Consent for publication: This paper includes all original data so consent for publication is not required.

Availability of data and materials: The data are available from the authors upon request.

Competing interests: The authors declare that they have no competing interest among them.

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Authors' contribution: MDB carried out field work, collected data and identified plant species. RMK analyzed data and helped to prepare the draft for the manuscript. Both the authors participated in writing and giving feedback on the manuscript and approved the final version of the manuscript.

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Supplementary File 1. Ethnomedicinal Data Collection in Kanchanpur District

Date……

Demographic information

1. Name of (a) informant(s)…….. (b). Age……. (c) Sex: Male /Female (d) Residence Ward no.:..…… Tole:…….. (e) How long have you been living in this area?

i) Since 10 years ……ii) Since 30 years……. iii) Since 50 years……. iv) More than 50 years f) Main occupation……. Category :- Agriculture = 1; Services = 2; Business = 3; Student = 4; Wagelabour = 5; Other (Specify)……= 6

2. Ethnomedicinal knowledge of respondent on Medicinal plants.

Name of the plant		Use of plant species	Key of identification	Plant parts used									Mode of use
Local name	Scientific name			Whole plant	Root	Flower /seed	Root/ Leaves	Stem/ leaves	Root/ Stem	stem	Stem/ seed	Bark	

3. Ethnomedicinal knowledge of respondent on mode of application of medicinal plants.

Name of plant	Vernacular name	Scientific name	Mode of used					
			Juice	Juice/paste	decoction	Decoction/juice	Paste	Infusion

4. Why do you choose plants from that locality?

Ans……

5. Mostly which staged plants are preferred for harvest?

Ans…….

6. How can these plants be preserved?

Ans……..……

7. What are the responses of local users about the medicinal plants?

Ans…….

8. Which plants are commonly used for medicinal purposes?

Ans……

9. How traditional knowledge about medicinal plants has been transferring among the people?

Ans……

Supplementary File 2. Plant composition of study area with their frequency, density and Importance Value Index records

Scientific name	Family	Frequency	Relative Frequency (%)	Density (Plant/m^2)	Relative Density (%)	Importance Value Index	Presence of species in study sites
Hemigraphis hirta (Vahl)T. Anderson	Acanthaceae	3	15	1.42	0.69	15.69	1 & 2
Achyranthes aspera L.	Amaranthaceae	6	30	1.71	0.83	30.83	2
Alternanthera sessilis (L.) DC	Amaranthaceae	5	25	3.96	1.91	26.91	1 & 2
Centella asiatica (L.) Urban.	Apiaceae	2	10	0.08	0.04	10.04	2
Colocasia esculenta (L.) Schott.	Araceae	4	20	1.88	0.91	26.79	2
Ageratum conyzoides L.	Asteraceae	9	45	26.02	12.55	57.55	1 & 2
Eclipta prostrata L.	Asteraceae	7	35	7.18	3.46	38.46	1 & 2
Parthenium hysterophorus L.	Asteraceae	5	25	1.21	0.58	25.58	2
Spilanthes calva DC.	Asteraceae	3	15	4.00	1.93	16.93	1 & 2
Murdannia nudiflora (L.) Brenan.	Commelinaceae	4	20	0.69	0.33	20.33	2
Commelina benghalensis (L.)	Commelinaceae	2	10	3.03	1.46	11.46	1 & 2
Evolvulus nummularuis (L.) L.	Convolvulaceae	4	20	14.27	6.89	26.89	1 & 2
Cyperus miliifolius Peopp.& Kunth	Cyperaceae	7	35	4.55	2.20	37.20	1
Cyperus rotundus L.	Cyperaceae	6	30	4.96	2.39	32.39	1 & 2
Cyperus haspen L.	Cyperaceae	4	20	1.54	0.74	20.74	2
Cyperus brevifolius Rottb.	Cyperaceae	3	15	3.50	1.69	16.69	1 & 2
Cyperus difformis L.	Cyperaceae	3	15	1.60	0.77	15.77	1 & 2
Cyperus compressus L.	Cyperaceae	3	15	1.20	0.58	15.58	1 & 2
Fimbristylis miliacea (L.) Vahl.	Cyperaceae	3	15	0.29	0.14	15.14	2
Cyperus corymbosus Rottb.	Cyperaceae	3	15	0.25	0.12	15.12	2
Cyperus iria L.	Cyperaceae	3	15	0.07	0.03	15.03	1 & 2
Fimbristylis dichotoma (L.) Vahl.	Cyperaceae	2	10	0.88	0.42	10.42	1 & 2
Cyperus squarrosus L.	Cyperaceae	2	10	0.31	0.15	10.15	1
Cyperus flavescens L.	Cyperaceae	2	10	0.16	0.08	10.08	2
Equisetum hyemale L.	Equisetaceae	2	10	0.02	0.01	10.01	2
Eriocaulon cinereum R. Br.	Eriocaulaceae	6	30	6.46	3.12	33.12	1 & 2
Euphorbia hirta L.	Euphorbiaceae	3	15	0.22	0.11	15.11	1 & 2
Ajuga integrifolia Buch.-Ham.	Lamiaceae	5	25	2.38	1.15	26.15	1
*Clerodendrum viscosum*Vent.	Lamiaceae	5	25	0.23	0.11	25.11	2
Desmodium triflorum (L.) DC.	Leguminosae	8	40	14.99	7.23	47.23	1 & 2
Mimosa pudica L.	Leguminosae	5	25	0.79	0.38	25.38	2
Senna tora (L.) Roxb.	Leguminosae	4	20	1.07	0.52	20.52	2
Alysicarpus vaginalis (L.) DC.	Leguminosae	2	10	0.04	0.02	10.02	2
Saraca indica L.	Leguminosae	2	10	0.02	0.01	10.01	2
Sida acuta Burm. f.	Malvaceae	5	25	1.00	0.48	25.48	2
Corchorus tridens L.	Malvaceae	3	15	0.13	0.06	15.06	2
Sida cordifolia L.	Malvaceae	3	15	0.04	0.02	15.02	2

Sida rhombifolia L.	Malvaceae	2	10	0.11	0.05	10.05	2
Marsilea quadrifolia L.	Marsileaceae	3	15	2.15	1.04	16.04	2
Melia azedarach L.	Meliaceae	2	10	0.06	0.03	10.03	2
Mollugo pentaphylla L.	Molluginaceae	2	10	0.07	0.03	10.03	2
Syzygium cumini (L.) Skeels	Myrtaceae	3	15	0.02	0.01	15.01	2
Ludwigia perennis L.	Onagraceae	5	25	0.94	0.45	25.45	1
Oxalis corniculata L.	Oxalidaceae	3	15	1.88	0.91	15.91	1 & 2
Phyllanthus niruri L.	Phyllanthaceae	3	15	1.67	0.81	15.81	2
Phyllanthus urinaria L.	Phyllanthaceae	2	10	4.49	2.17	12.17	1 & 2
Peperomia pellucida (L.) Kunth.	Piperaceae	4	20	1.15	0.55	20.55	2
Piper longum L.	Piperaceae	2	10	0.04	0.02	10.02	2
Imperata cylindrica (L.) Raeusch.	Poaceae	10	50	40.11	19.35	69.35	1 & 2
Cynodon dactylon (L.) Pers.	Poaceae	5	25	6.69	3.23	28.23	1 & 2
Rottboelia exaltata L.f.	Poaceae	5	25	3.45	1.66	26.66	1
Digitaria sanguinalis (L.) Scop.	Poaceae	5	25	2.17	1.05	26.05	2
Chrysopogan aciculatus (Retz.) Trin.	Poaceae	5	25	1.63	0.79	25.79	2
Echinochloa glabrescens Munro ex Hook.f.	Poaceae	4	20	1.20	0.58	20.58	1
Echinochloa colona (L.) Link	Poaceae	4	20	0.87	0.42	20.42	1 & 2
Paspalum conjugatum P.J. Bergius	Poaceae	4	20	0.21	0.10	20.10	2
Eragrostis tenella (Retz.) Stapf	Poaceae	3	15	1.04	0.50	15.50	2
Setaria pumila (Poir.) Roem. &Schult.	Poaceae	3	15	0.21	0.10	15.10	2
Brachiaria mutica (Forssk.) Stapf.	Poaceae	3	15	0.17	0.08	15.08	2
Oplismenus burmanni (Retz.) Beauv.	Poaceae	2	10	4.46	2.15	12.15	2
Chloris radiata (L.) Sw.	Poaceae	2	10	0.73	0.35	10.35	1 & 2
Dactyloctenium aegypticum (L.) P.Beauv.	Poaceae	2	10	0.19	0.09	10.06	2
Brachiaria ramosa (L.) Stapf.	Poaceae	2	10	0.15	0.07	10.07	2
Eleusine indica (L.) Gaertn.	Poaceae	2	10	0.06	0.03	10.03	1
Ceratopteris thalictroides (L.) Brongn.	Pteridaceae	3	15	0.75	0.36	15.36	1 & 2
Cheilanthes tenuifolia (Burm.f.) Sw.	Pteridaceae	2	10	0.98	0.47	10.47	1
Zizyphus mauritiana Lam.	Rhamnaceae	2	10	0.21	0.10	10.10	2
Rosa alba L.	Rosaceae	2	10	0.04	0.02	10.02	2
Hedyotis corymbosa (L.) Lam.	Rubiaceae	4	20	2.94	1.42	21.42	1 & 2
Lindernia procumbens (Krock.) Borbas	Scrophulariaceae	6	30	4.42	2.13	32.13	1 & 2
Mecardonia procumbens (Mill.) Small	Scrophulariaceae	4	20	8.30	4.00	24.00	1 & 2
Lindernia oppositifolia (L.) Mukerjee.	Scrophulariaceae	3	15	0.75	0.36	15.36	1
Lippia nodiflora (L.) Michx.	Verbenaceae	3	15	0.52	0.25	15.25	1 & 2
Lantana camara var. *aculeata* (L.) Mol.	Verbenaceae	3	15	0.02	0.01	15.01	2