Ethnobotanical knowledge and plant use patterns among the major ethnic communities of Mahankal Rural Municipality, Lalitpur District, Central Nepal

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Research

Abstract

Background: Plant species and their traditional knowledge play a vital role in sustaining the livelihoods, culture and health of communities in Nepal. Although several ethnobotanical studies have been conducted across the country, systematic documentation at the local level and active conservation initiatives remain limited, particularly in rapidly urbanizing regions.

Methods: This study was conducted in Mahankal Rural Municipality of Lalitpur District, central Nepal to document local ethnobotanical knowledge and practices under various aspects. Field work was carried out during June-July 2024 using purposive sampling of 56 respondents representing diverse genders, age groups and ethnic communities. Data were collected through semi-structured interviews, focus group discussions and participatory field walks with key informants including traditional healers and elderly knowledge holders.

Results: A total of 98 plant species belonging to 54 families were recorded of which 58 species were medicinal, 19 used as fodder, 15 for cultural/religious purposes and 14 used in food items. Those medicinal species were used in treating 41 various ailments with leaves and whole plants as the most commonly used parts. Similarly, oral administration was the predominant mode of application and juice was the common form medicinal products administered to the body. Informant Consensus Factor (ICF) and Relative Frequency of Citation (RFC) analyses revealed strong agreement for treatments of neoplasms (ICF=0.95), poisoning (ICF=0.92) and reproductive disorders (ICF=0.89). This highlights the reliability and cultural significance of certain species such as *Zanthoxylum armatum, Ageratina adenophora* and *Mentha spicata*. Statistical analysis demonstrated that education level (χ^2=18.42, p<0.01) and ethnicity (χ^2=24.67, p<0.001) significantly influenced knowledge distribution with Tamang communities showing distinctly higher familiarity with medicinal applications compared to Brahmin and Chhetri groups. Ethnicity also significantly affected treatment preferences for gastrointestinal and respiratory ailments (p<0.05). Younger generations (<40 years) exhibited markedly reduced knowledge of traditional practices compared to elders (>60 years) (H=32.15, p<0.001).

Conclusions: The study highlights both the richness of ethnobotanical species and vulnerability of traditional knowledge and its transfer to future generations. Priority conservation attention is required for overexploited species including *Zanthoxylum*

armatum, Taxus wallichiana, Swertia chirayita and *Valeriana jatamansi*, which face habitat loss and unsustainable harvesting pressure in the study area.

Keywords: Ailments, Ethnomedicine, Indigenous knowledge, Informant consensus factor (ICF), Local healers, Non-timber forest products (NTFPs), Relative frequency of citation (RFC), Traditional practices

Background

Throughout evolutionary history, plants have become humans' indispensable component for survival. They have used it initially for food, shelter, and protection. This relationship even evolved as humans discovered therapeutic properties of plant extracts, leading to the development of traditional medicine and pharmacology (Rahman *et al.* 2019). Globally, around 3,91,000 vascular plant species are estimated to be found on earth among which 3,69,000 are flowering plants and 60,065 tree species. These includes 31,128 useful plant species from which 28,187 were used for medicinal purposes till 2016 (Dhyani 2020). Around 80% of the population from Africa alone and developing countries depend on traditional medicines (Shaikh *et al.* 2009, WHO 2002). Such indigenous traditional knowledge are transmitted either from family, relatives, neighbours, teachers or other resources such as books, internet, television (Turreira-García *et al.* 2017). However, cultural values, less access, high cost are still hindering for easy hands to modern medicines on the other side, modernization, land-use change and less interest on youth to traditional medicines are losing indigenous plant knowledge (Arjona-García *et al.* 2021, Paudyal *et al.* 2022). The management and transmission of traditional knowledge to new generations is crucial not just for the preservation of cultural heritage but also for the prevention of biodiversity loss (Sáenz-Arroyo *et al.* 2005).

Nepal, despite being land-locked and covering just 0.1% of Earth's land area, is most biodiverse countries in the world with 10,091 recorded plant species representing approximately 3.2% of global flora (GoN 2014). Nearly 2331 species are of medicinal and aromatic value (Kunwar *et al.* 2022) and over 161 non-timber forest products (NTFPs) are traded commercially (Subedi 2006). These species support the livelihoods and rural economies as well (Roy 2010, Subedi 2006). Ethnobotanical studies across Nepal have documented extensive traditional plant use among communities in the Himalaya and mid-hills (Kunwar & Bussmann 2008). However, such studies had revealed how modernization, deforestation, habitat loss and commercialization threaten these resources and associated cultural knowledge (Joshi & Joshi 2008, Bhattarai 2020). Species having high-value such as *Nardostachys jatamansi, Swertia chirayita* and *Taxus wallichiana* are increasingly endangered while *Zanthoxylum armatum* and *Cinnamomum tamala* which are culturally significant species are facing serious overexploitation (IUCN 2000).

Ethnobotanical knowledge in Nepal is deeply entangled with indigenous and ethnic communities. Local healers including *Amchi, Baidhya and Jhakri* continue to provide primary healthcare in remote and rural regions of Nepal (Bastakoti 2019). However, knowledge transfer is declining in these regions which may be due to formal education systems, alternative healthcare access and socio-economic transformation (Rinto *et al.* 2023; Sulaiman *et al.* 2024). Results of such activities demand to document community-specific plant knowledge before it disappears completely (Kutal *et al.* 2021). Recent research stresses that preserving traditional plant use not only sustains cultural heritage but also contributes to biodiversity conservation, climate adaptation and novel pharmacological discovery (Pieroni & Vandebroek 2007, Turner *et al.* 2000).

Older individuals often hold deeper accumulated experiential knowledge (Begossi *et al.* 2002; Koster *et al.* 2016) while younger generations tend to depend less on traditional healing due to shifting livelihood and healthcare (Kunwar & Bussmann 2008). Due to the traditional role, women frequently possess more knowledge of medicinal and food plants used in households whereas men dominate timber or ritual plant knowledge (Gomes *et al.* 2024). However, women were mastered in treating the reproductive and childhood ailments as well which makes them more competitive than male (Díaz-Reviriego *et al.* 2016). Similarly, formal schooling system haven't fully engaged community-based learning can paradoxically weaken traditional knowledge (Demssie *et al.* 2020). Thus, including socio-demographic attributes such as age, gender and education play a vital role in understanding the distribution and transmission of ethnobotanical knowledge.

Mahankal Rural Municipality (MRM) located in Lalitpur district of central Nepal, represents a microcosm of these complex dynamics. It is home to diverse communities of Tamang, Brahmin, Chhetri and other ethnic groups. These communities maintain diverse knowledge of wild and cultivated flora for medicine, culture and household use. In contrast, geographically proximate neighbouring Konjyosom Rural Municipality (KRM) differs as highly dominated by Tamang ethnic group (75.78%) followed by Brahmin (13.91%; Gautam *et al.* 2023) and covered with 68.9% of forest cover (DFRS 2018). These differences make MRM ecologically and culturally unique making an appropriate site for ethnobotanical research. Yet, despite the municipality's rich floristic diversity and dependence on traditional practices, systematic documentation of ethnobotanical

knowledge remains limited. This study was undertaken to systematically document the plant use patterns among the major ethnic communities of Mahankal Rural Municipality, Lalitpur, Central Nepal. Additionally, it evaluates the influence of major socio-demographic factors such as education, ethnicity, age, and gender on the distribution and transmission of ethnobotanical knowledge to inform future conservation and documentation efforts.

Materials and Methods

Study area

Mahankal Rural Municipality (MRM) is situated at 27°50' N latitude and 85°40' E longitude in the southeast of Lalitpur District in central Nepal (Fig. 1). Its elevation ranges from about 1,200 m to over 2,500 m above sea level and covers an area of 82.44 km² of which 83.1% is covered by forest area being highest in Lalitpur district (DFRS 2018). The mid-hill region falls under moderate to subalpine climate zone due to this altitudinal fluctuation. The *Schima-Castanopsis* forests predominate in sub-tropical while *Quercus-Rhododendron* forests in sub-alpine zone. The average annual rainfall is more than 1,200 mm while the winter temperature is 2.3 °C and the summer average is 26.4 °C (Mahankal RM 2018).

The area harvests plentiful medicinal and aromatic plants (MAPs) for local trade and traditional uses which includes *Swertia chirayita, Valeriana jatamansi, Zanthoxylum armatum and Aconitum* spp. According to the 2021 national census, MRM has a population of 8,122 among which majority are Tamang (49.1%) followed by Brahmin (39.3%), Chhetri (5.5%) and remaining are occupied by other minority groups such as Pariyar, Baram, Sunuwar, Newar, Bishwokarma and Magar (Mahankal RM 2018).

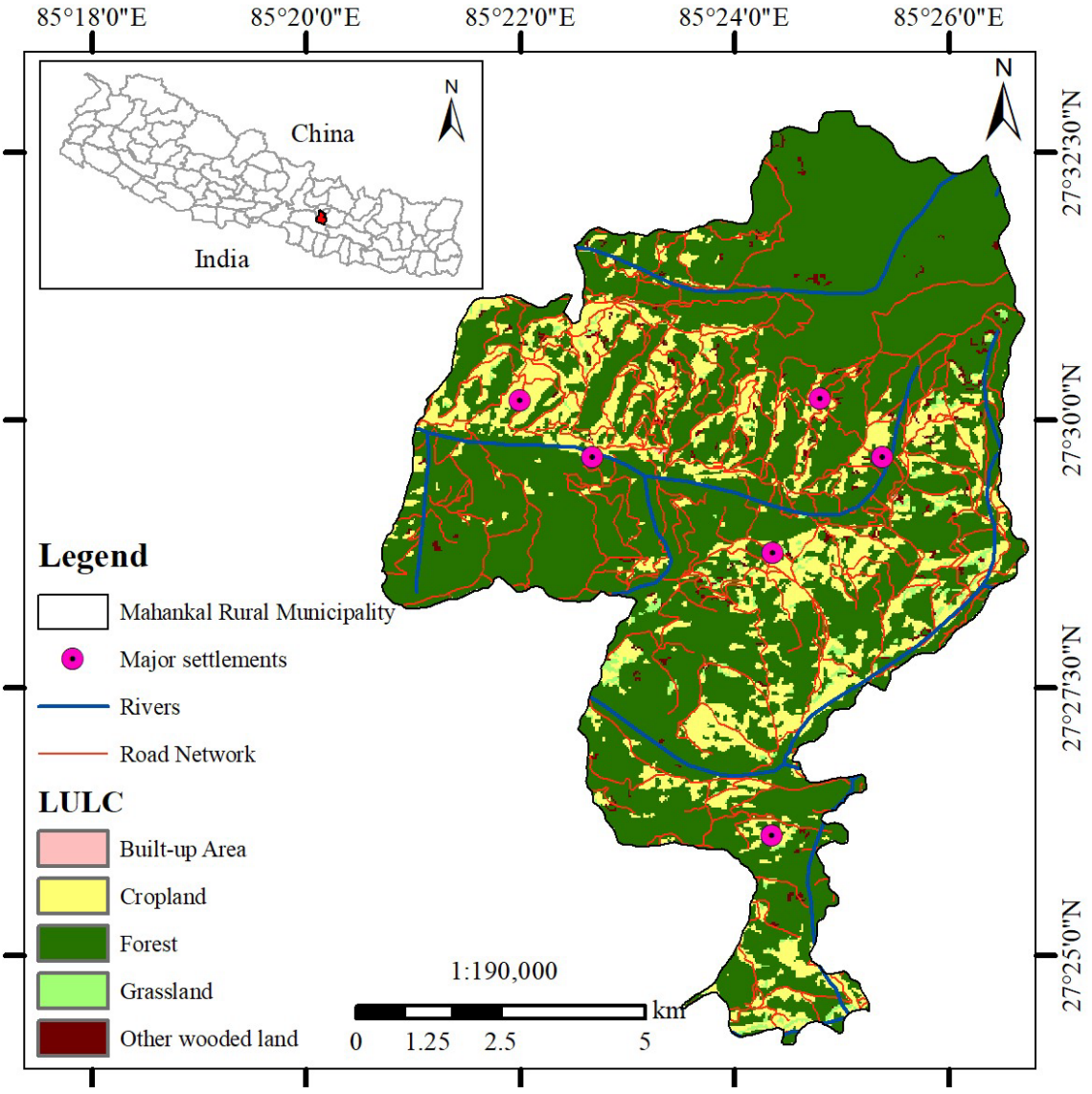

Figure 1. Mahankal Rural Municipality location in the geography of Nepal

Data Collection

A purposive sampling approach was used to select 56 respondents from households across Mahankal Rural Municipality during June- July 2024. This sample size has been considered sufficient in comparable studies across Nepal (Dulal *et al.* 2022; Kunwar *et al.* 2019; Uprety *et al.* 2010). Respondents were chosen based on their knowledge and experience on use of traditional plant regardless of gender, age and ethnicity. Respondents were identified through community recommendations, local healers' networks and consultation with ward chairman. Altogether 8 traditional healers and community elders were selected as key informants to ensure the reliability of ethnomedicinal information. The respondents were from Brahmin, Chhetri and Tamang from age ranging from 22 to 84 years. The age groups were then classified under 10 years interval as 20-30, 30-40, 40-50 and so on. The education level was categorized as literate and illiterate groups where literate was further categorized as secondary level and higher level.

Primary data were collected using participatory methods including semi-structured interviews, focus group discussions and key informant surveys. Semi-structured interviews were conducted with respondents to document plant identification, plants use, therapeutic purpose, preparation methods and cultural practices. Four Focus group discussions (FGDs) with 4-10 participants were organized to validate the responses and explore other essential themes such as seasonal availability and perceptions of plant efficacy. In addition, direct observation of plant collection, habitat and preparation practices were also recorded. Plant specimens were photographed, geo-referenced and recorded in field notes for subsequent verification including local names. The plant specimens were collected , carefully studied and identified with the help of (Joshi & Joshi 2008; Siwakoti & Varma 1999) which were crosschecked with the deposited specimens at Tribhuvan University Central Herbarium (TUCH). For the recent nomenclature, Plants of the World Online (POWO), (Shrestha *et al.* 2022) were taken as a reference material.

Data Analysis

Data were gathered and stored using Microsoft Excel 2016 and later pivoted as required by analysis. Descriptive analysis such as line chart, bar chart and pie-chart was created to summarize respondent demographics and ethnobotanical variables. To assess the cultural importance and degree of use-convergence of medicinal plants, quantitative ethnobotanical indices were calculated (Lulesa *et al.* 2025). Informant Consensus Factor (ICF) was applied using the formula as mentioned in equation (i).

$$ICF = (N_{ur} - N_t)/ (N_{ur} - 1)$$

where N_{ur} denotes the number of individual use reports in a given ailment category and N_t corresponds to the number of species used for that ailment, yielding values that indicate consensus among informants). Ailments were categorized under 12 groups with slight modification from (Heinrich *et al.*, 1998).

Similarly, Relative Frequency of Citation (RFC) was computed to determine the local significance of each plant species using the equation (ii).

$$RFC = FC/N$$

Where, FC is the number of informants that cites the use of a plant species, and N is the total number of informants. The RFC value ranges from 0 to 1, where a value of 0 indicates that none of the
respondents mentioned the species as useful while a value of 1 denotes that all informants cited the species for at least one use (Alexiades 1996).

The statistical analyses were performed in RStudio using R version 4.3.1. The bivariate analysis such as Chi-square tests were applied to assess associations between categorical variables (e.g., gender × knowledge domain; ethnicity × plant use), while Kruskal-Wallis tests were used to compare knowledge variation across variables such as education level and age groups. Similarly, Cluster Analysis using Jaccard similarity coefficients and Ward's method was used to group plants based on ethnomedicinal traits. Visualizations such as Sankey diagrams and Chord diagrams were also produced in RStudio to depict knowledge overlap and plant-use interconnections. Statistical significance was determined at a 95% confidence level ($p < 0.05$) for all analyses.

Results

A comparison of the present findings with previous ethnobotanical studies from Lalitpur District (Table 1) shows notable differences in taxonomic coverage, methodological detailing and socio-cultural documentation. Most of the studies were focused on ethnomedicinal plants only, whereas recent years studies had broadened its scope addressing demographic representation, primary traditional knowledge holders and knowledge transmission methods. The present study provides

ethnobotanically important species from Mahankal Rural Municipality (MRM) and provides detailed classification of ethnobotanical diversity, medicinal plants, plant parts used, preparation methods, ethnic groups involved and knowledge-holding patterns.

Table 1. Review of research on ethnobotany and ethnomedicine within Lalitpur district of Nepal comparing with recent study

Research	Shrestha & Joshi 1993	Maharjan *et al.* 2021	Gautam *et al.* 2022	Gautam *et al.* 2023	Nagarkoti & Joshi Shrestha 2022	Recent Study
Study area	Lele, Godawari Municipality	Laltipur	Bhardew, KRM	Konjyosom RM (KRM)	Shikharpa, Godawari Municipality	Mahankal RM
Date of study carried out	1989-1991	2020	2020-2021	2020-2022	NM	2024
Total ethnobotanical plant species	51	50	15	176	48	98
Total genus	49	47	15	158	47	90
Total families	31	6	13	82	33	54
Medicinal plants (no. of species)	51	50	15	176	48	57
Ailment categories documented	14	NC	NC	13	Categorized only by effectiveness of MPs used for curing the ailment	12
Plant part(s) used	C (7)	C (12)	C (8)	C (16)	C (10)	C (16)
Mode of preparation	C (5)	NC	C (5)	C (8)	C (8)	C (8)
Ethnic groups using plants	NM	NM	NM	Tamang	Pahari	Tamang, Chhetri, Brahmin
Primary knowledge holders	NM	NM	NM	Elder, Female	Elder	Elders, Female

*****C = Categorized, NC = Not Categorized, NM = Not Mentioned

Demographic 0verview

Among the 56 respondents, 28.57% were male and remaining female respondents dominated by 71.43%. It is clear that majority of respondents belong to Tamang community from both male and female categories where female Brahmins had not participated (Fig. 2). Respondents were dominated by Tamang ethnic groups with 67.86% followed by Chhetri (25%) and Brahmin (7.14%).

Similarly, the majority of the respondents were middle-aged from 30-40 years old (30.36%) and 40-50 years old (23.21%) with mean age being 48 years. The least age grouped respondents were from 60-70 and 80-90 years old accounting 8.93% each, and 20-30 and 70-80 years old (7.14% each). The response shows that literate respondents were slightly more than half (53.57%) of total from school level to bachelor level while the traditional knowledge was most commonly preserved (46.43%) among older, less formally educated individuals. 75% of the respondents rely on agriculture and livestock farming followed by 8.93% working on private institutions while remaining respondents were government employee, teachers and astrologist. 67.86% of the respondents in that area haven't received any training on cultivation, propagation, pest controls and harvesting while 19.64% have been trained to vegetable farming followed by plant propagation (Himalayan Yew; 10.71%) and pest control (1.79%).

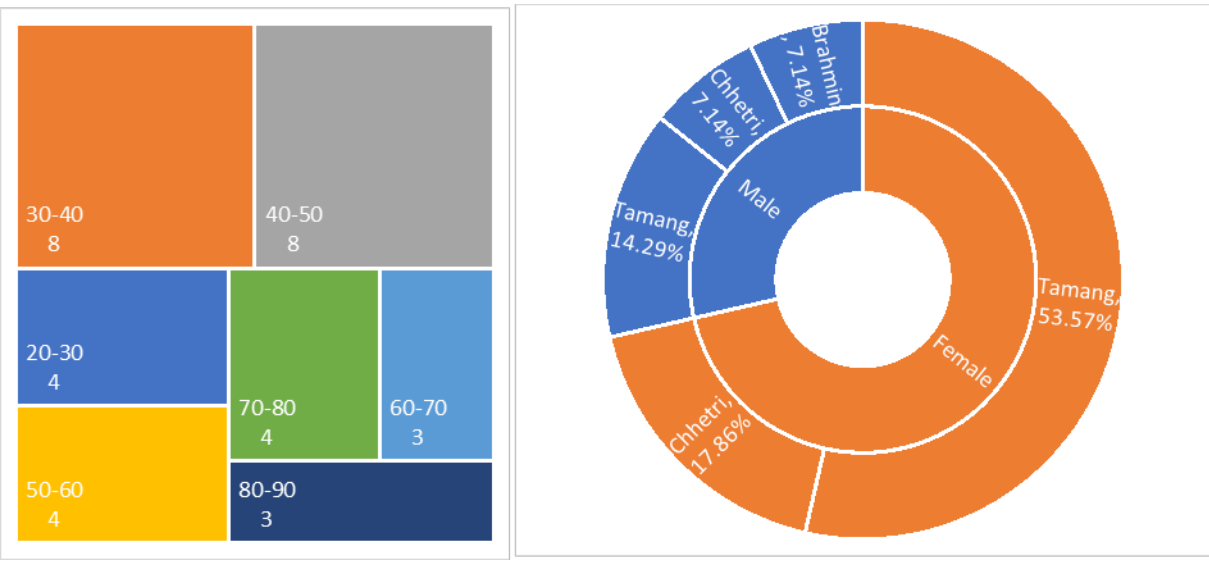

Figure 1. Demographic insights of respondents indicating (a) Age-group classification and (b) Sex and ethnicity distribution

Relation between socio-demographic characteristics and ethnobotanical knowledge

A chi-square test revealed no statistically significant association of treatment preference (hospital-based vs. traditional) between gender, age group and educational attainment ($p > 0.05$). However, treatment preference differed significantly across ethnic groups ($\chi^2=6.72$, $p = 0.03$) suggesting that cultural identity plays a role in determining reliance on traditional remedies.

Similarly, transmission of knowledge regarding medicinal plants was significantly influenced by only education level ($\chi^2 = 155.7$, $df = 108$, $p < 0.01$) indicating a tendency for differential knowledge retention or accessibility across educational strata. Figure 3 depicts the community demography distribution and their preference to ethnobotanical knowledge.

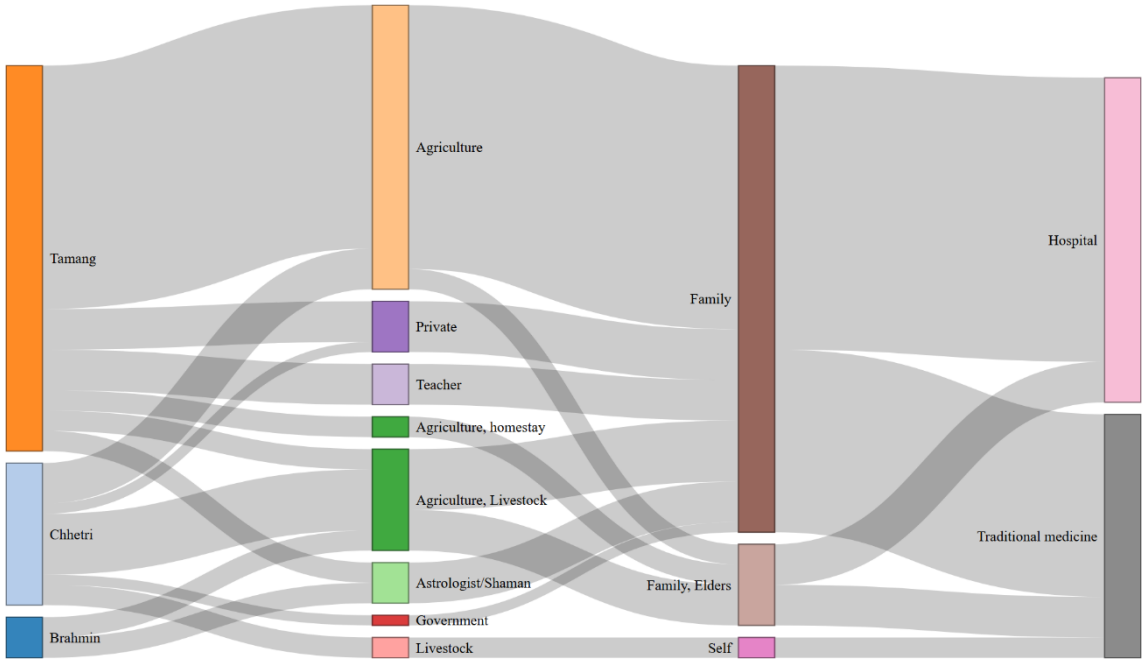

Figure 3. Demographic overview and its flow channel on ethnobotanical knowledge transfer and treatment preference

Ethnobotanical diversity

A total of 98 ethnobotanically significant plant species belonging to 54 families were recorded from Mahankal Rural Municipality (Table 2). The most represented families were Poaceae followed by Asteraceae reflecting a dominance of grasses and composite herbs typical of the midhills of Lalitpur (Fig. 4).

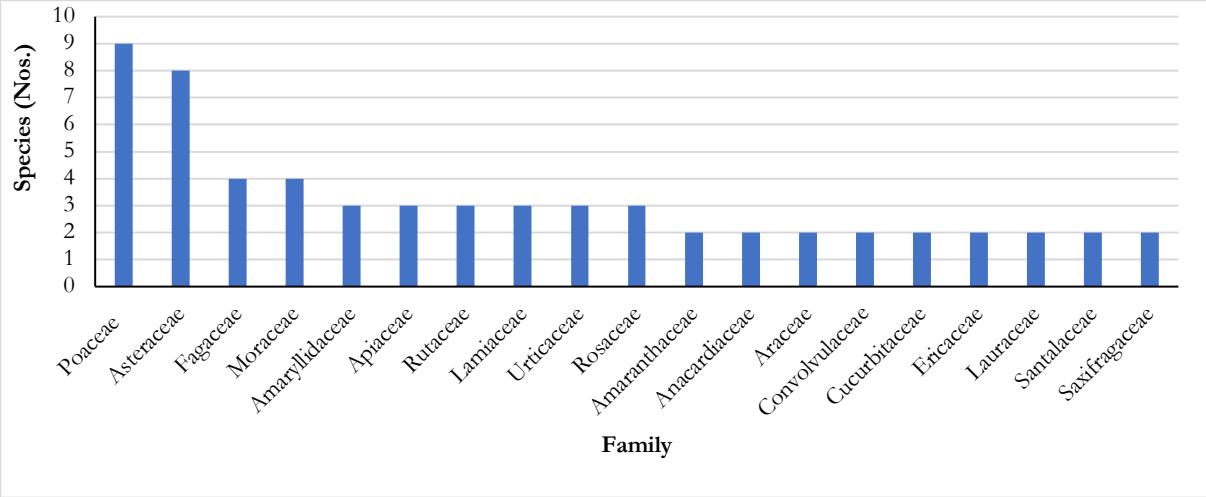

Figure 4. Distribution of dominant families of plants documented in the ethnobotanical survey

Habitat assessment revealed that 57.14 % of these 98 species were sourced from the wild followed by 34.69 % were cultivated at gardens or/and agricultural fields. The remaining 8.16 % plant species were found in both conditions (Fig. 5a). Herbs were maximum consumed life forms with 41.84% followed by trees (33.67%), shrubs (9.18%) and grasses (8.16%). Climbers and mushrooms were used in various field by just 7.14% together (Fig. 5b).

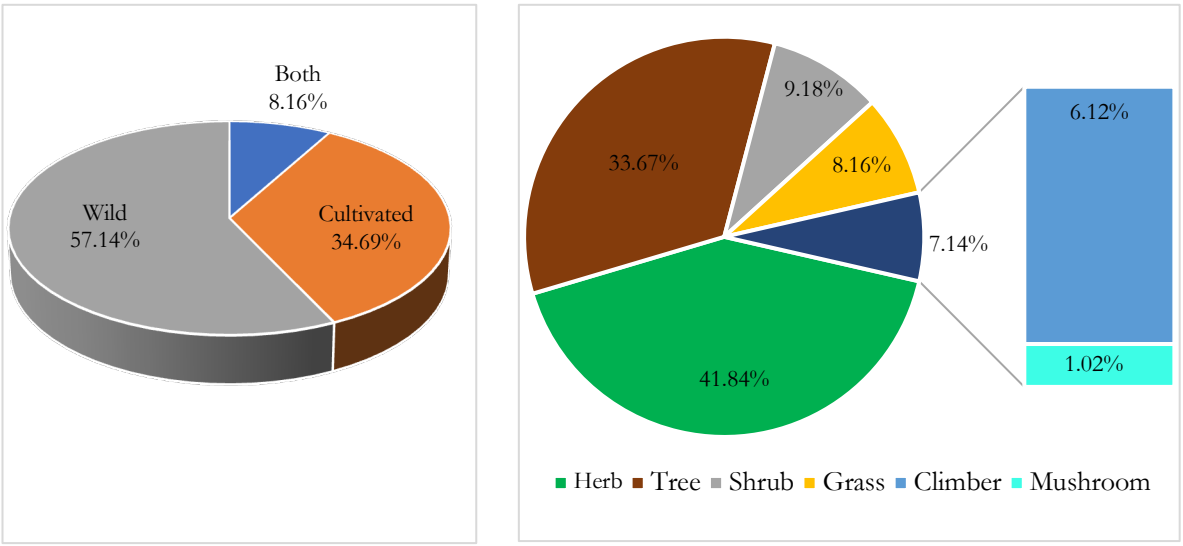

Figure 5. (a) Habitat of plants used and (b) life forms of plants used recorded during the survey

Different ethnobotanical use

Medicinal use

Among the recorded species 59.18% is of medicinal use (Table 3). These plants were used to treat 41 human ailments categorized under 12 broad disease groups frequently reporting gastrointestinal, respiratory, musculoskeletal, integumentary and general health conditions. In regard to the parts of plants used for treatment, leaves and whole plants were predominantly utilized in ethnomedicinal preparations (Fig. 6). All plant's parts are also used as medicine without leaving a trace (8 species) along with other parts only such as tuber, seeds, twigs and fruits. These medicines can be prepared in many forms such as paste, powder, juice and decoction but in this study, 22.41% of ethnomedicine is used in raw form followed by juice (17.24%) and decoction (15.52%). The mode or route of proper administration of such ethnomedicines were 71% by oral administration and 26% by topical and remaining 3% are taken by either topical or inhalation or orally. Despite having such diversity in plants and treatment process, only 42.86% of respondents used traditional medicines while remaining 57.14% prefer hospital and its services. The overall flow of use of plant species, its parts, forms and mode are illustrated in figure 7.

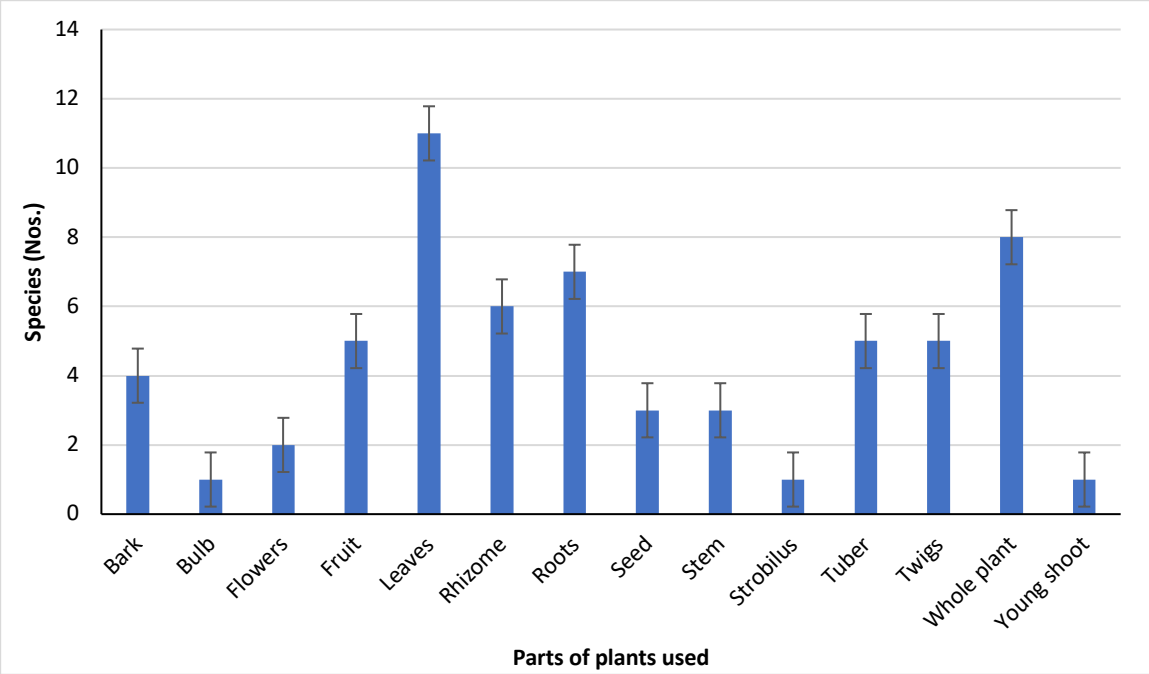

Figure 6. Parts of plants that are used to prepare the medicinal products by local people

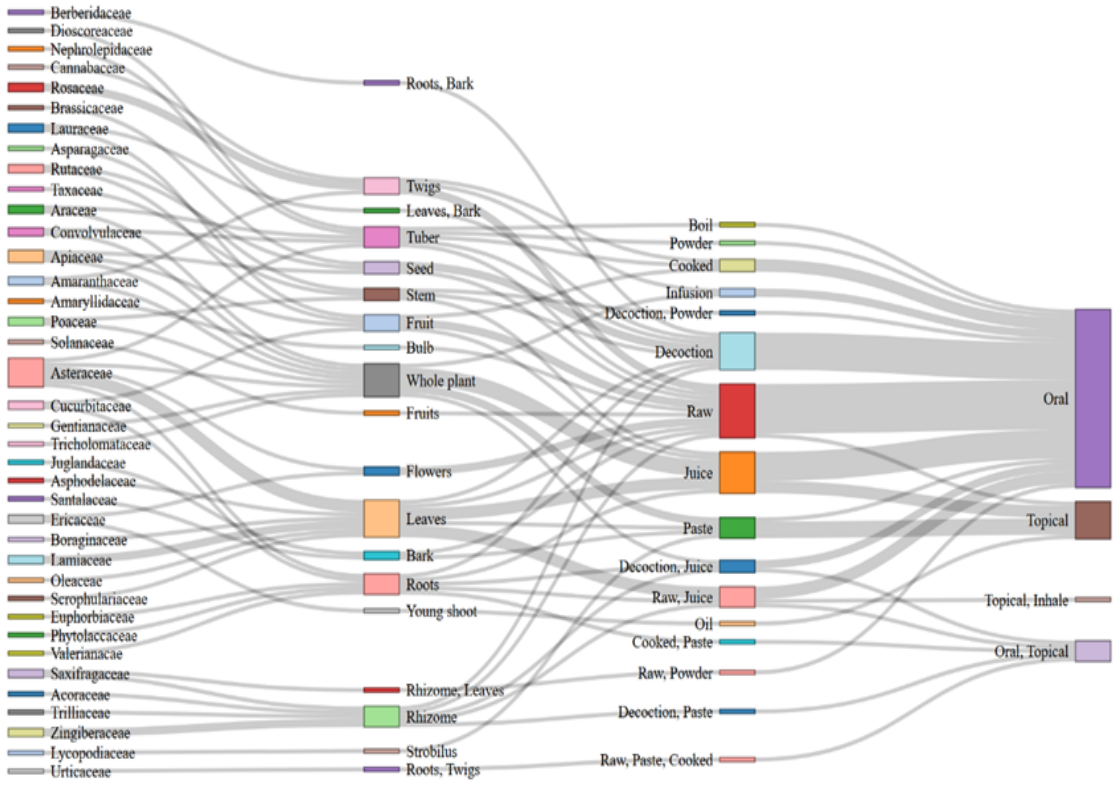

Figure 7. Visualization of ethnomedicinal flow from plant family to plant part, product form, and mode of application indicating plant knowledge among respondents where oral mode of intake is more used by the raw form of plant products

The Informant Consensus Factor (ICF) value was calculated for 12 ailment categories where it ranged from 0 to 1 (Lulesa *et al.* 2025, Fig. 8). ICF suggested that very high intra-cultural agreement on plant use in the categories of neoplasm, poisoning and reproductive disorders (ICF = 1.0) indicating that few plant species were consistently relied upon for specific treatments. The low value for genitourinary and cardiovascular diseases shows that disagreement and lack of communication among local practitioners regarding the use of those plant species for the treatment.

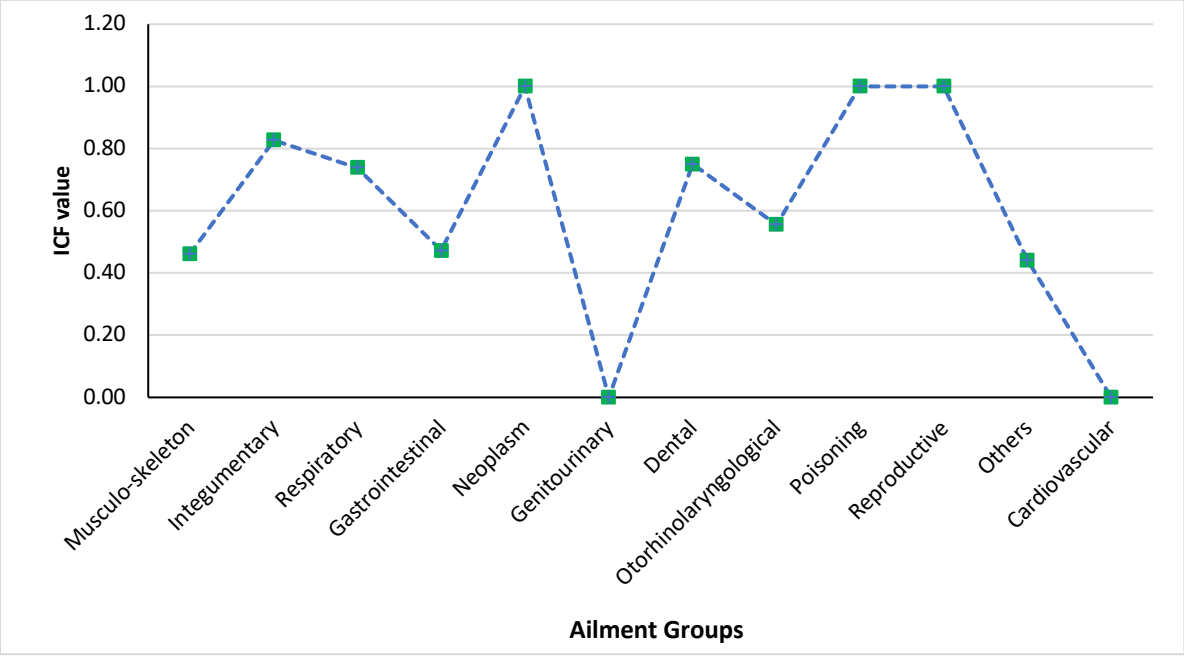

Figure 8. Informant Consensus Factor by Ailment Category

Similarly, the value of RFC ranges from 0.002 to 0.077 with the highest value obtained from *Zanthoxylum armatum* (0.077) followed by *Ageratina adenophora* (0.051) and *Mentha spicata* (0.044) as the most culturally valued species among respondents. The lowest value was obtained from 15 plant species such as *Cirsium verutum, Termitomyces* sp.*, Smallanthus sonchifolius, Persea americana* and *Galinsoga parviflora* with value 0.022 for all. Based on the survey, *Zanthoxylum armatum* (timur) is frequently used for toothache, stomach disorders, and common colds where its fruits are chewed raw or prepared as decoctions. Its aromatic pericarp also serves as a spice and oral cleanser. *Ageratina adenophora* (Banmara), despite being an invasive species, is widely applied for wound healing and skin infections. Fresh leaves are crushed into a paste and applied topically to stop bleeding. *Mentha spicata* (Pudina) is primarily used for digestive ailments such as stomach pain, gas, and nausea where leaves are consumed as tea or fresh juice for immediate relief worldwide.

Other ethnobotanical uses

Among the total recorded species, 19 (15.32%) were used as fodder followed by 15 (12.10%) used for cultural/religious purposes such as *Artemisia dubia, Ocimum tenuiflorum* and *Ficus religiosa.* Similarly, 14 species were used in food items such as pickle making (*Mentha spicata, Cymbopogon citratus),* spice use (*Zanthoxylum armatum, Cinnamomum tamala, Allium wallichii*) and aromatics for tea (*Rosmarinus officinalis*) while 13 species (10.48%) were use as fuelwood including *Taxus wallichiana, Quercus lanata* and *Alnus nepalensis*. *Ficus semicordata, Castanopsis indica, Quercus glauca* and *Pennisetum purpureum* are used for livestock fodder and *Arundinaria falcata* is used for mat and craft production.

Discussion

Socio-demographic and ethnobotanical knowledge

The majority of respondents were women aged 30-50 years, suggesting that females remain central in maintaining and transmitting ethnobotanical knowledge in Mahankal. Although statistical analysis revealed no significant gender- or age-based differences in knowledge distribution, education level significantly influenced plant recognition. A similar pattern was reported from Himalayan communities by Kunwar & Bussmann (2008). This contrasts with studies elsewhere that emphasized women's role as primary custodians of ethnomedicinal knowledge helping in transferring to generations (Quinlan & Quinlan 2007). Ethnic differences in treatment preference suggest that cultural identity remains an important determinant of reliance on traditional medicine, as seen in other multi-ethnic regions of Nepal. Despite having 55% of male respondents in the Changunarayan area of Bhaktapur, their knowledge on plants were limited significantly than female who made their livelihood interacting with plants for various purposes (Dulal *et al.* 2022). Similarly, Kunwar *et al.* (2019) also found that women are rich in traditional knowledge on ethnobotany and also on identifying the plants used than male even in Far-western region of Nepal. The higher representation of female and Tamang ethnic group respondents in our study, thus, reflect them as important indicator influencing ethnobotanical transmission pathways.

Such traditional knowledge continues to be transmitted orally, primarily by elderly women. However, migration, socio-economic change, and declining youth interest threaten this process (Manandhar 1995, Siwakoti *et al.* 2005). Similar concerns have been raised across South Asia, where modernization and access to biomedical care accelerate the erosion of ethnobotanical and traditional knowledge and practices (Bhattarai 2020, Joshi & Joshi 2008).

Ethnobotanical diversity and medicinal uses

This study documented 98 ethnobotanically important plant species of which 58 were of medicinal importance. Such diversity reflects the rich ecological setting and strong cultural reliance of communities of Mahankal on plant resources, comparable to other mid-hill and Himalayan communities in Nepal (Bhattarai 2020, Luitel *et al.* 2014, Manandhar 1990, Nepal 1999). The predominance of Poaceae and Asteraceae families as well as the dominance of herbs, reflects the similar patterns reported across Nepal in ethnobotanical studies (Adhikari *et al.* 2019, Bhandari *et al.* 2023, Gautam *et al.* 2023, Rokaya & Ghimire 2004). Their dominance may be due to their wide availability, high bioactive potential and ease of collection (Bessada *et al.* 2015, Vojvodić 2025). Similar finding was observed in ethnobotanical studies in various places in Nepal such as Dolpa (Rokaya & Ghimire 2004) and Ilam (Bhattarai 2020). Over half of the species were collected from the wild underscoring local communities' dependence on surrounding forests. This reliance on wild flora is both a cultural asset and a conservation concern with a high-demand species such as *Taxus wallichiana* and *Paris polyphylla*, which are regionally threatened (IUCN 2000). Among the 1,291 species belonging to 108 families and 357 genera of mushroom found in Nepal, 159 were found to be edible, 74 were medicinal and 100 were poisonous (Devkota & Aryal 2020). Mushroom species of *Termitomyces* are widely used both for food source and ethno-medicinal purposes across indigenous communities in tropical to temperate regions of Nepal (Aryal & Budhathoki 2013). However, no such food poisonings were recorded in the study area during the survey.

The predominance of medicinal plants indicates that traditional medicine continues to play a vital role in primary healthcare, even in peri-urban areas with increasing access to modern health services (Rokaya *et al.* 2010, Shrestha & Dhillion 2003). The use of 59.18% of plant species for medicinal purposes treating 41 ailments commonly using leaves and roots as the aligns with the earlier findings from central and eastern Nepal (Luitel *et al.* 2014, Rokaya *et al.* 2010). Similarly, while the domination of oral administration of such medicinal products, the prevalence of decoctions and paste used are also common practices along with juices and raw preparations. These traditional practices are widely used for treating many diseases and health conditions related to cough, bones, obesity and are reported across Nepal (Kunwar & Bussmann 2008).

Swertia chirata was used in curing fever in the present study which is supported by the study of Pandey (2006) whose finding also revealed its use in controlling fever along with jaundice, indigestion, cough, cold, blood and gall bladder problems. The traditional use of the flower (corolla/petals) of *Rhododendron arboreum* to help dislodge food or fish bones stuck in the throat in the present study is similar to other study as well (Gautam *et al.* 2023, Oli 2003, Shrestha & Dhillion 2003). The current study had reported the use of *Cynodon dactylon* for the treatment of cuts and wounds while Ghimire (2016) reported its use for the treatment of fever and pneumonia too. Raji ethnic group used wood ash, cow's urine and neem (*Azadirachta indica*) juice to control a kind of aphid (Lahi) in vegetables (Poudel 2015), similarly this study found that Tamang ethnic group used a mixture of cow's urine and *Artermisia dubia* (titepati) to control insect and pest. A total of 111 plant species were documented from Makwanpur District with detailed accounts of their ethnomedicinal uses, plant parts employed and preparation methods (Adhikari, 2020). Notably, Adhikari (2020) reported that the whole plant of *Valeriana jatamansi* is traditionally used for medicinal purposes. In contrast, our findings indicate that only the roots are utilized in treatment practices highlighting variations of ethnomedicinal knowledge across communities.

Cultural consensus and key species

High Informant Consensus Factor (ICF) values for neoplasms, poisoning, and reproductive disorders indicate that these remedies are well-established within the community and are common health practices (Heinrich *et al.* 1998, Trotter & Logan 1986). Similar patterns of high consensus for reproductive and gastrointestinal ailments have been documented in Tamang communities of Makwanpur (Luitel *et al.* 2014) and in high-altitude Himalayan groups where herbal remedies remain essential due to limited alternatives (Kunwar & Bussmann 2008). Conversely, low ICF values for cardiovascular and genitourinary issues reflect variability in local practices and possibly a shift toward medical treatments for such conditions. Such growing reliance in peri-urban settings like Mahankal area may be due to the improved facility of transportation and faster access to medicals, health posts, hospitals and clinics than previous years.

Relative Frequency of Citation (RFC) highlighted *Zanthoxylum armatum*, *Ageratina adenophora*, and *Mentha spicata* as the most culturally significant species. These species are widely used for common ailments such as stomach pain, fever and colds,

and their accessibility enhances their value. Comparable findings of high cultural salience for *Taxus wallichiana* and *Paris polyphylla* in mid-hills of Lalitpur and other districts from Central Nepal (K.C. 2021) highlight the shared reliance on medicinal plants across Nepal. High-RFC species represent opportunities for both sustainable harvesting and local value addition, linking biodiversity conservation with livelihood enhancement (Pieroni & Vandebroek 2007). However, the several species with high-RFC points to the urgent need for conservation and sustainable management.

Other uses and cultural continuity

Along with medicinal use, many species are essential in human societies serving essential cultural, domestic and livelihood purposes. Ritual plants such as *Ficus religiosa* and *Ocimum tenuiflorum* acting as central symbols of purification and protection. *Ficus religiosa* (peepal) is worshipped daily and during major rituals like Satya Narayan Puja and Buddha Jayanti, where its leaves are offered as sacred tokens of life and fertility. *Ocimum tenuiflorum* (tulsi) is planted in household courtyards and used in morning prayers, its leaves considered auspicious and medicinally purifying. These species reinforce cultural continuity and spiritual practices, similar to findings among the Newar and Pahari communities (Balami 2004, Nagarkoti & Shrestha 2022). Multipurpose species such as *Ficus semicordata* and *Quercus glauca* (fodder), *Quercus lanata* and *Alnus nepalensis* (fuelwood), and *Arundinaria falcata*, *Cymbopogon citratus* (household crafts) emphasize the inseparability of ecological and cultural knowledge aligning with ethnobotanical studies in Bhaktapur and Suryabinayak (Bhaila *et al.* 2022). Such multifunctionality highlights the essence of local floras affecting human lifestyle. Furthermore, Adhikari (2020) emphasized the importance of preserving and acknowledging such traditional practices so that future generations may continue to benefit from validated treatments

Limitation, conservation implications, and future directions

During this study, verbal consent was only used to respect literacy and cultural sensitivities. This might limit formal accountability and data traceability. Therefore, future ethnobotanical research should encourage written or audio-recorded consent wherever possible and ensure transparent communication of participants' rights and benefit-sharing which align with the Nagoya Protocol to uphold ethical integrity and community trust.

Promoting cultivation of high-RFC species such as *Zanthoxylum armatum, Taxus wallichiana, and Paris polyphylla* through community nurseries can reduce extraction pressure and create livelihood opportunities. Yet, current nurseries in Mahankal remain poorly supported, constrained by limited land, technical guidance and weak market access. Thus, strengthening nursery networks and developing species-specific propagation and rotational harvesting guidelines through forest user groups could enhance both biodiversity and income generation eventually, uplifting livelihood.

Future initiatives should integrate youth engagement and intergenerational learning, enabling local stewardship of ethnobotanical knowledge. Research should further examine how socio-economic change affects knowledge retention and focuses on the ecological sustainability of cultivated medicinal species. Safeguarding this knowledge requires urgent documentation and revitalization through community registers, integration into local curricula, and participatory conservation programs (Cunningham 2001, Turner *et al.* 2000).

Conclusion

This study documented 98 ethnobotanically important plant species belonging to 54 families used by the ethnic communities of Mahankal Rural Municipality, Lalitpur which demonstrate its high dependence for medicinal, cultural, fodder, fuelwood and subsistence needs. Of these, 58 plant species were utilized for medicinal purposes treating 41 human ailments along with a high reliance on wild-sourced species only (57.14%). These findings highlight the multifunctional role of plant resources in local livelihoods and its ecological importance.

Leaves and whole plants were the most commonly harvested, and the most common route of administration was oral (71%) which reflect this practice is widely reported across Himalayan ethnobotanical traditions. Quantitative ethnobotanical indices further revealed high Informant Consensus Factor (ICF = 1.0) for reproductive disorders, poisoning and neoplasm, indicating well-established medicinal practices. Similarly, Relative Frequency of Citation (RFC) identified *Zanthoxylum armatum, Ageratina adenophora,* and *Mentha spicata* as key species deserving priority for community-level conservation and sustainable utilization. These both indices reflect the cultural significance and therapeutic reliability of traditional remedies.

Despite the use of 58 medicinal plants, the study reveals a critical vulnerability in ethnobotanical knowledge transmission. The traditional ethnobotanical knowledge was found to be concentrated among elder people and women, while statistical

analysis demonstrates that ethnic group significantly influences treatment preference and education level strongly affects knowledge transfer. Due to no proper transfer of such knowledge and practices, it is at risk of rapid decline.

Based on these findings, targeted and operational conservation measures are required. Clear guidelines of species-specific sustainable harvesting, propagation and rotational cultivation can be co-developed with local forest user groups to reduce extraction pressure on wild populations of culturally and ecologically important species such as *Zanthoxylum armatum* and *Mentha spicata*. Ultimately, structured intergenerational knowledge transfer will only be sustainable if the youths and traditional knowledge holders get actively involved encouraging proactive youth engagement through intergenerational training workshops and strengthen local livelihoods and biodiversity conservation in Mahankal Rural Municipality.

Declarations

List of abbreviations: FGDs: Focus group discussions, ICF: Informant Consensus Factor, MRM: Mahankal Rural Municipality, NTFPs: Non-timber forest products, POWO: Plants of the World Online, RFC: Relative Frequency of Citation, TUCH: Tribhuvan University Central Herbarium.

Ethics approval and consent to participate: We obtained verbal consent from all participants before beginning the ethnobotanical study.

Consent for publication: Not applicable

Availability of data and materials: The data were used to generate the diagrams and analyse them can be provided upon request to corresponding author(s).

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Author contributions: A.B. and N.P.G. designed the overall strategy of the study and the questionnaires for the ethnobotanical survey. A.B. conducted fieldwork and collected plant specimens to prepare the herbarium identification and identified plants. A.B. and B.T. processed the survey data and interpreted the data. A.B. wrote the initial manuscript which was further reviewed and edited by B.T. All authors read, revised and approved the final manuscript.

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Table 2. Detailed ethnobotanical information based on use and type of plant species

Scientific Name	Family	Local Name	Life Form	Use Category	Specimen Number
Achyranthes aspera L.	Amaranthaceae	Datiwan	Herb	Medicinal	MRM-01
Acorus calamus L.	Acoraceae	Bojho	Herb	Medicinal	MRM-02
Aegle marmelos (L.) Correa	Rutaceae	Bel	Tree	Cultural / Religious	MRM-03
Ageratina adenophora (Sprengel) R. M. King & H. Robinson	Asteraceae	Kalejhar	Herb	Medicinal	MRM-04
Allium ascalonicum L.	Amaryllidaceae	Chhyapi	Herb	pickle	MRM-05
Allium sativum L.	Amaryllidaceae	Lasun	Herb	Medicinal	MRM-06
Allium wallichii Kunth,	Amaryllidaceae	Jimbu	Herb	Spice	MRM-07
Alnus nepalensis D. Don,	Betulaceae	Utis	Tree	Fuelwood	MRM-08
Aloe vera (L.) Burm. f.	Asphodelaceae	Ghiu kumari	Herb	Medicinal	MRM-09
Artemisia dubia Wall. ex Besser,	Asteraceae	Titepati	Herb	Medicinal, Cultural / Religious	MRM-10
Arundinaria falcata (Nees)	Poaceae	Nigalo	Grass	Crafts (Doko, dalo), fence	MRM-11
Asparagus racemosus Willd.	Asparagaceae	Kurilo	Climber	Medicinal	MRM-12
Astilbe rivularis Buch.-Ham. ex D. Don	Saxifragaceae	Thulo okhati	Herb	Medicinal	MRM-13
Bauhinia variegata L.	Fabaceae	Koiralo	Tree	Pickle	MRM-14
Berberis asiatica Roxb. ex DC.	Berberidaceae	Chutro	Shrub	Medicinal, Fuelwood	MRM-15
Bergenia ciliata (Haw.) Sternb.	Saxifragaceae	Pakhanved	Herb	Medicinal	MRM-16
Boehmeria rugulosa Wedd.	Urticaceae	Daar	Grass	Fodder	MRM-17
Brassica juncea (L.) Czern.	Brassicaceae	Chinne ko saag	Herb	Pickle	MRM-18
Buddleja asiatica Lour.	Scrophulariaceae	Bhimsen pati	Tree	Medicinal	MRM-19
Cannabis sativa L.	Cannabaceae	Ganja	Herb	Medicinal, Cultural / Religious	MRM-20
Castanopsis indica (Roxb.) Miq.	Fagaceae	Katus	Tree	Fodder	MRM-21
Centella asiatica (L.) Urb.	Apiaceae	Ghodtapre	Herb	Medicinal	MRM-22
Chenopodium album L.	Amaranthaceae	Bethe	Herb	Medicinal, Fodder	MRM-23
Cinnamomum tamala (Buch.-Ham.) Nees & Eberm.	Lauraceae	Tejpat	Tree	Medicinal, Tea fragrance, spice	MRM-24
Cirsium verutum (D. Don) Spreng.	Asteraceae	Thakal	Herb	Medicinal	MRM-25
Citrus limon (L.) Burm. f.	Rutaceae	Kagati	Tree	Medicinal, Tea, flavoring	MRM-26
Colocasia esculenta (L.) Schott	Araceae	Pidalu	Herb	Medicinal	MRM-27
Coriandrum sativum L.	Apiaceae	Dhaniya	Herb	Medicinal, Pickle, spice	MRM-28
Curcuma longa L.	Zingiberaceae	Besar	Herb	Medicinal	MRM-29
Cuscuta reflexa Roxb.	Convolvulaceae	Akashbeli	Climber	Medicinal	MRM-30
Cymbopogon citratus (DC.) Trin.	Poaceae	Lemon grass	Grass	Tea fragrance	MRM-31
Cynodon dactylon (L.) Pers.	Poaceae	Dubo	Grass	Medicinal, Cultural / Religious	MRM-32

Cynoglossum zeylanicum (Vahl ex Hornem.) Thunb. *ex Lehm.*	Boraginaceae	Kuro	Herb	Medicinal	MRM-33
Debregeasia longifolia (Buem.f.) Wedd.	Urticaceae	Tusaro	Shrub	Fodder	MRM-34
*Desmostachya bipinnata (*L.) Stapf	Poaceae	Kush	Grass	Cultural / Religious	MRM-35
Dioscorea bulbifera L.	Dioscoreaceae	Ban tarul	Climber	Medicinal	MRM-36
Edgeworthia gardneri (Wall.) Meisn.	Thymelaeaceae	Argeli	Shrub	Fodder	MRM-37
Euphorbia hirta L.	Euphorbiaceae	Akhlejhar	Herb	Medicinal	MRM-38
Eurya acuminata DC.	Pentaphylacaceae	Jhingane	Tree	Fuelwood	MRM-39
Euryops spp	Asteraceae	Pahelo phool	Shrub	Medicinal	MRM-40
Ficus auriculata Lour.	Moraceae	Timilo	Tree	Fodder	MRM-41
Ficus benghalensis L.	Moraceae	Bar	Tree	Cultural / Religious	MRM-42
Ficus religiosa L.	Moraceae	Peepal	Tree	Cultural / Religious	MRM-43
Ficus semicordata Buch.-Ham. ex Sm.	Moraceae	Duto	Tree	Fodder	MRM-44
Foeniculum vulgare Mill.	Apiaceae	Saunp	Herb	Medicinal	MRM-45
Galinsoga parviflora Cav.	Asteraceae	Chitlange jhar	Herb	Medicinal	MRM-46
Gaultheria fragrantissima Wall.	Ericaceae	Dhasingare	Shrub	Medicinal, Cultural / Religious	MRM-47
Imperata cylindrica (L.) P. Beauv.	Poaceae	Siru ghans	Grass	Fodder	MRM-48
Ipomoea batatas (L.) Lam.	Convolvulaceae	Sakharkhanda	Herb	Medicinal	MRM-49
Jasminum humile L.	Oleaceae	Jai phool	Shrub	Medicinal	MRM-50
Juglans regia L.	Juglandaceae	okhar	Tree	Medicinal	MRM-51
Juniperus sp.	Cuppresaceae	Dhupi	Tree	Cultural / Religious	MRM-52
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	Dabdabe	Tree	Fuelwood	MRM-53
Lycopodium clavatum L.	Lycopodiaceae	Nagbeli/Jhyau	Climber	Medicinal	MRM-54
Magnolia champaca (L.) Baill.ex Pierre	Magnoliaceae	Chap	Tree	Cultural / Religious	MRM-55
Mangifera indica L.	Anacardiaceae	Mango	Tree	Cultural / Religious	MRM-56
Mentha spicata L.	Lamiaceae	Babari	Herb	Medicinal, Pickle	MRM-57
Momordica charantia L.	Cucurbitaceae	Titekarelo	Climber	Medicinal	MRM-58
Musa paradisiaca L.	Musaceae	Kera	Herb	Cultural / Religious	MRM-59
Myrica esculenta Buch.-Ham. ex D. Don	Myricaceae	Kafal	Tree	Fuelwood	MRM-60
Valeriana jatamansi Jones.	Valerianceae	Sugandhawal/ Jatamasi	Herb	Medicinal	MRM-61
Nephrolepis cordifolia (L.) C.Presl.	Nephrolepidaceae	Paniamala	Herb	Medicinal	MRM-62
Ocimum tenuiflorum L.	Lamiaceae	Tulsi	Herb	Medicinal, Cultural / Religious	MRM-63
Osyris lanceolata Hochst. & Steud.	Santalaceae	Nundhiki	Herb	Medicinal, Tea	MRM-64
Paris polyphylla Sm.	Trilliaceae	Satuwa	Herb	Medicinal	MRM-65
Pennisetum purpureum Schumach	Poaceae	Napier	Grass	Fodder	MRM-66
Persea americana Mill.	Lauraceae	Avocado	Tree	Medicinal	MRM-67

Phytolacca acinosa Roxb.	Phytolaccaceae	Jaringo	Herb	Medicinal	MRM-68
Prunus cerasoides D. Don	Rosaceae	Paiyun	Tree	Fodder	MRM-69
Prunus persica (L.) Batsch	Rosaceae	Aaru	Tree	Medicinal	MRM-70
Quercus glauca Thunb.	Fagaceae	phalat	Tree	Fodder	MRM-71
Quercus lanata Sm.	Fagaceae	Banjh	Tree	Fuelwood, Fodder	MRM-72
Quercus semecarpifolia Sm.	Fagaceae	Khasru	Tree	Fuelwood, Fodder	MRM-73
Raphanus sativus L.	Brassicaceae	Mula	Herb	Medicinal	MRM-74
Rhaphidophora decursiva (Roxb.) Schott	Araceae	Kanchirne	Climber	Medicinal	MRM-75
Rhododendron arboreum Sm.	Ericaceae	laligurans	Tree	Medicinal, Fuelwood, Fodder	MRM-76
Rosmarinus officinalis L.	Lamiaceae	rosemary	Shrub	tea fragrance	MRM-77
Rubus ellipticus Sm.	Rosaceae	Ainselu	Shrub	Medicinal	MRM-78
Saccharum officinarum Lindl.	Poaceae	Ukhu	Grass	Medicinal	MRM-79
Salix babylonica L.	Salicaceae	Bans	Tree	Fuelwood, Fodder	MRM-80
Santalum album L.	Santalaceae	Chandan	Tree	Fuelwood	MRM-81
Saurauia napaulensis DC.	Actinidiaceae	Gogan	Tree	Fodder	MRM-82
Schima wallichii (DC.) Korth.	Theaceae	Chilaune	Tree	Fuelwood	MRM-83
Senecio nudicaulis Buch.-Ham. ex D. Don	Asteraceae	Dudhilo	Herb	Fodder	MRM-84
Smallanthus sonchifolius (Poepp.) H.Rob.	Asteraceae	Bhui shyau	Herb	Medicinal	MRM-85
Smilax aspera L.	Smilacaceae	Kukur daino	Herb	Pickle	MRM-86
Solanum torvum Sw.	Solanaceae	Bihi	Herb	Medicinal	MRM-87
Solena amplexicaulis (Lam.) Gandhi	Cucurbitaceae	Golkakri	Herb	Medicinal	MRM-88
Swertia chirayita (Roxb. ex Fleming) Karsten	Gentianaceae	Chiraito	Herb	Medicinal	MRM-89
Syzygium cumini (L.) Skeels	Myrtaceae	Jamun	Tree	Fuelwood	MRM-90
Tagetes erecta L.	Asteraceae	Sayapatri	Herb	Medicinal, Cultural / Religious	MRM-91
Taxus wallichiana Zucc.	Taxaceae	Lauth salla	Tree	Medicinal, Fuelwood	MRM-92
Termitomyces sp.	Tricholomataceae	Fusfuse chyau	Mushroom (Fungi)	Medicinal	MRM-93
Thysanolaena latifolia (Roxb. ex Hornem.) Honda	Poaceae	Amriso	Grass	Cultural / Religious, Fodder	MRM-94
Urtica dioica L.	Urticaceae	Sisnoo	Herb	Medicinal	MRM-95
Zanthoxylum armatum DC.	Rutaceae	Timur	Shrub	Medicinal, Pickle	MRM-96
Zea mays L.	Poaceae	Makai	Grass	Food for cattle	MRM-97
Zingiber officinale Rosc.	Zingiberaceae	Adhuwa	Herb	Medicinal, Spice	MRM-98

Table 3. Ethnomedicinal information of plants recorded durring the study

Scientific Name	Local Name	Parts Used	Mode of Preparation	Mode of Administration
Achyranthes aspera L.	Datiwan	Whole plant	Juice	Oral
Acorus calamus L.	Bojho	Rhizome	Raw	Oral
Ageratina adenophora (Sprengel) R. M. King & H. Robinson	Kalejhar	Leaves	Paste	Topical
Allium sativum L.	Lasun	Bulb	Raw	Oral
Aloe vera (L.) Burm. f.	Ghiu kumari	Leaves	Raw, Juice	Oral, Topical
Artemisia dubia Wall. ex Besser	Titepati	Leaves	Raw, Juice	Topical, inhale
Asparagus racemosus Willd.	Kurilo	Stem	Decoction	Oral
Astilbe rivularis Buch.-Ham. ex D. Don	Thulo okhati	Rhizome, Leaf	Raw, Powder	Oral
Berberis asiatica Roxb. ex DC.	Chutro	Root, Bark	Decoction	Oral
Bergenia ciliata (Haw.) Sternb.	Pakhanved	Rhizome	Raw, Juice	Oral
Buddleja asiatica Lour.	Bhimsen pati	Leaves	Juice	Oral
Cannabis sativa L.	Ganja	Twigs	Raw	Oral
Centella asiatica (L.) Urb.	Ghodtapre	Whole plant	Juice	Oral
Chenopodium album L.	Bethe	Twigs	Cooked	Oral
Cinnamomum tamala (Buch.-Ham.) Nees & Eberm.	Tejpat	Leaves, Bark	Decoctionf	Oral
Cirsium verutum (D. Don) Spreng.	Thakal	Root	Raw, Juice	Oral
Citrus limon (L.) Burm. f.	Kagati	Fruit	Juice	Oral
Colocasia esculenta (L.) Schott	Pidalu	Tuber	Boil	Oral
Coriandrum sativum L.	Dhaniya	Seed	Decoction	Oral
Curcuma longa L.	Besar	Rhizome	Decoction, Paste	Oral, Topical
Cuscuta reflexa Roxb.	Akashbeli	Whole plant	Decoction, Juice	Oral
Cynodon dactylon (L.) Pers.	Dubo	Whole plant	Juice	Topical
Cynoglossum zeylanicum (Vahl ex Hornem.) Thunb. ex Lehm.	Kuro	Leaves	Juice	Topical
Dioscorea bulbifera L.	Ban tarul	Tuber	Decoction	Oral
Euphorbia hirta L.	Akhlejhar	Root	Decoction, Juice	Oral
Euryops spp	Pahelo phool	Whole plant	Infusion	Oral
Foeniculum vulgare Mill.	Saunp	Fruit	Raw	Oral
Galinsoga parviflora Cav.	Chitlange jhar	Leaves	Juice	Topical
Gaultheria fragrantissima Wall.	Dhasingare	Young shoot	oil	Topical
Ipomoea batatas (L.) Lam.	Sakharkhanda	Tuber	Cooked	Oral
Jasminum humile L.	Jai phool	Leaves	Raw	Oral
Juglans regia L.	Okhar	Bark	Raw	Oral
Lycopodium clavatum L.	Nagbeli/Jhyau	Strobilus	Paste	Topical
Mentha spicata L.	Babari	Leaves	Raw, Juice	Oral
Momordica charantia L.	Titekarelo	Fruit	Cooked	Oral
Valeriana jatamansi Jones.	Sugandhawal / Jatamasi	Root	Decoction	Oral
Nephrolepis cordifolia (L.) C.Presl.	Paniamala	Tuber	Raw	Oral
Ocimum tenuiflorum L.	Tulsi	Leaf	Decoction	Oral
Osyris lanceolata Hochst. & Steud.	Nundhiki	Bark of Stem	Paste	Topical
Paris polyphylla Sm.	Satuwa	Rhizome	Decoction, Juice	Oral, Topical
Persea americana Mill.	Avocado	Fruit	Raw	Oral
Phytolacca acinosa Roxb.	Jaringo	Root	Cooked, Paste	Oral, Topical
Prunus persica (L.) Batsch	Aaru	Twigs	Raw	Topical

Raphanus sativus L.	Mula	Seed	Raw	Oral
Rhaphidophora decursiva (Roxb.) Schott	Kanchirne	Whole plant	Paste	Topical
Rhododendron arboreum Sm.	laligurans	Flower	Raw	Oral
Rubus ellipticus Sm.	Ainselu	Twigs	Infusion	Oral
Saccharum officinarum Lindl.	Ukhu	Stem	Juice	Oral
Smallanthus sonchifolius (Poepp.) H.Rob.	Bhui shyau	Tuber	Powder	Oral
Solanum torvum Sw.	Bihi	Fruit	Raw	Oral
Solena amplexicaulis (Lam.) Gandhi	Golkakri	Root	Juice	Oral
Swertia chirayita (Roxb. ex Fleming) Karsten	Chiraito	Whole plant	Juice	Oral
Tagetes erecta L.	Sayapatri	Flower	Raw	Oral
Taxus wallichiana Zucc.	Lauth salla	Stem	Decoction. Powder	Oral
Termitomyces sp.	Fusfuse chyau	Whole plant	Paste	Oral
Urtica dioica L.	Sisnoo	Root, Twigs	Raw, Paste, Cooked	Oral, Topical
Zanthoxylum armatum DC.	Timur	Seed	Decoction	Oral
Zingiber officinale Rosc.	Adhuwa	Rhizome	Decoction	Oral