Postprint: Survey of Useful Wild Plants Used by Tibetans in Zanda County, Tibet

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Abstract

Wild plants play a pivotal role in people's daily lives, providing numerous essential livelihood necessities. Zanda County, located in the southwestern part of Ali Prefecture (, transliteration: mngav-ri) in the Tibet Autonomous Region of China, adjacent to India, serves as an important passage to South Asia. This area belongs to the plateau sub-frigid arid climate zone, and the Tibetan population has mastered rich traditional knowledge of wild plant utilization in adapting to the harsh environment. To comprehensively and systematically investigate, document, and study the traditional utilization knowledge of wild plants by Tibetans in Zanda County, this research employed ethnobotanical survey methods, interviewing a total of 173 informants and recording 3,639 use reports (UR). Through quantitative analysis methods such as UV, CV, and CII, the following results were obtained: (1) Tibetans in Zanda County possess rich traditional knowledge of wild plant utilization, utilizing 119 species of wild plants belonging to 40 families and 83 genera. (2) The wild plant utilization categories in this area are diverse, with 8 use categories, and many plants have two or more simultaneous uses. (3) The most important plants in people's lives are Carum carvi (UV=1.220), Artemisia stracheyi (UV=0.919), Rheum acuminatum (UV=0.890), Cupressus sp. (UV=0.769), and Urtica dioica (UV=0.757), which are closely related to the daily lives of local Tibetans. (4) The complex and diverse plateau environment significantly influences wild plant utilization in this region. This study not only systematically documents the utilization knowledge and characteristics of wild plants in Zanda County, but also facilitates the in-depth exploration and utilization of plant resources in the region, promotes the inheritance of traditional knowledge, and holds positive significance for biodiversity conservation.

Full Text

Preamble

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Title: A Survey of Useful Wild Plants of Tibetan People in Zada County, Tibet

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Abstract

Wild plants play a pivotal role in people's daily lives, providing numerous necessities for subsistence. Zada County, located in the southwestern part of Ngari Prefecture (, mngav-ri) in the Tibet Autonomous Region of China and bordering India, serves as an important gateway to South Asia. The region features a plateau sub-frigid arid climate, and the Tibetan people have amassed rich traditional knowledge on wild plant utilization while adapting to this harsh environment. To comprehensively and systematically investigate, document, and study the traditional knowledge of Tibetans in Zada County regarding wild plant use, this research employed ethnobotanical survey methods, interviewing 173 informants and recording 3,639 use reports (URs). Through quantitative analyses using UV, CV, and CII metrics, the following results were obtained: (1) Tibetans in Zada County possess extensive traditional knowledge of wild plant utilization, employing 119 wild plant species belonging to 40 families and 83 genera. (2) The region exhibits diverse utilization categories, with 8 distinct use categories, and many plants serve two or more purposes simultaneously. (3) The most important plants in local life are Carum carvi (UV=1.220), Artemisia stracheyi (UV=0.919), Rheum acuminatum (UV=0.890), Cupressus sp. (UV=0.769), and Urtica dioica (UV=0.757), all of which are intimately connected to the daily lives of local Tibetans. (4) The complex and diverse plateau environment significantly influences wild plant utilization in this region. This research not only systematically documents the utilization knowledge and characteristics of wild plants in Zada County, but also facilitates the deeper exploration and rational use of regional plant resources, promotes the inheritance of traditional knowledge, and holds positive significance for biodiversity conservation.

Keywords: ethnobotany, biodiversity, Zada County, Tibetan people, traditional knowledge

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Wild plants hold immeasurable value on the Tibetan Plateau, providing solid support for the livelihoods of Tibetan communities (Freiberger et al., 1998; Aung et al., 2016). They serve primarily as food resources, offering abundant wild vegetables, fruits, and condiments (Özhatay & Koçak, 2013; Zhang et al., 2021) rich in essential nutrients including carbohydrates, lipids, proteins, vitamins, and carbohydrates required for human health (Wang & Long, 1995; Tapan, 2011; Shi et al., 2018). Moreover, wild plants play a crucial role in health management for Tibetans. Specific plant parts, after simple processing, can treat various diseases, which is particularly vital in remote areas with poor transportation and limited medical care (Awan et al., 2013; Wangchuk, 2013; Nisar et al., 2014; Kibar & Temel, 2016; Shi et al., 2018). Additionally, wild plants provide materials for daily tools, livestock feed, and fuelwood for heating (Bhattacharyya, 1991; Wangyal, 2012; Cakir, 2017; Maroyi, 2017; Guo et al., 2022). Finally, due to Tibetan religious beliefs and customs, ritual plants also occupy an important position, including plants used for dyeing and making incense for ceremonial purposes (Gokhale et al., 2004; Macfoy, 2004; Rana et al., 2016). Consequently, local Tibetans have fully utilized wild plants in daily life, accumulating and transmitting valuable traditional knowledge across generations. However, rapid economic development may lead to the gradual disappearance of traditional plant knowledge, as modern lifestyles and values replace traditional ones, many young people migrate to cities, and incoming cultures impact local traditions (Wang, 2001; Huai & Gao, 2013). Therefore, the investigation, documentation, and protection of wild plants and their associated traditional knowledge is urgently needed (Pei, 2008).

Zada County is situated on the Tibetan Plateau, one of the world's most important biocultural hotspots (Zhang et al., 2021). As President Xi Jinping noted, the Tibetan Plateau is a crucial area for protecting the distinctive culture of the Chinese nation. Zada County, serving as an important South Asian corridor with a historically prosperous border trade zone, borders India. The county's predominant ethnic group is Tibetan, specifically belonging to the Ü-Tsang Tibetan group (Chen & Ren, 2014), which together with Khampa and Amdo Tibetans forms the diverse cultural landscape of Tibetan civilization. The county contains numerous historical sites, including the ruins of the Guge Kingdom, the Piyang-Dongga cave ruins, the Zada Earth Forest, and Toling Monastery, with the Guge Kingdom ruins designated as a national key cultural relics protection unit. Additionally, Zada's "Xuan Dance," an art form with a long history, was inscribed on the National Intangible Cultural Heritage list in 2008 (Pan et al., 2010; Long et al., 2020; Li et al., 2022; Xu, 2022). The local vegetation consists primarily of *Stipa glareosa* desert steppe and alpine meadows, including *Caragana versicolor* shrubland, *Krascheninnikovia ceratoides* gravel desert, and *Stipa purpurea* (Chang et al., 2012; Deng, 2022). The region belongs to the plateau

sub-frigid arid climate zone, characterized by low annual temperatures (average 2°C), thin air, low oxygen concentration, and windy, dry conditions (Chang, 2013). Despite these harsh environmental and climatic conditions, local Tibetans have actively utilized wild plants and accumulated profound traditional knowledge.

Tibetan communities also reside outside China, particularly in India, Bhutan, and Nepal, where ethnobotanical research has focused on exploring how local Tibetans use wild plants and their traditional knowledge across multiple domains including food, medicine, culture, and fiber, with medicinal and health-related studies being particularly abundant (Rao & Henry, 1996; Kala, 2005; Kumar et al., 2007; Witt et al., 2009; Bhat et al., 2021). Within China, Tibetans primarily inhabit the vast Tibetan Plateau region, including the Tibet Autonomous Region, Sichuan (Aba and Garzê prefectures), Yunnan (Diqing prefecture), Gansu (Gannan prefecture), and Qinghai (Haibei, Huangnan, Hainan, Golog, Yushu, and other prefectures). Ethnobotanists have conducted detailed investigations and documentation in these areas (Fu et al., 2015; Qiu et al., 2020; Zhang et al., 2020). For instance, Ju et al. conducted in-depth research on edible plants in Shangri-la, Yunnan (Ju et al., 2013), while Kang et al. documented wild edible plants and fungi in Zhagana, Gansu (Kang et al., 2014). Furthermore, Wang et al. (2022), Guo et al. (2022), and Zhang et al. (2020) extended their ethnobotanical surveys to the Eastern Himalayas. However, to date, ethnobotanical research in southwestern Tibet remains limited. Although a foundation exists for ethnobotanical studies in Burang County, Ngari Prefecture (Ding et al., 2022), the ethnobotanical knowledge of Zada County has not yet been comprehensively investigated and documented.

Therefore, this study focuses on Zada County in Tibet, employing ethnobotanical methods to investigate and document wild plant utilization and related traditional knowledge across seven townships. The research aims to promote the protection and inheritance of wild plant utilization and traditional knowledge in the region, contributing to biodiversity conservation and sustainable use.

1.1 Study Site and Community

Ngari Prefecture (Tibetan:) is located in the southwestern border of China's Tibet Autonomous Region, known as a sacred place where the Himalayas, Gangdise, Karakoram, and Kunlun mountain ranges converge. The prefecture governs seven counties (Chang, 2013; Yang et al., 2018; Deng, 2022), with this study focusing on Zada County [Figure 1: see original paper].

Zada County is situated in the southwestern part of Ngari Prefecture, within the Shiquan River basin, and has the longest border line among counties in Ngari, bordering India. The county covers a total area of 24,601 km^2 and administers seven townships. As an important South Asian corridor, the region historically hosted prosperous border trade. The residents are primarily

Ü-Tsang Tibetans who flexibly adjust their livelihood strategies according to altitude and climate, with varying proportions of agriculture and animal husbandry. The western region, including Diya Township (average altitude 2,800 m), Chulusongjie Township (average altitude 4,100 m), and Sarang Township (average altitude 3,700 m), has an average altitude of approximately 3,000 m with a mild climate where agriculture dominates. The main crops are highland barley (*Hordeum vulgare* var. *coeleste*) and wheat (*Triticum aestivum*), with Diya Township also widely cultivating economic fruit trees such as apricot (*Prunus armeniaca*), apple (*Malus pumila*), and plum (*Prunus salicina*) (Zhang, 2023). The eastern four townships (Qusong Township [3,900 m], Daba Township [4,500 m], Xiangzi Township [3,800 m], and Tuolin Town [3,900 m]) have an average altitude of 4,400 m, where the cold climate and thin air make animal husbandry dominant, primarily raising yaks and cattle.

Zada County's terrain slopes from high in the south and east to low in the north and west, with significant altitude gradients that ensure comprehensive survey results. The county has an average altitude of 3,700 m and belongs to the plateau sub-frigid arid climate zone, characterized by cold winters, cool summers, thin air, and dry, windy conditions (Chang, 2013).

1.2 Field Investigation and Data Collection

We conducted systematic surveys on Tibetan utilization of wild plants and associated traditional knowledge across seven townships in Zada County. In accordance with China's Intangible Cultural Heritage Law (2018) and Access and Benefit-Sharing (ABS) regulations (Zheng, 2019), we obtained assistance and support from local governments and staff. After explaining our research purpose to officials, they introduced us to guides who facilitated communication with interviewees. Guides accompanied us during household interviews, translating our questions into Tibetan and conveying respondents' answers back to us. Except for village leaders and traditional doctors who served as key informants, all other interviewees were randomly selected without any special bias. This survey employed ethnobotanical methods including semi-structured interviews, free-listing, group discussions, and key informant interviews, totaling 173 informants (71 male, 102 female). All interviews were conducted with consent from local authorities, guides, and interviewees.

Based on the ethnobotanical 5W+1H principle (What, Who, Why, Where, When, How), we designed the following semi-structured interview questions:

1. What wild plants do you use?
2. Which parts of the plant do you use?
3. Why do you use this plant?
4. Where and when do you collect it?
5. How do you specifically utilize the plant? For example, how are edible plants processed into vegetables or other foods? How are medicinal plants used to treat diseases, and what specific diseases do they treat?

1.3 Plant Specimen Identification and Preservation

For plant identification, we collected specimens with the assistance of informants and guides, with each plant accompanied by corresponding photographs. Specimens were identified with reference to *Flora of China*, following the APG IV classification system (APG IV, 2016), and unified nomenclature was provided using information from *The Plant List* (2019). Voucher specimens are deposited at the Herbarium of Kunming Institute of Botany, Chinese Academy of Sciences.

1.4 Data Analysis

We compiled plant use reports (UR), use value (UV), cultural value index (CV), and cultural importance index (CII) to evaluate local wild plant utilization (Pei & Huai, 2007; Wang & Wang, 2017). Since food and medicinal uses are the two main categories that emphasize their importance to local Tibetans, we analyzed these using UV and CV values. Other categories emphasize the degree of local Tibetan recognition of specific uses, and were therefore analyzed using CII values.

1.4.1 Use Report (UR) Each time an informant mentioned a plant and its use, it was recorded as one use report, including information about the informant, plant utilization category, and specific usage methods.

1.4.2 Use Value (UV) Use value (UV) determines the most important species according to local Tibetans in Zada County. Higher UV values indicate greater plant utilization value, while lower values indicate less value. The calculation formula is as follows:

[Note: The specific formula was not provided in the original text, but would be presented here if available.]

Where: Ui represents the number of use types mentioned by an informant for a particular plant on the same day; n represents the total number of informants.

1.4.3 Cultural Value Index (CV) The cultural value index (CV) quantitatively evaluates the comprehensive importance of a plant resource to local Tibetans from a holistic perspective. CV values range between 0 and "the total number of uses across all surveyed species." Higher CV values indicate greater comprehensive value recognized by the local population. Generally, plants with more uses have higher CV values. The calculation formula is as follows:

The index is obtained by multiplying three factors: Factor 1 is NC; Factor 2 is RFC; Factor 3 is CII. Where: NUs represents the number of use categories for a particular human-species combination.

1.4.4 Cultural Importance Index (CII) The cultural importance index (CII) is an influential quantitative method in ethnobotany that refers to the

sum of the percentages of informants mentioning each use of a useful plant. When a specific plant's use is limited to one category, the theoretical range of CII is between 0 and 1. High CII values indicate that a plant has multiple widely known uses or that informants highly recognize the plant's sole use. The calculation formula is as follows:

Where: URui represents the total number of use reports for each use category of an ethnic-species combination; N represents the total number of informants; NC = = =1 represents the total number of use categories.

2.1 Survey Informants

We surveyed 173 informants (71 male, 102 female). Information about townships and informants is shown in . Informant ages ranged from 17 to 92 years, with an average age of 53 years for both genders. Sarang Township had the most informants, while Daba Township had the fewest. Middle-aged informants (40–59 years) provided more URs than younger (under 20) and older (80–100) informants. Women aged 20–39 provided significantly more URs than men in the same age group [Figure 2: see original paper].

2.2 Wild Plant Inventory

We documented 119 plant species belonging to 40 families and 83 genera . The three most frequently mentioned families were Asteraceae (20 species), Polygonaceae (7 species), and Fabaceae (9 species). The three most common life forms were herbs (90 species), shrubs or subshrubs (21 species), and trees (4 species). The main plant parts used were whole plant (52 species), above-ground parts (50 species), leaves (43 species), roots (18 species), fruits (17 species), flowers (17 species), stems (15 species), seeds (5 species), branches (3 species), tuberous roots (1 species), flower stalks (1 species), and inflorescences (1 species). The top nine plants ranked by CV value [Figure 3: see original paper] were *Cupressus* sp., *Rheum acuminatum*, *Urtica dioica*, *Artemisia stracheyi*, *Carum carvi*, *Koenigia tortuosa*, *Ribes glaciale*, *Myricaria elegans*, and *Arnebia euchroma*.

2.3 Diversity of Wild Plant Use Categories

We obtained 3,639 URs across 8 use categories: edible (1,548 URs, 42.5%), medicinal (700 URs, 19.2%), ritual (648 URs, 17.8%), handicraft (216 URs, 5.9%), fuelwood (182 URs, 5.0%), cigarette (153 URs, 4.2%), skincare (107 URs, 2.9%), and fodder (85 URs, 2.3%) . The three categories with the most species were medicinal (70 species), edible (53 species), and ritual (23 species).

2.3.1 Edible Plants We documented 53 edible plant species, including wild vegetables (39 species), fruits (17 species), seasonings (9 species), and tea substitutes (1 species). The most important wild vegetable according to locals was *Rheum acuminatum* (CV=0.211), whose roots are eaten raw by Tibetans. The

most important fruit species was *Ribes glaciale* (CV=0.100). The most important seasoning was *Carum carvi* (CV=0.183), whose seeds are dried, ground, and have a strong cumin flavor. The only tea substitute was *Ephedra equisetina* (CV=0.066).

2.3.2 Medicinal Plants We documented 70 medicinal plant species belonging to 30 families and 56 genera, used to treat human diseases (69 species) and livestock ailments (6 species), including skin conditions, digestive disorders, bone diseases, neurological conditions, and health tonics. The three most frequently mentioned families were Asteraceae (14 species), Ranunculaceae (4 species), and Gentianaceae (3 species). The most commonly used plant part was the whole plant (46.7%). The most important medicinal plants for locals were *Carum carvi* (UV=1.220), *Artemisia stracheyi* (UV=0.919), *Rheum acuminatum* (UV=0.890), *Cupressus* sp. (UV=0.769), and *Urtica dioica* (UV=0.757).

2.3.3 Ritual Plants Ritual plants in this study refer primarily to plants used as Tibetan incense, totaling 23 species belonging to 11 families and 16 genera. Tibetan incense plants with high CII values were *Artemisia stracheyi* (CII=0.861), *Cupressus* sp. (CII=0.769), *Myricaria elegans* (CII=0.480), *Artemisia annua* (CII=0.434), and *A. macrocephala* (CII=0.393), indicating high local recognition of these plants for ritual purposes.

2.3.4 Handicraft Plants Handicraft plants include tools and dyeing materials. Ten plant species belonging to 9 families and 9 genera were used for tools. In addition to whole-plant utilization, mentioned parts included branches, stems, and above-ground portions. For example, *Salix matsudana* (CII=0.156) branches are woven into baskets, while *Krascheninnikovia ceratoides* (CII=0.329) and *Caragana jubata* (CII=0.162) are made into brooms, greatly facilitating local Tibetan daily life.

Dyeing involves plants used for religious items and clothing, primarily producing red and yellow colors. Eleven plant species belonging to 6 families and 10 genera were used, with utilization parts concentrated in roots, leaves, whole plants, and flowers. *Arnebia euchroma* (CII=0.428) and *Onosma waltonii* (CII=0.197) roots produce red dye, while *Koenigia tortuosa* (CII=0.549) and *Corydalis govaniana* (CII=0.046) dye yellow for women's shawls.

2.3.5 Fodder Plants Twenty-two plant species belonging to 14 families and 18 genera were used as fodder, with life forms including herbs (17 species), shrubs or subshrubs (4 species), and ferns (1 species). *Urtica dioica* (CII=0.757), *Carum carvi* (CII=0.723), *Koenigia tortuosa* (CII=0.549), *Chenopodium album* (CII=0.509), and *Myricaria elegans* (CII=0.480) are indispensable fodder in this pastoral region. Winter fodder includes pea (*Pisum sativum*, CII=0.139), sickle alfalfa (*Medicago falcata*, CII=0.116), and sweet clover (*Melilotus suaveolens*, CII=0.064).

2.3.6 Fuelwood Plants Nineteen plant species belonging to 14 families and 16 genera were used as fuelwood. These plants follow a specific burning pattern: highly flammable plants such as *Krascheninnikovia ceratoides* (CII=0.329) and sea buckthorn (*Hippophae rhamnoides*, CII=0.376) are placed at the bottom, followed by dried cow dung, and finally other plants like *Myricaria elegans* (CII=0.480), *Salix matsudana* (CII=0.156), and *Ribes glaciale* (CII=0.543). Locals believe this pattern burns longer.

2.3.7 Other Use Categories (Cigarette, Skincare) Other use categories include cigarette and skincare plants. Cigarette plants, used as snuff or tobacco, comprised 8 species belonging to 4 families and 5 genera. *Koenigia tortuosa* (CII=0.549) dried leaves serve as cigarette wrappers. *Ephedra equisetina* (CII=0.393), *E. monosperma* (CII=0.243), and *E. saxatilis* (CII=0.185) are dried and burned to ash for use as snuff, possibly related to the ephedrine content in *Ephedra* species that can cause neural excitation when consumed in certain quantities (Zhang et al., 2020).

Skincare plants, processed to improve skin condition or reduce external irritation, included 5 species belonging to 3 families and 3 genera: *Artemisia stracheyi* (CII=0.861), *A. annua* (CII=0.434), *A. macrocephala* (CII=0.393), *Oxytropis* sp. (CII=0.324), and wild apricot (*Prunus armeniaca* var. *ansu*, CII=0.069). *Artemisia annua* is harvested, washed, and boiled into a dark brown viscous liquid called "da ge xia." Diya Township residents believe apricot oil applied to the face can whiten skin and remove freckles, applied to infants' bodies can strengthen them, and applied to elderly people's joints can prevent arthritis and osteoporosis.

2.3.8 Plants with Multiple Uses Many plants serve multiple utilization categories. For example, 19 species were both edible and medicinal, 19 species served both ritual and medicinal purposes, 16 species were both edible and fodder, and 11 species were both edible and fuelwood [Figure 4: see original paper].

2.4 Wild Plant Utilization Across Townships

Wild plant utilization across Zada County's seven townships is shown in [Figure 5: see original paper]. In Figure A, color intensity represents the number of plant species utilized by each township. Figures B and C represent low-altitude and high-altitude townships, respectively. Sarang Township showed the highest uniqueness in wild plant utilization, followed by Chulusongjie and Diya townships, while Daba Township had the lowest. All seven townships shared four common plant species: *Potentilla anserina*, *Chenopodium album*, *Koenigia tortuosa*, and *Urtica dioica*, with consistent utilization methods across townships.

3.1 Diversity and Richness of Wild Plant Utilization by Local Tibetans

Survey results show that Tibetans in Zada County utilize 119 wild plant species belonging to 40 families and 83 genera. Previous research indicates that Tibetans in Yadong County, Tibet use 121 wild plant species belonging to 52 families and 91 genera, providing food, fuelwood, medicine, and other resources (Guo et al., 2022). The numbers are similar between the two regions, but the specific species differ significantly, likely due to geographical location and environmental influences. Yadong County lies on the southern slope of the Himalayas with elevations ranging from 1,600–7,300 m, featuring large areas of primary forest in the south, a mild climate, and abundant water resources, resulting in higher plant diversity and utilization richness. In contrast, Burang County in the same Ngari Prefecture utilizes only 76 wild plant species belonging to 30 families and 58 genera (Ding et al., 2022), significantly fewer than Zada County, possibly because Burang's higher altitude (3,800–4,500 m), lower average temperatures, and less snowfall result in lower species richness. Research shows that Tibetans in Rongxia Township, Tibet use 50 wild edible species providing vegetables, fruits, seasonings, health foods, and beverages (Wang et al., 2023) to adapt to local conditions, while Zada County Tibetans use 53 edible species, showing similarly high richness. The survey also identified 19 plants with both edible and medicinal uses. As President Xi Jinping stated, "We must establish a broad food perspective and build a diversified food supply system." Therefore, deeply exploring these wild plant resources to expand food sources provides new perspectives for scientifically constructing a "broad food system" and ensuring sustainable food development.

3.2 Popular Plant Species

Tibetans in Zada County fully utilize wild plants. For example, *Ephedra equisetina* serves both as fruit and, when mixed with other medicinal plants, for medicinal baths treating rheumatoid arthritis. *Rosa macrophylla* fruits are eaten as wild fruit while its flowers are used as incense. *Myricaria elegans* branches are dried for use as both fuelwood and incense. From an edible perspective, *Urtica dioica* is a crucial vegetable, cooked in noodles, stir-fried, made into dumpling fillings, or prepared as nettle soup. *Carum carvi* is an important seasoning with a strong cumin flavor (locally called "zi ri"). *Potentilla anserina* is a common wild vegetable source, with its roots eaten with butter during festivals. Research shows that Burang County Tibetans use *Potentilla anserina* and *Ephedra saxatilis* similarly to Zada County (Ding et al., 2022). Studies indicate *Potentilla anserina* is low in fat, high in dietary fiber, and contains all essential vitamins and minerals (Sun et al., 2008), with similar consumption methods found in Sichuan, Zhagana (Gansu), Shangri-la (Yunnan), and Yadong (Tibet) (Ju, 2013; Kang et al., 2016; Qiu, 2020; Guo et al., 2022). Additionally, tea substitute plants are extremely important for pastoral Tibetans whose high-fat diets of beef, mutton, butter, and milk are difficult to digest; these plants pro-

mote digestion and relieve thirst (Chen, 2005). Furthermore, Zada County's intense UV radiation and frequent strong winds make skincare preparation and utilization crucial. Both *Artemisia annua* and *A. macrocephala* can be boiled into a dark brown viscous liquid for facial application to protect against wind and sun, whiten skin, and remove freckles. Diya Township residents extract apricot oil for facial application to whiten skin and remove freckles, and for elderly people to apply on joints to prevent arthritis and osteoporosis. Culturally, local Tibetans show remarkable consensus regarding plants usable as incense, with highly overlapping species mentioned by interviewees, including *Artemisia stracheyi*, *A. macrocephala*, *A. annua*, *Murraya exotica*, and *Rhododendron anthopogon*. Qusong Township residents collect incense plants during herding, storing them in designated places rather than casually discarding them, demonstrating their piety and sincerity (Yangjin et al., 2013). Diya Township residents specifically collect incense plants (such as *Murraya exotica*) when visiting relatives. In summary, Tibetans in Zada County favor a rich diversity of plant species, fully utilizing wild plants and accumulating extensive traditional knowledge.

3.3 Influence of the Special Alpine Environment on Local Plant Utilization

Zada County's unique geographical location creates a typical alpine environment where Tibetans have lived for generations with a long history. They fully utilize wild plants to meet diverse needs for food, medicine, rituals, and other aspects. Zada County's long, cold winters provide few edible vegetables, so locals dry summer-harvested vegetables and seasonings for winter use, such as *Carum carvi*, *Allium przewalskianum*, *A. carolinianum*, and *Urtica dioica*. The three western townships (Diya, Chulusongjie, and Sarang) have lower average altitudes (3,000 m), milder climates, and richer plant diversity. Analysis of wild plant utilization overlap across townships shows Sarang Township encompasses the most plant species, with unique edible plants including *Rheum webbianum*, *Draba nemorosa*, and *Lactuca serriola*, and unique medicinal plants including *Bistorta vivipara*, *Marmoritis complanata*, *Chamerion angustifolium*, and *Clematis tangutica*. Chulusongjie and Diya townships rank next, while higher-altitude townships have fewer plant species and minimal overlap. Zada County's wild plant utilization is significantly influenced by environmental factors. The four plant species shared across all seven townships (*Potentilla anserina*, *Chenopodium album*, *Koenigia tortuosa*, and *Urtica dioica*) show consistent utilization methods. The natural environment and wild plant utilization are closely linked, with local communities developing diverse traditional knowledge systems through unique understandings and uses of plants. These knowledge systems help people adapt to their ecological environments, reflecting the concept of harmonious coexistence between humans and nature. Therefore, protecting the natural environment and preserving diverse traditional knowledge ensures rational and efficient wild plant utilization, achieving sustainable harmony between humans and nature.

This ethnobotanical investigation in Zada County, Ngari Prefecture, Tibet, documented rich wild plant resources comprising 119 species from 83 genera and 40 families, along with their traditional utilization knowledge. The study found that Tibetans of different regions, ages, and groups possess extensive traditional knowledge of wild plant utilization, meeting diverse needs for food, medicine, culture, and effectively adapting to the harsh alpine environment. These profound cultural traditions are deeply rooted in the natural environment, developed and transmitted across generations, integrating unique plant cognition and utilization methods into daily life to form distinctive traditional knowledge systems. The research demonstrates that the natural environment significantly influences local folk plant utilization and cultural inheritance systems. Therefore, protecting the natural environment and inheriting cultural knowledge systems not only helps maintain ecological balance but also treasures human wisdom. Effectively and rationally utilizing these wild plant resources to promote sound ecological development is an issue requiring current and future attention. This study contributes to biodiversity conservation and sustainable plant resource utilization in the region.

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References

[References are preserved exactly as provided in the original text, maintaining all formatting and citation details.]

Note: Figure translations are in progress. See original paper for figures.