Eating from the wild: diversity of wild edible plants used by Tibetans in Shangri-la region, Yunnan, China

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Abstract

Background: Locally harvested wild edible plants (WEPs) provide food as well as cash income for indigenous people and are of great importance in ensuring global food security. Some also play a significant role in maintaining the productivity and stability of traditional agro-ecosystems. Shangri-la region of Yunnan Province, SW China, is regarded as a biodiversity hotspot. People living there have accumulated traditional knowledge about plants. However, with economic development, WEPs are threatened and the associated traditional knowledge is in danger of being lost. Therefore, ethnobotanical surveys were conducted throughout this area to investigate and document the wild edible plants traditionally used by local Tibetan people.

Methods: Twenty-nine villages were selected to carry out the field investigations. Information was collected using direct observation, semi-structured interviews, individual discussions, key informant interviews, focus group discussions, questionnaires and participatory rural appraisal (PRA).

Results: Information about 168 wild edible plant species in 116 genera of 62 families was recorded and specimens were collected. Most species were edible greens (80 species) or fruits (78). These WEPs are sources for local people, especially those living in remote rural areas, to obtain mineral elements and vitamins. More than half of the species (70%) have multiple use(s) besides food value. Some are crop wild relatives that could be used for crop improvement. Several also have potential values for further commercial exploitation. However, the utilization of WEPs and related knowledge are eroding rapidly, especially in the areas with convenient transportation and booming tourism.

Conclusion: Wild food plants species are abundant and diverse in Shangri-la region. They provide food and nutrients to local people and could also be a source of cash income. However, both WEPs and their associated indigenous knowledge are facing various threats. Thus, conservation and sustainable utilization of these plants in this area are of the utmost importance. Documentation of these species may provide basic information for conservation, possibly further exploitation, and will preserve local traditional knowledge.

Keywords: Wild edible plants, Traditional knowledge, Biodiversity, Ethnobotany, Shangri-la region

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Background
Wild edible plants (WEPs) refer to species that are harvested or collected from their wild natural habitats and used as food for human consumption [1-3]. They provide staple food for indigenous people, serve as supplementary food for non-indigenous people and are one of the primary sources of cash income for poor communities [4-6]. WEPs play an important role in ensuring food security and improve the nutrition in the diets of many people in developing countries [1,5]. They are potential sources of species for domestication and provide valuable genetic traits for developing new crops through breeding and selection [7,8].

Although domesticated plants are the main source of food and income for people in rural areas, they are not able to meet the annual food requirements [9-11]. Thus, the collection and consumption of wild edible plants has been “a way of life” to supplement dietary requirements for many rural populations throughout the world [5,12]. However, due to social change and acculturation processes, indigenous knowledge (or traditional knowledge) about the use of wild edible species is declining and even vanishing with modernization and increasing contacts with western lifestyles [13]. Meanwhile, the loss of traditional knowledge has also been recognized as one of the major factors that have negative effects on the conservation of biological diversity [14]. Thus, it is becoming urgent to document and revitalize traditional knowledge of WEPs to preserve genetic and cultural diversity [12,15,16]. China is renowned for its wide use of wild harvested resources in the human diet, and many studies have focused on wild edible plants [17-28]. These ethnobotanical surveys not only play an important role in conserving traditional knowledge associated with WEPs, but also contribute to nutritional analysis of the most widely used species [1,13]. Nutritional analyses may provide significant information for the utilization of those species that have the best nutritional values, thus helping to maintain dietary diversity and improve local food security [1,2,15].

Diqing Tibetan Autonomous Prefecture of Yunnan Province, commonly known as the Shangri-la region, belongs to the world-famous area called Three Parallel Rivers (Nujiang River, Lancang River and Jinsha River). It is the core of the eastern Himalayas and is regarded as a biodiversity hotspot [29]. Because of its complex topography and high diversity of climates, abundant plant and animal species are distributed in this area [30,31]. Although Tibetans account for about 32.36% of the total population of the whole prefecture and have a relatively well-preserved and distinct cultural identity, there are also Lisu, Han, Naxi, Yi as well as Bai populations, among whom mutual cultural influences have existed for a long time [30,31]. Furthermore, the diet of local Tibetan people differs somewhat from that of Tibetans in Xizang Autonomous Region. People living in the Tibetan Plateau have a limited range of food choices. The staple traditional diet includes Tsampa (made from hull-less barley), yak meat, mutton, buttered tea, sweet tea, barley wine and yogurt [32]. They seldom eat vegetables or fruits. On the other hand, because plant resources in Diqing Prefecture are more plentiful, and local Tibetans are influenced by other nationalities, they not only cultivate various crops, but also collect wild edible plants as supplementary food. These WEPs provide various microelements, and are also an important feature of local agrobiodiversity in which Tibetans have traditionally lived. However, the ecology of Diqing Tibetan Autonomous Prefecture is very fragile, and agrobiodiversity is being rapidly lost due to many natural and human caused factors [33-35]. Many precious plant resources that may have potential for future sustainable development are vanishing before they have been discovered. The reduction of plant diversity also leads to the extinction of the associated indigenous knowledge [36]. Thus, documentation and evaluation of edible plants and relevant local knowledge is urgently needed. This work may guide proper conservation and sustainable utilization of those wild food plants and related indigenous knowledge.

Although there are several ethnobotanical studies concerning wild food plants used by ethnic minorities, such as Mongolians [18,19], Miao in Hunan Province [21] and various ethnic groups in Yunnan Province [5,17,26-28], to our knowledge, information on WEPs of the Shangri-la region used by Tibetans has not previously been documented. In order to fill this gap, ethnobotanical surveys were conducted throughout the prefecture. Scientific and local names, plant parts used, modes of preparation, seasonality patterns in collection and use, and commercialization possibilities of the WEPs are presented in this paper.

Methods
Study area
The study was carried out in Diqing Tibetan Autonomous Prefecture, northwest Yunnan, situated in the south of the Qinghai-Tibet Plateau of the eastern Himalayas, at the junction of Yunnan, Tibet and Sichuan Provinces (between 98°35'-100°19' E and 26°52'-29°16' N) (Figure 1). Three counties, Shangri-la, Deqin and Weixi are administered by the prefecture, with a total area of 23,870 square kilometers and a population of about 400,000. The terrain is higher in the north and lower in the south. The lowest altitude, 1,480 m is at the junction of the Biyu and Lancang Rivers in Weixi County, and the highest altitude, 6,740 m is Kawagebo Peak of the Meili Snow Mountains. The climate of Diqing is divided into five zones: 1)
northern subtropical and warm temperate (below 2500 m); 2) temperate (2500–3000 m); 3) cold temperate (3000–4000 m); 4) frigid (4000–5000 m); and 5) glacier (above 5000 m). Abundant plant resources are distributed in this area because of its unique geographical location and climate diversity [31].

Field survey and data collection
Prior to our field work, relevant literature was consulted to obtain information on the topography, climate, and local culture of Diqing Prefecture, this was helpful in choosing the specific study sites [31]. Field studies were carried out during three visits in March, July and August, 2012. After considering the terrain and climate condition, 29 villages belonging to three counties (8 in Shangri-la, 3 in Weixi and 18 in Deqin) and located in high mountains as well as lower river valleys were randomly selected to carry out ethnobotanical investigation (Table 1). Two-hundred and eighty-two randomly selected households (eight to ten people per village) were surveyed. Ethnobotanical data were collected through different interview methods (participatory rural appraisal (PRA), direct observation, semi-structured interviews, key informant interviews, individual discussions, focus group discussions and questionnaires) [37-40].

During our survey, the local Tibetan pronunciations, parts used, collection period and preparation methods plants were recorded. Because local Tibetan pronunciations differ from the formal Tibetan pronunciation of Xizang Autonomous Region, and the names of some species were even pronounced the same as in Mandarin Chinese, we recorded the names phonetically exactly as they were spoken to us. Most Tibetans in Diqing Prefecture, especially the official workers, students and traders can speak basic Mandarin, therefore our interviews were in Mandarin and did not use interpreters.
Specimens were examined and identified by the authors and other taxonomists and will be deposited in the Herbarium of the Minzu University of China (Beijing).

**Results and discussion**

**Wild food plant diversity and frequently utilized species**

The study area is floristically rich and has a large number of useful WEP species. The 168 species documented include angiosperms (153 spp.), gymnosperms (4), pteridophytes (4), algae (2) and lichens (5) (Table 2), of which 41.1% are endemic to China and 11.9% endemic to northwestern Yunnan Province. Details of utilization are given in Table 3 (plants mentioned only by one informant are not documented in this list). The average number of species mentioned per informant is around ca. 8 species.

### Table 1 Villages surveyed in investigations of wild edible plants used by Tibetans in Shangri-la region, Yunnan Province, China

| No. | Name of village              | Latitude (north) | Longitude (east) | Altitude (m) |
|-----|------------------------------|------------------|------------------|--------------|
| 1   | Laza Village, Shangri-la County | 27°45.396'       | 99°40.228'       | 3320         |
| 2   | Jiefang Village, Shangri-la County | 27°51.468'     | 99°41.564'       | 3280         |
| 3   | Nishi Village, Shangri-la County    | 27°47.218'       | 99°40.595'       | 3290         |
| 4   | Kaisong Village, Shangri-la County     | 27°53.496'      | 99°38.215'       | 3270         |
| 5   | Dala Village, Shangri-la County       | 27°31.112'      | 99°57.36'        | 3370         |
| 6   | Xiaozhongdian Village, Shangri-la County | 27°34.12'     | 99°47.59'        | 3260         |
| 7   | Xingfu Village, Shangri-la County    | 28°8.276'       | 99°25.588'       | 2230         |
| 8   | Nixi Village, Shangri-la County       | 28°41.2'        | 99°29.348'       | 3170         |
| 9   | Laohao Village, Weixi County          | 27°10.541'      | 99°17.204'       | 2260         |
| 10  | Gongyuan Village, Weixi County        | 27°21.5035'     | 99°51.1145'      | 1690         |
| 11  | Biluo Village, Weixi County           | 27°25.228'      | 99°15.88'        | 2630         |
| 12  | Feilaisi Village, Deqin County        | 27°26.312'      | 98°52.444'       | 3390         |
| 13  | Wunongding Village, Deqin County      | 28°26.564'      | 98°54.468'       | 3530         |
| 14  | Mingyong Village, Deqin County        | 28°28.84'       | 98°47.42'        | 2270         |
| 15  | Adunzi Village, Deqin County          | 28°29.136'      | 98°54.389'       | 3290         |
| 16  | Gusong Village, Deqin County          | 28°29.377'      | 98°54.101'       | 3590         |
| 17  | Adong Village, Deqin County           | 28°45.468'      | 98°39.144'       | 2690         |
| 18  | Hongpo Village, Deqin County          | 28°17.24'       | 98°54.18'        | 2810         |
| 19  | Guonian Village, Deqin County         | 28°17.1671'     | 98°51.4961'      | 2130         |
| 20  | Juilongding Village, Deqin County      | 28°20.42'       | 98°53.132'       | 2570         |
| 21  | Sinong Village, Deqin County          | 28°20.918'      | 98°47.342'       | 2320         |
| 22  | Badong Village, Deqin County          | 27°57.396'      | 98°54.0'         | 2240         |
| 23  | Cizhong Village, Deqin County         | 28°01.1664'     | 98°54.1614'      | 1970         |
| 24  | Gongka Village, Deqin County          | 28°35.276'      | 98°52.12'        | 3080         |
| 25  | Jiunong Village, Deqin County         | 28°43.2877'     | 98°41.76'        | 3160         |
| 26  | Luwa Village, Deqin County            | 28°40.30'       | 98°41.843'       | 2290         |
| 27  | Xiaruo Village, Deqin County          | 27°48.3.77'     | 99°18.5.11'      | 2040         |
| 28  | Tuoding Village, Deqin County         | 27°46.109'      | 99°25.732'       | 1940         |
| 29  | Benzilan Village, Deqin County        | 28°14.3683'     | 99°18.743'       | 2150         |

**Table 2 Taxonomic distribution of wild edible plants used by Tibetans in Shangri-la region, Yunnan Province, China**

| Plant group  | Number of species | Number of genera | Number of families |
|--------------|------------------|------------------|-------------------|
| Angiosperm   | 153              | 101              | 47                |
| Gymnosperm   | 4                | 4                | 4                 |
| Pteridophytes| 4                | 4                | 4                 |
| Algae        | 2                | 2                | 2                 |
| Lichen       | 5                | 5                | 5                 |
| Total        | 168              | 116              | 62                |
| Latin name                  | Local name | Family name | Distribution | Parts used       | Local use (edible only)                                                                 | Collection period | Additional local use(s)                                                                 | Frequency |
|-----------------------------|------------|-------------|--------------|------------------|---------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------|-----------|
| Actinidia arguta            | Zhemenkoubu| Actinidiaceae| Shangri-la, Weixi and Deqin | Fruits          | ripe fruits eaten fresh.                                                               | Aug-Sept          | Whole plants used as hedge plants.                                                         | ***       |
| (Siebold et Zucc.) Planch. ex Miq. |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Actinidia pilosula          | Zhemenkoubu| Actinidiaceae| Shangri-la, Weixi and Deqin | Fruits          | ripe fruits eaten fresh.                                                               | Aug-Sept          | Whole plants used as hedge plants.                                                         | **        |
| (Finet et Gagnep.) Stapf ex Hand.-Mazz. |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Actinidia venosa            | Zhemenkoubu| Actinidiaceae| Shangri-la, Weixi and Deqin | Fruits          | ripe fruits eaten fresh.                                                               | Aug-Sept          | Whole plants used as hedge plants.                                                         | **        |
| Rehder                      |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Adenophora khasiana         | Zheibamiedu| Campanulaceae| Weixi and Deqin | Roots            | stewed with meat and eaten as tonic.                                                   | Jul-Sept          | Flowers and stems used for weisang. Aerial parts used as fodder. Roots used to treat cough and clearing heat. | ***       |
| (Hook. f. et Thomson) Collett et Hemsli. |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Alectoraria sulcata         | Shuhua     | Usneaceae   | Shangri-la, Weixi and Deqin | Whole plant     | stir-fried                                                                            | Jul-Sep           |                                                                                           | **        |
| Nyl.                        |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Allium hookeri              | Rijuci     | Liliaceae   | Shangri-la, Weixi and Deqin | Aerial parts    | stir-fried or added to soups                                                          | May-Aug           |                                                                                           | ***       |
| Thwaites var. mulense Airy-Shaw |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Allium ovalifolium          | Rijuci     | Liliaceae   | Shangri-la, Weixi and Deqin | Aerial parts    | stir-fried or added to soups                                                          | May-Aug           |                                                                                           | ****      |
| Hand.-Mazz.                 |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Allium trifurcatum          | Rijuci     | Liliaceae   | Shangri-la, Weixi and Deqin | Aerial parts    | stir-fried or added to soups                                                          | May-Aug           |                                                                                           | ****      |
| (F. T. Wang et T. Tang) J. M. Xu |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Amaranthus caudatus L.      | Yani       | Amaranthaceae| Shangri-la, Weixi and Deqin | Young stems and leaves | stir-fried or added to soups                                                              | Jun-Jul           | Aerial parts used as fodder.                                                              | ***       |
| Amaranthus hypochondracus L. | Yani       | Amaranthaceae| Shangri-la, Weixi and Deqin | Young stems and leaves | stir-fried or added to soups                                                              | Jun-Jul           | Aerial parts used as fodder.                                                              | ***       |
| L.                         |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Amygdalus mira              | Yemaotao; Kamu | Rosaceae   | Shangri-la, Weixi and Deqin | Fruits          | eaten fresh.                                                                          | Jul-Aug           | Seeds used to relieve a cough and cure injuries.                                         | ***       |
| (Koehne) Ricker             |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Anemone rivularis           | Huizhangcao| Ranunculaceae| Weixi         | Roots            | stewed with meat and eaten as tonic.                                                   | Jun-Sept          | Roots used to treat bronchitis. Whole plant used as ornamental.                           | *         |
| Buch.-Harn. ex DC.          |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Aralia caesia               | Shutoucai  | Araliaceae   | Shangri-la    | Young leaves and leaf buds | stir-fried or eaten fresh                                                               | Apr-May           |                                                                                           | ****      |
| Hand.-Mazz.                 |            |             |              |                  |                                                                                       |                   |                                                                                           |           |
| Scientific Name               | Authority                  | Family       | Location          | Part(s) Used                  | Season     |Notes |
|------------------------------|----------------------------|--------------|-------------------|-------------------------------|------------|------|
| Aralia chinensis L.          | Gege                       | Araliaceae   | Shangri-la, Weixi and Deqin | Young leaves and leaf buds stir-fried or eaten fresh | Apr-May     | Bark used for weisang |
| Arctium lappa L.             | Baomujicigen               | Asteraceae   | Shangri-la, Weixi and Deqin | Roots | stewed with meat and eaten as tonic. | Jun-Aug | Fruits, leaves and roots used to relieve fever, and treat measles, dysentery and gastropathy. |
| Arisaema erubescens (Wall.)  | Reduo                      | Araceae      | Shangri-la, Weixi and Deqin | Young leaves | stir-fried | Jun-Jul | Tubers used to relieve cough and treat hemoptysis and pneumonia. |
| Aristolochia delavayi Franch.| Ricaoko                    | Aristolochiaceae | Shangri-la | Whole plants | stir-fried and used as spice | Aug-Sept | Whole plants used as stomachic tonic. |
| Armeniaca murre Siebold     | Kangjue                    | Rosaceae     | Shangri-la, Weixi and Deqin | Fruits | eaten fresh. | Aug | Used as rootstock for Armeniaca vulgaris. |
| Arundinaria faberi Rendle    | Sunzi                      | Poaceae      | Shangri-la, Weixi and Deqin | New shoots | boiled or stir-fried | Jul-Aug | Aerial parts used as fodder and to make bamboo wares. |
| Berberis amoena Dunn        | Qiesi                      | Berberidaceae | Shangri-la, Weixi and Deqin | Young stems, leaves and fruits | eaten fresh | May-Sep | Whole plants used as fence and hedge plants. |
| Berberis jamesiana Forrest et W. W. Sm. | Qiesi | Berberidaceae | Shangri-la, Weixi and Deqin | Young stems, leaves and fruits | eaten fresh | May-Sep | Whole plants used as fence and hedge plants. |
| Berberis pruinosa Franch.   | Qiesi                      | Berberidaceae | Shangri-la, Weixi and Deqin | Young stems, leaves and fruits | eaten fresh | May-Sep | Whole plants used as fence and hedge plants. |
| Berberis weisiensis C. Y. Wu ex S. Y. Bao | Qiesi | Berberidaceae | Shangri-la, Weixi and Deqin | Young stems, leaves and fruits | eaten fresh | May-Sep | Whole plants used as fence and hedge plants. |
| Berchemia hirtella Tsai et K. M. Feng | Zhila | Rhamnaceae | Deqin | Fruits | eaten fresh | Aug-Sep | |
| Berchemia hirtella Tsai et K. M. Feng | Zhila | Rhamnaceae | Deqin | Young leaves | used for making tea | Apr-Jun | |
| Berchemia sinica C. K. Schneid. | Zhila | Rhamnaceae | Deqin | Fruits | eaten fresh | Aug-Sep | |
| Berchemia sinica C. K. Schneid. | Zhila | Rhamnaceae | Deqin | Young leaves | used for making tea | Apr-Jun | |
| Boehmeria penduliflora Wedd. ex Long | Sejia | Urticaceae | Deqin | Young stems and leaves | boiled or stir-fried | Jun-Jul | |
Table 3 Wild edible plants used by the Tibetans in Shangri-la region, Yunnan Province, China (Continued)

| Plant Name                        | Family       | Usage                             | Season       | Notes                                           |
|-----------------------------------|--------------|-----------------------------------|--------------|------------------------------------------------|
| **Boehmeria tricuspis (Hance) Makino** | Urticaceae   | Deqin Young stems and leaves stir-fried | Jun-Jul      | Leaves used as fodder. Bark used for papermaking. * |
| **Broussonetia papyrifera (L.) L'Hér. ex Vent.** | Moraceae     | Shangri-la, Weixi and Deqin Fruits eaten fresh | Sep-Oct      |                                                |
| **Capsella bursapastoris (L.) Medik.** | Brassicaceae | Shangri-la, Weixi and Deqin Aerial part stir-fried | May-Jun      | Aerial parts used as fodder. **                  |
| **Cardamine yunnanensis Franch.** | Brassicaceae | Shangri-la, Weixi and Deqin Aerial part stir-fried | May-Jun      | Aerial parts used as fodder. **                  |
| **Cephalotaxus fortunei Hook. var. alpina H. L. Li** | Cephalotaxaceae | Weixi, Deqin Seeds eaten fresh or stir-fried | Sep-Oct      | Plants used as fuel-wood. Seeds used to expel parasite. * |
| **Cerasus conadenia (Koehne) T. T. Yu et C. L. Li** | Rosaceae     | Shangri-la, Weixi and Deqin Fruits eaten fresh | Jul-Aug      | Flowers and leaves used for weisang ***         |
| **Cerasus tomentosa (Thunb.) Wall.** | Rosaceae     | Shangri-la, Weixi and Deqin Fruits eaten fresh | Jul-Sept     | **                                              |
| **Chaenomeles speciosa (Sweet) Nakai** | Rosaceae     | Shangri-la, Weixi and Deqin Fruits stewed with meat as spice and used to prepare local wine | Sept-Oct     | ***                                             |
| **Chenopodium album L.** | Chenopodiaceae | Shangri-la, Weixi and Deqin Young stems and leaves stir-fried | Jun-Jul      | Aerial parts used as fodder. ***               |
| **Cinnamomum glanduliferum (Wall.) Meisner** | Lauraceae    | Shangri-la, Weixi and Deqin Fruits stir-fried and used as spices | Aug-Sept     | Fruits used to treat stomachache. *           |
| **Cirsium japonicum (Thunb.) Fisch. ex DC.** | Asteraceae   | Shangri-la, Weixi and Deqin Roots stewed with meat and eaten as tonic | Jun-Aug      | Young stems and leaves used as fodder. *** |
| **Codonopsis pilosula (Franch.) Nannf. var. handeliana (Nannf.) L. T. Shen** | Campanulaceae | Deqin and Weixi Roots stewed with meat and eaten as tonic | Jul-Sept     | Aerial parts used as fodder. Roots used to invigorate the spleen. *** |
| **Coriaria nepalensis Wall.** | Coriariaceae | Weixi Fruits eaten fresh | May-Jun      | *                                               |
| Common Name | Local Name | Family | Region | Uses | Notes |
|-------------|------------|--------|--------|------|-------|
| Cornus capitata Wall. | Jisuo, Jisuiziguo | Cornaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh | Aug-Sept | Fruits, stems and leaves used as veterinary medicine. *** |
| Cornus macrophylla Wall. | Dengtaishu | Cornaceae | Shangri-la, Weixi and Deqin | Seeds used for making vegetable oil. | Aug-Sept | Plants used as fuel-wood. ** |
| Cornus schindleri Wangerin | Saisaizi | Cornaceae | Shangri-la, Weixi and Deqin | Seeds used for making vegetable oil | Aug-Sept | Plants used as fuel-wood. ** |
| Cornus ulotricha C. K. Schneid. et Wangerin | Dengtaishu | Cornaceae | Shangri-la, Weixi and Deqin | Seeds used for making vegetable oil | Aug-Sept | Plants used as fuel-wood. * |
| Corylus chinensis Franch. | Jili | Betulaceae | Shangri-la, Weixi and Deqin | Fruits used for making pastries | Sept-Oct | Wood used for construction or furniture. ** |
| Corylus yunnanensis (Franch.) Camus | Shanbaiguo | Betulaceae | Shangri-la, Weixi and Deqin | Fruits used for making pastries | Sept-Oct | Woods used for construction or furniture. * |
| Cotinus coggygria Scop. var. glaucocephala C. Y. Wu | Jiade | Anacardiaceae | Shangri-la | Young leaves boiled or stir-fried | May-Jun | Whole plants used as ornamental. * |
| Crataegus chungtiensis W. W. Sm. | Lubu | Rosaceae | Weixi and Shangri-la | Fruits eaten fresh | Sept | Whole plants used as fence and hedge plants. *** |
| Crataegus oresbia W. W. Sm. | Lubu | Rosaceae | Weixi and Shangri-la | Fruits eaten fresh | Aug-Sept | Whole plants used as fence and hedge plants. *** |
| Cynanchum forrestii Schitr. | Babeda | Asclepiadaceae | Deqin and Weixi | Fruits eaten fresh | Aug-Oct | Roots steved with meat and eaten to treat rheumatism. * |
| Davidia involucrata Baill. var. villosiniana (Dode) Wangerin | Labizi | Nyssaceae | Weixi | Fruits eaten fresh | Sept-Oct | Whole plant used as ornamental. * |
| Debregesia orientalis C. J. Chen | Jiaojia | Urticaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh and used to make local wine | Jun-Aug | Roots used to treat rheumatoid arthritis and broken bones. * |
| Decaisnea insignis (Griff.) Hook. f. et Thomson | Xianli | Lardizabalaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh and used to make local wine | Jul-Aug | Roots and fruits used to clearing heat. *** |
| Dioscorea melanophyma Prain et Burkill | Huangshayue | Dioscoreaceae | Weixi | Tubers boiled or stir-fried | Jun-Jul | Aerial parts used as fodder. ** |
| Diospyros lotus L. | Tazhi | Ebenaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh | Sept-Oct | *** |
| Scientific Name | Common Name | Family | Locations | Parts Used | Harvest Period | Uses |
|----------------|-------------|--------|-----------|------------|---------------|------|
| Duchesnea indica (Andrews) Focke | Dihongpao | Rosaceae | Shangri-la, Weixi and Deqin | Fruits | June-July | * |
| Elaeagnus multiflora Thunb. | Cibie | Elaeagnaceae | Shangri-la, Weixi and Deqin | Fruits | June-July | ** |
| Elaeagnus umbellata Thunb. | Yangnaiguo | Elaeagnaceae | Shangri-la, Weixi and Deqin | Fruits | June-July | ** |
| Eriobotrya salwinensis Hand-Mazz. | | Rosaceae | Shangri-la, Weixi and Deqin | Fruits | June-Aug | Plants used as fuel-wood. | * |
| Eutrema deltoideum (Hook. f. et Thomson) O. E. Schulz | Limo | Brassicaceae | Shangri-la, Weixi and Deqin | Young stems and leaves | May-June | Aerial parts used as fodder. | ** |
| Eutrema heterophyllum (W. W. Sm.) H. Hara | Limo | Brassicaceae | Shangri-la, Weixi and Deqin | Young stems and leaves | May-June | Aerial parts used as fodder. | ** |
| Eutrema himalacum Hook. f. et Thomson | Limo | Brassicaceae | Shangri-la, Weixi and Deqin | Young stems and leaves | May-June | Aerial parts used as fodder. | ** |
| Fagopyrum dibotrys (D. Don) H. Hara | Wanao | Polygonaceae | Deqin | Young stems and leaves | June-Aug | Aerial parts used as fodder. | * |
| Fargesia melanostachys (Hand.-Mazz.) T. P. Yi | Sunzi | Poaceae | Shangri-la, Weixi and Deqin | New shoots | May-Aug | Aerial parts used as fodder and to make bamboo wares. | ***** |
| Ficus pumila L. | Dongshili | Moraceae | Shangri-la, Weixi and Deqin | Fruits | July-Aug | Leaves used as fodder. | * |
| Ficus sarmentosa Buch.-Harn. ex Sm. | dongshili | Moraceae | Shangri-la, Weixi and Deqin | Fruits | July-Aug | Leaves used as fodder. | * |
| Foeniculum vulgare Mill. | Asi | Apiaceae | Shangri-la, Weixi and Deqin | Young stems and leaves | May-July | eaten fresh or stir-fried | ** |
| Fragaria moquinensis (Franch.) Cardot | Gasuo | Rosaceae | Shangri-la, Weixi and Deqin | Fruits | June-July | Whole plants used as fodder. | ** |
| Galinsoga parviflora Cav. | Nawabijia | Asteraceae | Deqin and Weixi | Young stems and leaves | June-Aug | Whole plants used as fodder. | * |
| Common Name                     | Local Name       | Family           | Place of Cultivation | Part Used          | Season | Uses (Comments)                                                                 |
|--------------------------------|------------------|------------------|----------------------|--------------------|--------|--------------------------------------------------------------------------------|
| Ginkgo biloba L.               | Baiguo           | Ginkgoaceae      | Deqin, Weixi         | Seeds              | Sep-Oct| Seeds used to treat asthma.                                                     |
| Gnaphalium affine D. Don        | Qingmincai       | Asteraceae       | Weixi                | Young leaves       | Apr-May| Leaves used to treat cuts and gun shot wounds.                                  |
| Hemerium lanceum (Thunb. ex Sw.) Vuille. | Liangxiongde | Orchidaceae      | Shangri-la           | Whole plant        | Aug-Sep| Whole plant used as fodder.                                                    |
| Hippophae rhamnoides L. subsp. yunnanensis Roui | Xiu             | Elaeagnaceae     | Deqin, Shangri-la    | Fruits             | Aug-Oct| Fruits used to treat cough and invigorate the circulation of blood. ***        |
| Houttuynia cordata Thunb.       | Zhergen          | Saururaceae      | Weixi, Shangri-la    | Leaves and roots   | Jun-Jul|                                                                              |
| Juglans regia L.               | Daiga            | Juglandaceae     | Shangri-la, Weixi and Deqin | Seeds              | Aug-Sept| Plants used as fuel-wood. ***                                                  |
| Kalopanax septemlobus (Thunb.) Kuritz. | Cilaobao       | Araliaceae       | Shangri-la, Weixi and Deqin | Young stems and leaves | May-Jun|                                                                              |
| Lethariella cladonioides (Nyl.) Krog | Gangge          | Parmeliaceae     | Deqin                | Whole plant        | Aug-Oct| Used to tranquilize mind and clearing heat.                                    |
| Leycesteria formosa Wall.       | Sezha            | Caprifoliaceae   | Deqin                | Fruits             | Aug-Oct|                                                                              |
| Ligusticum daucoides (Franch.) Franch. | Riqincai    | Apiaceae         | Shangri-la           | Whole plants       | Apr-May| Aerial parts used as fodder. ***                                               |
| Lindera kariensis W. W. Sm.     | Rhujiao          | Lauraceae        | Weixi, Deqin         | Fruits             | Jul-Sept|                                                                              |
| Lindera nacusua (D. Don) Merr.  | Rhujiao          | Lauraceae        | Weixi                | Fruits             | Jul-Sept|                                                                              |
| Lindera obtusiloba Blume var. heterophylla (Mei) H. P. Tsui | Rhujiao | Lauraceae        | Weixi                | Fruits             | Jul-Sept|                                                                              |
| Lindera reflexa Hemsl.          | Rhujiao          | Lauraceae        | Weixi                | Fruits             | Jul-Sept|                                                                              |
| Lobaria sp.                     | Qingwapi         | Stictaceae       | Shangri-la and Weixi | Aerial part         | Jul-Sept| Whole plant used to treat dyspepsia.                                           |
| Lycopus lucidus Turcz. ex Benth. | Ganluo           | Lamiaceae        | Shangri-la           | Young stems and leaves | Jul-Aug|                                                                              |
| Plant                        | Family       | Location          | Part Used          | Season     | Notes                                      |
|------------------------------|--------------|-------------------|--------------------|------------|--------------------------------------------|
| Mahonia duclouxiana Gagnep.  | Jusa         | Berberidaceae     | Deqin              | Aug-Sep    | Whole plants used as hedge plants.         |
| Maianthemum atropurpureum (Franch.) LaFrankie | Liliaceae | Shangri-la, Weixi and Deqin | Young shoots and leaves | May-Jun    | Aerial parts used as fodder. ***** |
| Maianthemum forrestii (W. W. Smith) LaFrankie | Liliaceae | Shangri-la and Weixi | Young shoots and leaves | May-Jun    | Aerial parts used as fodder. ***** |
| Maianthemum henryi (Baker) LaFrankie | Liliaceae | Weixi, Shangri-la | Young shoots and leaves | May-Jun    | Aerial parts used as fodder. *** |
| Maianthemum henryi (Baker) LaFrankie | Liliaceae | Shangri-la, Weixi and Deqin | Young shoots and leaves | May-Jun    | Aerial parts used as fodder. ***** |
| Maianthemum purpureum (Wallich) LaFrankie | Liliaceae | Shangri-la and Deqin | Young shoots and leaves | May-Jun    | Aerial parts used as fodder. ***** |
| Malus rockii Rehder          | Tangli       | Rosaceae          | Shangri-la, Weixi and Deqin | Sept       | Plants used as fuel-wood, and rootstock for Malus pumila. Whole plants used as fence. *** |
| Malus spectabilis (Ait.) Borkh. | Haitangguo   | Rosaceae          | Shangri-la, Weixi and Deqin | Sept       | Fruits decoction used to treat dark urine. ** |
| Malva verticillata L.        | Jiangba      | Malvaceae         | Deqin              | Jun-Aug    | Leaves, stems and seeds used as fodder. Whole plant used as ornamental. * |
| Matteuccia struthiopteris (L.) Tadaro | Huangguaxiang   | Onocleaceae   | Shangri-la, Weixi and Deqin | Immature fronds | eaten fresh or stir-fried | May-Jun | ***** |
| Medicago lupilina L.         | Mocuo        | Fabaceae          | Deqin, Shangri-la  | Jun-Jul    | Leaves, stems, flowers and seeds used as fodder. * |
| Megacarpaea delavayi Franch. | Yuose        | Brassicaceae      | Shangri-la, Weixi and Deqin | Young stems and leaves | eaten fresh or stir-fried | May-Jun | Aerial parts used as fodder. ** |
| Megacarpaea polyandra Benth. ex Madden | Yuose        | Brassicaceae      | Shangri-la, Weixi and Deqin | Young stems and leaves | stir-fried | May-Jun | Aerial parts used as fodder. ** |
| **Mentha canadensis** L. | Qiubi | Lamiaceae | Shangri-la, Weixi and Deqin | Young leaves | eaten fresh or stir-fried | Jun-Aug | **
| Nostoc sphaeroides Kützing | Shuimuer | Nostocaceae | Shangri-la | Whole plant | eaten fresh or added to soups | Jun-Jul | Whole plant used to treat burns and scalds. *
| Metapanax delavayi (Franch.) J. Wen et Frodin | Araliaceae | Weixi, Deqin | Young leaves | used for making tea | Apr-May | Whole plants used as hedge plants. *
| Ophioglossum reticulatum L. | Yimyidun | Ophioglossaceae | Shangri-la | Immature fronds | stir-fried or added to soups | Jul-Aug | Whole plants used to treat impotence and lumbago. *
| Ophiothallus monacanthus (Wild.) Haw. | Xianrengu | Cactaceae | Shangri-la, Weixi and Deqin | Fruits | eaten fresh | Aug-Sep | Tuber and fruits used as fodder. Whole plants used as fence and hedge plants. ***
| Oreorchis indica (Lindl.) Hook. f. | Xiabaji | Orchidaceae | Shangri-la, Weixi and Deqin | Pseudobulbs | boiled or stir-fried | Jun-Aug | Whole plants used as fodder. Pseudobulbs used to stop bleeding and detumescence. *
| Osmunda japonica Thunb. | Shuijuecai | Osmundaceae | Weixi | Immature fronds | stir-fried | May-Jun | ***
| Osteomeles schwertnii C. K. Schneid. | Sele | Rosaceae | Shangri-la, Weixi and Deqin | Fruits | eaten fresh | Aug-Sept | Leaves and fruits used as fodder. **
| Panax japonicus (T. Nees) C. A. Meyer var. major (Burkill) C. Y. Wu et K. M. Feng | Gedeqi | Araliaceae | Shangri-la | Young stems and leaves | eaten fresh or stir-fried | May-Jun | Whole plants used as fodder. Roots used to stop bleeding. ***
| Panax japonicus (T. Nees) C. A. Meyer var. major (Burkill) C. Y. Wu et K. M. Feng | Gedeqi | Araliaceae | Shangri-la | Rhizomes | stewed with meat and eaten as tonic. | Jul-Aug | Whole plants used as fodder. Rhizomes used to stop bleeding. ***
| Pentapanax henryi Harms | Araliaceae | Shangri-la, Weixi and Deqin | Young stems and leaves | eaten fresh or stir-fried | Apr-May | **
| Photinia glomerata Rehder et E. H. Wilson | Chongsi | Rosaceae | Deqin | Fruits | eaten fresh | Sept | *
| Phyllanthus emblica L. | Ganlan | Euphorbiaceae | Shangri-la | Fruits | eaten fresh | Jul-Sept | Barks used to extract tannin. ***
| Phytolacca acinosa Roxb. | Tuoqiong | Phytolaccaceae | Deqin | Young stems and leaves | eaten fresh or stir-fried | Jul-Aug | Roots used to promote diuresis. *
| Plant Name                          | Family          | Location               | Part Used                    | Season          | Use                                                                 |
|-----------------------------------|----------------|------------------------|-----------------------------|----------------|----------------------------------------------------------------------|
| Pinellia pedatisecta Schott       | Araceae         | Deqin                  | Young leaves, stir-fried     | Jun-Jul        | Corms used to treat vomit and reduce phlegm.                         |
| Pinus armandii Franch.            | Pinaceae        | Seiut, Songzi          | Seeds, eaten fresh or stir-fried | Sept-Oct       | Leaves and stems used for weisang. Needles used as fodder. Plants used as fuel-wood. |
| Pistacia weinmanniiifolia J. Li    | Anacardiaceae   | Deqin                  | Fruits                      | Aug-Sept       | Leaves and stems used for weisang. Leaves and fruits used as fodder. |
| Plantago asiatica L.              | Plantaginaceae  | Shangri-la, Weixi and Deqin | Whole plants, boiled or stir-fried | Jun-Aug        | Leaves, stems, flowers and seeds used as fodder.                     |
| Plantago major L.                 | Plantaginaceae  | Shangri-la, Weixi and Deqin | Whole plants, boiled or stir-fried | Jun-Aug        | Leaves, stems, flowers and seeds used as fodder.                     |
| Potentilla anserina L.             | Rosaceae        | Shangri-la, Weixi and Deqin | Roots, eaten fresh or boiled | Jun-Sept       | Leaves, stems and fruits used as fodder. Roots used to control leukorrhea flow. |
| Potentilla corandrifolia D. Don var. dumosa Franch. | Rosaceae | Shangri-la, Weixi and Deqin | Roots, eaten after boiling | Jun-Sept       | Whole plants used as fodder.                                       |
| Potentilla leuconota D. Don        | Rosaceae        | Shangri-la, Weixi and Deqin | Roots, eaten after boiling   | Jun-Sept       | Whole plants used as fodder.                                       |
| Prasiola subareolata Skuja.        | Prasiolaceae    | Shangri-la              | Whole plants, eaten fresh or added to soups | Jun-Jul        |                                                                    |
| Prunus pumila utilis Royle         | Rosaceae        | Shangri-la, Weixi and Deqin | Seeds, used for making vegetable oil | Jul-Aug        |                                                                    |
| Pteridium aquilum (L.) Kuhn var. latiusculum (Desv.) Underw. ex A. Heller | Pteridaceae    | Shangri-la, Weixi and Deqin | Immature fronds, eaten fresh or stir-fried | May-Jul       | Whole plant used to treat rheumatism or for clearing heat.          |
| Pyracantha fortuneana (Maxim.) H. L. Li | Rosaceae   | Shangri-la, Weixi and Deqin | Fruits                      | Sept-Oct       |                                                                    |
| Pyrus betulifolia Bunge            | Rosaceae        | Shangri-la, Weixi and Deqin | Fruits                      | Aug-Oct        |                                                                    |
| Pyrus calleryana Decne.            | Rosaceae        | Shangri-la, Weixi and Deqin | Fruits                      | Aug-Oct        |                                                                    |
| Plant Name                        | Species | Family    | Location          | Uses                                                                 | Harvest Period |
|----------------------------------|---------|-----------|-------------------|----------------------------------------------------------------------|----------------|
| Pyrus pashia                     | Buch.-Ham. ex D. Don | Rosaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Oct        |
| Pyrus pseudopashia T. T. Yu      | Suilun  | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Ramalina fastigiata (Pers.) Ach. | Shuhua  | Ramalinaceae | Whole plant       | Whole plant stir-fried                                                | Jul-Sept       |
| Rheum likiangense Sam.           | Mojue   | Polygonaceae | Shangri-la and Deqin | Young leaves eaten fresh                                              | Jun-Aug        |
| Ribes alpestre Wall. ex Decne.   | Suanmiguoguo | Saxifragaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh and used to prepare local wine                    | Aug-Sept       |
| Ribes moupinense Franch.         | Hiangshen | Saxifragaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh and used to prepare local wine                    | Jul-Oct        |
| Ribes glaciale Wall.             | Niangxi  | Saxifragaceae | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Rosa omeiensis Rolf.             | Xuwabala | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Jul-Sept       |
| Rosa praecucens Byhouwer         | Xielermedu | Rosaceae  | Shangri-la         | Fruits eaten fresh                                                     | Sept-Oct       |
| Rosa soulieana Crép.             | Xuwabala | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Rubus assamensis Focke            | Hongpao; Yongde | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Rubus fockeanus Kurz              | Hongpao; Yongde | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Rubus niveus Thunb.               | Hongpao; Yongde | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Rubus pectinellus Maxim.          | Jiaoxumu | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Rubus pentagonus Wall. ex Focke   | Hongpao; Yongde | Rosaceae  | Shangri-la, Weixi and Deqin | Fruits eaten fresh                                                     | Aug-Sept       |
| Plant Name                  | Location               | Family            | Uses                                                                 | Season  | Notes                                                                 |
|-----------------------------|------------------------|-------------------|---------------------------------------------------------------------|---------|-----------------------------------------------------------------------|
| *Rubus polyodontus* Hand.-Mazz. | Hongpail; Yongde      | Rosaceae          | Fruits eaten fresh, whole plants used as fence.                      | Aug-Sept| *                                                                     |
| *Rubus rubrisetulosus* Cardot | Hongpail; Yongde      | Rosaceae          | Fruits eaten fresh, whole plants used as fence.                      | Aug-Sept| **                                                                   |
| *Rubus stans* Focke          | Hongpail; Yongde      | Rosaceae          | Fruits eaten fresh, whole plants used as fence.                      | Aug-Sept| **                                                                   |
| *Sageretia thea* (Osbeck) M. C. Johnst. | Luozi          | Rhamnaceae        | Fruits eaten fresh.                                                  | Apr-May | *                                                                     |
| *Sambucus chinensis* Lindl.   | Debangqiongjie        | Caprifoliaceae    | Fruits eaten fresh, aerial parts used as fodder.                     | Jul-Sept| ***                                                                  |
| *Schisandra rubriflora* (Franch.) Rehder et E. H. Wilson | Wuweizi          | Schisandraceae    | Fruits eaten fresh and used to prepare local wine.                  | Aug-Oct | *** Fruits used as antidiarrheic and for invigorating kidney. Whole plant used as ornamental. |
| *Sinopodophyllum hexandrum* (Royle) T. S. Ying | Agabule           | Berberidaceae     | Fruits eaten fresh.                                                  | Jul-Sept| ** Roots, stems and leaves used to clear heat. Seeds used to cure antenatal pain and help expelling placenta. Whole plant used as ornamental. |
| *Spiranthes sinensis* (Pers.) Ames | Xiaobaiji         | Orchidaceae       | Whole plant stewed with meat and eaten as tonic.                    | Aug-Sept| * Whole plants used as fodder.                                       |
| *Stachys koyangensis* (Vaniot) Dunn var. *franchetiana* (H. Lév.) C. Y. Wu | Riganlu          | Lamiaceae         | Tubers boiled or stir-fried.                                         | Jun-Sept| * Whole plants used as fodder.                                       |
| *Taxillus chinensis* (DC.) Danser | Yawakeqi         | Loranthaceae      | Fruits eaten fresh.                                                  | Aug-Oct | **                                                                   |
| *Taxillus thibetensis* (Lecomte) Danser | Yawakeqi         | Loranthaceae      | Fruits eaten fresh.                                                  | Aug-Oct | ***                                                                  |
| *Thamnolia verniculatis* Ach. | Xiare               | Thamnoliaceae     | Whole plant used for making tea, wine and beverage.                 | Aug-Oct | * Used to tranquilize mind and clear heat.                            |
| *Thlaspi arvense* L. Manlancai | Weixi and Deqin     | Brassicaceae      | Young stems and leaves stir-fried or used for making pickle.        | May-Jun | ** Aerial parts used as fodder.                                       |
| Species                                      | Family          | Uses                                           | Season (months) | Notes                                |
|----------------------------------------------|-----------------|-----------------------------------------------|-----------------|--------------------------------------|
| **Thlaspi arvense** L. **Manlancai**          | Brassicaceae    | Seeds used for making vegetable oil           | Jul-Aug         | Aerial parts used as fodder. **      |
| **Thlaspi yunnanense** Franch. **Manlancai** | Brassicaceae    | Young stems and leaves stir-fried or used for making pickle. | May-Jun         | Aerial parts used as fodder. **      |
| **Thlaspi yunnanense** Franch. **Manlancai** | Brassicaceae    | Seeds used for making vegetable oil           | Jul-Aug         | Aerial parts used as fodder. **      |
| **Tibetia himalaica** (Baker) H. P. Tsui     | Fabaceae        | Roots eaten fresh                             | Jun-Aug         | Aerial parts used as fodder. *       |
| **Toona sinensis** (Juss.) Roem.             | Meliaceae       | Leaf buds eaten fresh or stir-fried           | May-Jun         |                                     |
| **Torreya fargesii** Franch. var. **yunnanensis** (C. Y. Cheng et L. K. Fu) N. Kang | Taxaceae        | Weixi, Shangri-la seeds eaten fresh or stir-fried | Sept-Oct        | Plants used as fuel-wood. *          |
| **Toxicodendron succedaneum** (L.) Kuntze    | Anacardiaceae   | Fruits used for making vegetable oil          | Jul-Sept        | Wax is extracted from fruits to use in varnish and polish. * |
| **Toxicodendron vernicifluum** (Stokes) F. A. Barkley | Anacardiaceae   | Fruits used for making vegetable oil          | Jul-Sept        | Wax is extracted from fruits for using in varnish and polish. * |
| **Triosteum himalayanum** Wall. **Sachi**    | Caprifoliaceae  | Fruits eaten fresh                            | Aug-Sept        | Aerial parts used as fodder. *       |
| **Typhonium diversifolium** ex Schott **Banxia** | Araceae         | Young leaves used for making pickle           | Jul-Aug         |                                     |
| **Urtica fissa** E. Pritz. **Yanglala**      | Urticaceae      | Young stems and leaves stir-fried             | Jun-Jul         |                                     |
| **Urtica mainei** H. Lév. **Yanglala**       | Urticaceae      | Young stems and leaves stir-fried             | Jun-Jul         |                                     |
| **Viburnum betulifolium** Batalin **Ruosi**  | Caprifoliaceae  | Fruits eaten fresh and used to prepare local tonic wine | Aug-Sept        |                                     |
| **Viburnum kansuense** Batalin **Ruosi**     | Caprifoliaceae  | Fruits eaten fresh and used to prepare local tonic wine | Aug-Sept        |                                     |
| **Vitis betulifolia** Diels et Gilg **Geng** | Vitaceae        | Fruits eaten fresh                            | Jul-Oct         | Leaves used as fodder. **            |
| Plant Name             | Family    | Region          | Part Used         | Season     | Frequency |
|-----------------------|-----------|-----------------|-------------------|------------|-----------|
| Zanthoxylum bungeanum | Rutaceae  | Shangri-la, Weixi and Deqin | Young stems and leaves | Apr-May    | ****      |
| Yemu                  |           |                 |                   |            |           |
| Zanthoxylum bungeanum | Rutaceae  | Shangri-la, Weixi and Deqin | Fruits          | Jul-Sept   | *****     |

Frequency: ***** > 75% of respondents; **** > 50% of respondents; *** > 1/4 of respondents; ** > 1/8 of respondents; * < 1/8 of respondents, but at least 2 respondents.
distributed into different life forms, with herbs (43.5%) and shrubs (26.8%) having the most species, similar to a survey conducted in Yunnan Province [17] and another in Hunan Province [21]. The majority of food plants belong to the Rosaceae (34 species), Liliaceae (9), Brassicaceae (9), Araliaceae (6) and Berberidaceae (6). The genera represented by the highest number of species are Rubus (8 species), followed by Maianthemum (6), Berberis (4), Cornus (4), Lindera (4) and Pyrus (4).

The most frequently used parts are fruits, young leaves and stems (Figure 2). This result is similar to other investigations, such as a study of the Shuhi people in the Hengduan Mountains (southwest China) [24], studies in Xishuangbanna, southern Yunnan (China) [26,28] and surveys among Inner Mongolian herdsmen [18]. The preference for wild collected leafy vegetables and fruits over underground plant parts seems to be common among diverse ethnic groups in China and the Himalayan area, and might be due to the ease of collecting above ground parts [24]. Collection period varies from April to August (for young leaves and stems) and July to October (for fruits and seeds). Most plant parts are collected in summer and autumn (Table 3). These plants are often dried in the sun after collection and stored (a very common preserving technique [22]) until winter. Most uses are specific to a particular plant part (such as young leaf, new shoot or ripe fruit), although in a few cases a single plant part has different uses, e.g., seeds of Juglans regia are eaten fresh or used to make vegetable oil. More than one plant part is used for about 7% of the species. For example, young leaves and stems of Panax japonicus var. major are used as a vegetable, while rhizomes are stewed with meat and eaten as a tonic. Leaves of Thlaspi yunnanense are used as a vegetable, while vegetable oil is made from the seeds.

Young leaves, stems and fruits of Berberis amoena, B. jamaquina, B. pruinosa and B. eisiensis are eaten fresh. Young stems and leaves of Zanthoxylum bungeanum are boiled or stir-fried, and the fruits as a condiment. Fruits of Berchemia kirtella and B. sinica are eaten fresh and the young leaves to make tea. In total, vegetable (41.9%) is the most used category followed by fruit (40.8%) (Table 4). Ripe fruits are often eaten fresh, green leafy vegetative parts (e.g., young leaves and stems) are usually boiled or stir-fried, less commonly they are eaten fresh as salad or added to soups. All these plants are used as ingredients for the hot pot, since Tibetans in this region like hot pot very much.

These wild edible plants play an important role in providing local Tibetans with various vital nutrition elements, such as vitamins and minerals needed to maintain health and promote immunity against disease. For example, butter rice with ginseng fruits is a famous and traditional Tibetan dish. Ginseng fruits are the roots of Potentilla anserina, a perennial herb, and was reported to have low fat, high dietary fiber, all essential amino acids, various mineral elements and vitamins [41]. Other wild vegetables and fruits frequently used by local Tibetans include Maianthemum atropurpureum, Allium ovalifolium, Aralia chinensis, Hippophae rhamnoides subsp. yunnanensis and Amygdalus mira, which are all mentioned by nearly every respondent.

Multiple uses of wild edible plants
In addition to edible use, 71.4% of the reported wild edible plants (120 species) have additional uses (Tables 3 and 5). Such species are common in rural areas and are important to local people [12,42]. They not only balance the nutritional value of starchy diets (compensating for lack of several vitamins, proteins and minerals), but may also provide pharmacologically active compounds. The multiple uses attest to the importance of these plants for subsistence and as a part of local cultural heritage [12]. Thirty-one species (18.5%) are also used as medicine, most are herbs (19 species) or trees (6 species). These medicinal plants are used to treat gastropathy, cough, fever, rheumatism, dysentery, fractures, dyspepsia, hemoptysis, and

Table 4 Specific edible uses of wild edible plants used by Tibetans in Shangri-la region, Yunnan, China

| Specific use   | Number of plants |
|---------------|-----------------|
| vegetable     | 80              |
| fruit         | 78              |
| wine          | 11              |
| vegetable oil | 9               |
| spice         | 8               |
| tea           | 5               |
| Total         | 191             |
asthma. For a few species, the same part is not only used as food, but is also used for medicinal purposes. For example, the roots of *Anemone rivularis* are stewed with meat and eaten as tonic by local people, and the decoction of them are used to treat bronchitis.

WEPs can provide resources for future exploitation of new health foods. As living standards improve, there is a globally increased demand for healthy and safe food [21]. Compared to conventional, cultivated vegetables, wild food plants require less care, are not affected by pesticide pollution, and are a rich source of micronutrients.

However destructive harvesting is a significant concern and in the present study this was documented to occur in at least 21 species used for medicine, the underground parts (root, tuber and corm) of fourteen species and the whole plant of seven species. This manner of harvest may have a serious consequence from both the survival of plants and from an ecological point of view [43]. The conservation and sustainable utilization of species with multiple uses should be taken into consideration.

Fifty-two species (31%) were used as fodder. For example *Potentilla coriandrifolia* var. *dumosa* is regarded as high-quality forage at high altitude (3500–4300 m). Further study of its nutrient composition can be done in order to understand the rationale for its usage and development potential.

Ten species have cultural significance in a religious rite named *weisang*, during which specific plants are burned for smoke. These are *Adenophora khasiana*, *Aralia chinensis*, *Cerasus conadenia*, *Pinus armandii*, *Pistacia weinmanniifolia*, *Ribes moupinense*, *Ribes glaciale*, *Rosa praelucens*, *Rubus pectinellus* and *Torreya fargesii* var. *yunnanensis*. This rite plays an important role in Tibetans’ daily life, and it is said that the fragrance in the smoke can not only make the mountain god pleased, but also wash dirty things away from people. Tibetans pray for good harvest, good fortune, happiness and prosperity in this manner.

**Most preferred** species and their commercial potential

Besides food value, the recorded species provide the possibility to supplement household income of rural people with limited cash income opportunities [44]. In our survey, the most preferred plants (mentioned by more than 50% of respondents) include *Maianthemum*, *Allium*, *Aralia*, *Arundinaria faberi*, *Fargesia melanostachys*, *Pteridium aquilinum* var. *latiusculum*, *Matteuccia struthiopteris*, *Zanthoxylum bungeanum*, *Ligusticum daucoides*, *Hippophae rhamnoides* subsp. *yunnanensis* and *Pistacia weinmanniifolia*. All these plants are collected from remote mountains by local people and traded in local markets, which provides the possibility to increase the income of rural people with low cash income.

*Maianthemum* species (*zhuyecai* or “bamboo-leaved vegetable”) are the most frequently mentioned wild vegetable. In Diqing Prefecture, the leaves of six species are eaten (*M. atropurpureum*, *M. forrestii*, *M. henryi*, *M. oleraceum*, *M. purpureum* and *M. tatsienense*). They are added to soups, stir-fried with bacon or eaten raw as salad. Several studies have focused on the nutritional analysis of *zhuyecai* and found they contained higher amount of protein, essential amino acids, vitamin C and mineral elements compared with some common vegetables [45-47]. Although local people do not use them as medicine, *Maianthemum* species were reported for medicinal use since ancient times. For instance, *M. japonica* and *M. henryi* are employed to treat kidney diseases, activate blood circulation and alleviate pain [44,48]. *M. atropurpureum* contains a variety of steroidal saponins and nucleosides which may possess anti-tumor activities [49-51]. Three new steroidal saponins having cytotoxic properties against human cancer cells were isolated from *zhuyecai* and *M. atropurpureum* and *M. tatsienense*). They are added to soups, stir-fried with bacon or eaten raw as salad. Several studies have focused on the nutritional analysis of *zhuyecai* and found they contained higher amount of protein, essential amino acids, vitamin C and mineral elements compared with some common vegetables [45-47]. Although local people do not use them as medicine, *Maianthemum* species were reported for medicinal use since ancient times. For instance, *M. japonica* and *M. henryi* are employed to treat kidney diseases, activate blood circulation and alleviate pain [44,48]. *M. atropurpureum* contains a variety of steroidal saponins and nucleosides which may possess anti-tumor activities [49-51]. Three new steroidal saponins having cytotoxic properties against human cancer cells were isolated from *zhuyecai* and *M. atropurpureum* and *M. tatsienense*. They are added to soups, stir-fried with bacon or eaten raw as salad. Several studies have focused on the nutritional analysis of *zhuyecai* and found they contained higher amount of protein, essential amino acids, vitamin C and mineral elements compared with some common vegetables [45-47]. Although local people do not use them as medicine, *Maianthemum* species were reported for medicinal use since ancient times. For instance, *M. japonica* and *M. henryi* are employed to treat kidney diseases, activate blood circulation and alleviate pain [44,48]. *M. atropurpureum* contains a variety of steroidal saponins and nucleosides which may possess anti-tumor activities [49-51]. Three new steroidal saponins having cytotoxic properties against human cancer cells were isolated from *zhuyecai* and *M. atropurpureum* and *M. tatsienense*.

### Table 5 Types of multiple uses for edible wild plants utilized by Tibetans in Shangri-la region, Yunnan, China

| Kind of usage   | Number of species | Percentage |
|-----------------|-------------------|------------|
| Edible          | 168               | 100.0      |
| Fodder          | 52                | 31.0       |
| Medicinal       | 31                | 18.5       |
| Fence           | 22                | 13.1       |
| Ornamental      | 11                | 6.5        |
| Weisang         | 10                | 6.0        |
| Fuel-wood       | 9                 | 5.4        |
| Construction    | 4                 | 2.4        |

*The religious rite of burning offerings for smoke, which plays an important role in local Tibetan’s daily life.*
enough to construct a reliable priority list for future con-

servation, domestication and exploitation. Further detailed

nutrition analysis and phytochemical investigation should

be undertaken to comprehensively evaluate food and medi-
cinal value of these “most preferred” plants, which could

provide scientific and important information.

It is generally believed that local people are more likely
to support and participate in conservation initiatives if
they can receive direct benefits from such efforts [55]. If
managed sustainably, these plants could be a good
means of income generation for rural communities.

Market surveys, value chain analyses and the risk of
overexploitation should be assessed thoroughly [13,56].

Maianthemum populations (zhuyecai) are becoming rare
in Shangri-la County although there were rich resources
20 years ago. Uprooting and harvesting the entire plant
during collection were observed and identified as causes
of decline for Sinopodophyllum hexandrum, Aristolochia
delavayi, Megacarpaea delavayi and Codonopsis pilosula
var. handeliana. Because few people in this area are
aware of sustainable harvesting, the conservation and
proper utilization of these species should be taught.

Crop wild relatives for genetic improvement and crop
production

Crop wild relatives (CWRs) are species that are closely re-
lated to crops including crop progenitors. These wild rela-
tives of domesticated crops may provide genes having
higher resistance to adverse circumstance that could prove
particularly important in response to global climate change,
which will undoubtedly alter the environmental conditions
under which our crops grow and dramatically impact
agriculture [4,57,58]. CWRs are also of great importance
to maintain the productivity and stability of traditional agro-
cosystems [59,60]. Conservation of these species ensures
that diverse genetic resources are preserved and could be
used in the improvement of crops as a contribution to 21st
century food security [4,7,8]. The main options for CWRs
conservation are ex situ in gene banks and in situ in the
natural or farmed environment [59,61,62]. It is widely rec-
ognized that in situ is necessary to conserve the full range
of genetic diversity inherent in and between plant popula-
tions, with ex situ techniques as a backup [58]. Taxon-
inventory is the starting point for in situ conservation which
provides the baseline data critical for biodiversity assess-
ment and monitoring [63]. Some of the wild relatives of
fruit, vegetable and spice crops documented in this study
are species of Actinidia, Allium, Amaranthus, Amygdales,
Arctium, Armeniaca, Capsella, Cerasus, Craetaegus,
Dioscorea, Diospyros, Eriobotrya, Foeniculum, Fragaria,
Hippophaes, Juglans, Malus, Mentha, Pyrus, Toona, Vitis
and Zanthoxylum. Take Amygdales mira as an example.

Due to its advantageous traits, such as high adaptability
and longevity, resistance to disease and tolerance to
drought and cold, it could be a genetic resource for peach
improvement. Another case is Pyrus betulifolia, which is
usually used as stock to graft various pear cultivars. It is
drought resistant, cold tolerant and long living, making it a
good candidate for providing useful genes to improve the
quality of pears. Young leaves of Allium ovalifolium could
be eaten as vegetables, and leaves are relatively larger than
those of other Chinese chives. Thus, it might be used as a
source for breeding new variety of chives. Two other
species, Rosa omeiensis and R. praerucens have edible and
ornamental uses and exhibit high cold tolerance. They may
provide beneficial genes for future study and exploitation in
developing new crops.

Issues of conservation

Wild edible plant species are threatened by various natural
causes and human activities [4,34]. Extreme weather
caused by global climate change, such as heavy snow and
severe droughts, has resulted in the decrease and even loss
of many wild food plant populations. Various human ac-
tivities such as land use change, habitat destruction, over-
harvesting and over-grazing, are major threats. In recent
years, with the construction of roads, airports, reservoirs
and other infrastructure, wild habitats for edible plants
were severely impacted. Unsustainable harvesting of food
plant species with good market price also contributes to a
decrease of these plants.

Threats are not only limited to wild food plants them-

selves, the traditional knowledge associated with WEPs is
also endangered. Therefore, systematic documentation of
indigenous knowledge and biological resources is of great
significance [55,64]. Along with economic development
and increasing income, only a few people want to collect
wild edible plants. The younger generation is becoming
less interested in them, thus causing the loss of traditional
knowledge. In Shangri-la County tourism is booming and
local people eagerly want to serve as guides or drivers in
tourist areas to pursue more money. With the conveni-
ence of transportation, residents can buy much more
vegetables from the markets than ever before and do not
need to collect wild species. However, in more remote
rural communities where transportation is still inconveni-
ent and people seldom go to the market, indigenous
knowledge about WEPs is relatively intact. In Deqin
County much land has been converted to grape cultivation
to develop a wine industry and agricultural chemicals are
used frequently, causing the decrease of various wild ed-
ible species, and even cultivation of the very important
species, hull-less barley, Hordeum vulgare, the staple food
of Tibetan communities [65,66] is threatened. During our
survey we found that most people are reluctant to culti-
vate hull-less barley now because planting grapes can
bring more cash income.
Conclusion
This paper is the first ethnobotanical study of wild food plants used by local Tibetans in Diqing Tibetan Autonomous Prefecture. As plant resources in this area are rather plentiful, and under the influence of other ethnic groups, local Tibetans not only cultivate various crops, but also collect wild edible plants as food. Our survey showed the diversity of WEPs and related indigenous knowledge in this area.

Different parts of plants are used by local people, and the most frequently used parts were fruits, young leaves and stems. These plants have different specific food uses, with leafy vegetable uses being most frequent, followed by fruit uses. WEPs provide food and nutrients to local communities, such as essential amino acids, various vitamins and minerals which are needed to keep healthy and enhance immunity against diseases and infections.

If properly harvested, WEPs could be the source of cash income for local people with low cash income because they are enjoyed by local people very much and often traded in markets. Furthermore, with the increased demand for green, healthy and safe food in modern society, wild food resources have attracted global interest because they are pollution-free and contain numerous important micronutrients and pharmacologically active substances. In order to properly utilize the wild food resources, we have some suggestions: 1) properly exploit and improve conservation and management of wild food plants; 2) focus on scientific research on wild food resources; 3) protect the natural environment and habitat for wild food plants.

In addition to food value, more than 50% of recorded plants have medicinal, ornamental, and cultural and other uses that are important in local Tibetan culture. Furthermore, some are crop wild relatives and could provide useful genes for crop improvement, which may have significant consequence on global food security. However, along with the development of economy, these multi-valued resources are threatened by human activities and natural causes, and associated traditional knowledge is eroding rapidly. Therefore, sustainable management of these resources as well as conserving biodiversity is of the utmost importance.

In a word, our ethnobotanical surveys provide data and information basis for conservation and sustainable utilization of local wild edible plants, and also contribute to preserve cultural and genetic diversity in Diqing Tibetan Autonomous Prefecture.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
CL designed the study, YJ, BL and JXZ performed the field survey. YJ drafted the manuscript, BL revised the manuscript. CLL revised and finalized the manuscript. All authors read and approved the final manuscript.

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References
1. Lulekal E, Asfaw Z, Kelbessa E, Van Damme P: Wild edible plants in Ethiopia: a review on their potential to combat food insecurity. Africa Focus 2011, 24(1):121.
2. Heywood VH: Ethnopharmacology, food production, nutrition and biodiversity conservation: towards a sustainable future for indigenous peoples. J Ethnopharmacol 2011, 137:1–15.
3. Seal T: Evaluation of nutritional potential of wild edible plants, traditionally used by the tribal people of Meghalaya state in India. Amer J Plant Nutr Fertil Tech 2012, 21:9–26.
4. Uperty Y, Poudel R, Shrestha K, Rajabhandary S, Tiwari N, Shrestha U, Asselin H: Diversity of use and local knowledge of wild edible plant resources in Nepal. J Ethnobiol Ethnomed 2012, 8:16.
5. Ghorbani A, Langenberger G, Sauerborn J: A comparison of the wild food plant use knowledge of ethnic minorities in Naban River Watershed National Nature Reserve, Yunnan, SW China. J Ethnobiol Ethnomed 2012, 8:17.
6. Menendez-Baceta G, Aceituno-Mata L, Tardio J, Reyes-Garcia V, Pardo-de-Santayana M: Wild edible plants traditionally gathered in Gorbelaldea (Biscay, Basque Country). Genet Resour Crop Evol 2012, 59:1329–1347.
7. Ford-Lloyd BV, Schmidt M, Armstrong SJ, Barazani O, Engels J, Ge S, Hadas R, Hammer K, Kell SP, Kang D, Khooshbakht K, Li Y, Long CL, Lu BR, Ma KP, Nguyen VT, Qiu LJ, Wei W, Zhang ZW, Maxted N: Crop wild relatives-undervalued, underutilized and under threat? Biodiversity 2011, 11:559–565.
8. Pandey A, Torner AK, Bhandari DC, Paneek SK: Towards collection of wild relatives of crop plants in India. Genet Resour Crop Evol 2008, 55:187–202.
9. Mira S, Maikhuri R, Kala C, Rao K, Saxena K: Wild leafy vegetables: A study of their subsistence dietetic support to the inhabitants of Nanda Devi Biosphere Reserve, India. J Ethnobiol Ethnomed 2008, 4:15.
10. Arenas P, Scapa GP: Edible wild plants of the chortore Indians, Gran Chaco, Argentina. Bot J Linn Soc 2007, 153:73–85.
11. Joshi N, Kehlenbeck K, Maass BL: Traditional, neglected vegetables of Nepal: Their sustainable utilization for meeting human needs, Conference on International Agricultural Research for Development, Tropentag. 2007:1–10.
12. Shrestha PM, Dhillon SS: Diversity and traditional knowledge concerning wild food species in a locally managed forest in Nepal. Agroforest Syst 2006, 66:65–63.
13. Terrone C, Van Damme P, Dhe’da Djalo B: Eating from the wild: Turumbu, Mbole and Bali traditional knowledge on non-cultivated edible plants, District Tshopo, DR Congo. Genet Resour Crop Evol 2011, 58:385–618.
14. Keller GB, Mndiga H, Maass BL: Diversity and genetic erosion of traditional vegetables in Tanzania from the farmer’s point of view. Plant Genet Resour Charact Util 2005, 3:400–413.
15. Tardio J, Pardi-De-Santayana M, Morales R: Ethnobotanical review of wild edible plants in Spain. Bot J Linn Soc 2006, 152:27–71.
16. Luczaj L, Zóvko Končič M, Miličev T, Dolina K, Pandža M: Wild vegetable mixes sold in the markets of Dalmatia (southern Croatia). J Ethnobiol Ethnomed 2013, 9:2.
