

Being Blessed by Qomolangma: The Diversity and Local Knowledge of Wild Edible Plants Used by Chenthang Sherpa People to Treat Seasonal Food Shortage

Xiaoyong Ding

Kunming Institute of Botany Chinese Academy of Sciences

Yu Zhang

Kunming Institute of Botany Chinese Academy of Sciences

Lu Wang

Kunming Institute of Botany Chinese Academy of Sciences

Huifu Zhuang

Kunming Institute of Botany Chinese Academy of Sciences

Wenyun Chen

Kunming Institute of Botany Chinese Academy of Sciences

Yuhua Wang (✉ wangyuhua@mail.kib.ac.cn)

Kunming Institute of Botany Chinese Academy of Sciences <https://orcid.org/0000-0003-3138-1312>

Research Article

Keywords: Wild edible plants, Local knowledge, Seasonal food shortage, Sherpa, Chenthang Town, Qomolangma

Posted Date: February 19th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-211888/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Background

Wild edible plants (WEPs), which are identified as non-cultivated and non-domesticated plants for food. WEPs provided food, nutrition, herbs and other plant products for people in underdeveloped areas, such as the Everest region, to maintain their daily lives. Chenthang Town is the only Sherpa ethnic township in China. The core purpose of this research is to investigate, collect, and record the WEPs and related local knowledge and functions in the Sherpa community. Looking forward to answering the ultimate question, why did Sherpa people choose these plants?

Materials and methods

The field study was carried out in the six Sherpa communities of Chenthang Township from September 2019 to August 2020. The WEPs and related local knowledge were collected by semi-structured interview and direct observation. And the field works were performed with the assistance of local guides. During the field survey, we collected plant specimens based on the principle of one plant with one vernacular name. In this study, we used use-report (UR) and cultural importance index (CI) to evaluate the comprehensive utilization value of WEPs in the daily diet of Sherpa people.

Results

We interviewed 78 people individually who provided us with 1,199 use-reports. In total, we collected 84 WEPs belonging to 62 genera in 40 families. These species were identified into 78 ethno-species by local people, and the vernacular name of each ethno-species was recorded. These use-reports were classified into 6 use-categories. All of these plants were native wild plants. In these plants, *Arisaema utile*, *Sorbus cuspidat* and *Elaeagnus umbellate* have been introduced into home gardens by local people. According to the description of the Sherpa people, we drew a collecting calendar of WEPs. The Sherpa collect WEPs almost throughout the year, except for January and February.

Conclusion

WEPs have made a huge contribution to the Sherpa dietary in supplementing Carbohydrate, nutrition, and healthcare during the seasonal food shortage. In general, the diversity and products and services of WEPs based on local knowledge enhance the resistance and resilience of local food supply system to treat food shortage which might be the answer to why the locals choose these plants.

1 Background

Food shortage is a serious worldwide problem, especially in the less developed and remote regions of Asia and Africa. Meanwhile, climate change and extreme weather have increased the vulnerability of local

farmers and herdsman to livelihoods, which would exacerbate the food shortage problem in these regions [1]. The latest estimates showed that nearly 690 million people (8.9% of the global population) were undernourished, with the largest number of hungry in Asia, before the 2019 Covid-19 pandemic [2]. And, the global pandemic of COVID-19 will have negative impact on food systems worldwide [3].

Wild edible plants (WEPs), which are identified as non-cultivated and non-domesticated plants for food, could provide many products and services to daily lives of local people in rural areas [4–11]. WEPs play a significant role as supplements to treat food shortage, when normal food supplies fall off [10–13]. Additionally, WEPs also have healthcare [14] and nutrition benefits [15] for local communities. Local people can earn extra income by selling some economic WEPs [10]. As a part of traditional expression, the traditional knowledge of WEPs is lost along with the loss of traditional culture [16]. WEPs were considered an effective way to understand local knowledge and culture related to the biodiversity. In some remote and underdeveloped areas, WEPs are still an important source of plant products, such as vegetables, fruits, and starch to support daily needs [4–13]. Even in some urban areas, WEPs were still indispensable sources of vegetables and fruit [17–19]. Some starch-rich WEPs could help people in remote areas fight hunger in times of food shortage [20]. Furthermore, many rural people in developing countries face seasonal food shortages every year between the depletion of grain stocks and the next harvest [21]. WEPs are an important part of the daily diet in many remote areas and underdeveloped areas, which is especially obvious during seasonal food shortages [22]. Therefore, WEPs are very important in underdeveloped and remote areas.

Mount Everest (Jo-mo-glang-ma-gang-ri or Qomolangma) is the world's highest mountain nature reserve. It is one of the world's biodiversity hotspots, covering 36,000 square kilometers of the Himalayas [23]. The core region of the Mount Everest Reserve is one of the most remote and underdeveloped area both in China and world, which results that the livelihoods of native people heavily depend on natural resources [24]. Chenthang Township is located in the core area of the Mount Everest Reserve, and there was no clear motor road linking the township to outside until recently [25]. As a result, people living in this area have to face rugged terrain, and the channels for the exchange of products and knowledge between the local community and the outside world are blocked. Sherpa is a cross-border ethnic group living on both sides of the Himalayas, mainly in Nepal (Solu, Khumbu Canyon) and Xizang, China (Mount Everest National Nature Reserve) [26, 27]. Sherpa are known as “the Porter of the Himalayas”, because they work for mountain expeditions as guides and porters.

Some previous ethnobotanical studies of Sherpa people focused on the traditional edible plants and the utilization of traditional medicinal plants in central and eastern Nepal and the Indian state of Sikkim [28–32]. These studies showed that the Sherpa have accumulated a wealth of traditional knowledge about WEPs and medicines from the surrounding living environment. Furthermore, most of these researches in this area focused on the biodiversity of this area, and few discussed the correlation between local people and biodiversity, such as knowledge of local WEPs [24, 33]. So far, however, the ethnobotanical study of Sherpa people in China remains a blank. Therefore, it is necessary to investigate the WEPs and related local knowledge of the Sherpa in China.

Local people living in rural areas and remote areas usually supplement their daily diet by using WEPs, and have accumulated a wealth of plant knowledge. The ecological conditions and cultural significance of WEPs seem to affect local people's knowledge and consumption of WEPs [34]. The diversity and function of the plants in the local environment are closely related to the local people's understanding of the plant world in the surrounding environment. Therefore, the core purpose of this research is to investigate, collect and record the WEPs and their local knowledge and functions in the Sherpa community. Looking forward to answering the ultimate question, why did they choose these plants?

Specifically, the purpose of this study was to investigate, collect and record the traditional use of WEPs and relative local knowledge accumulated by Sherpa people in China. The present study aims to answer the following questions: (1) What plants are consumed by Sherpa people, and how to prepare? (2) What plants are important to the local community, And why? (3) What functions did these plants provide? (4) Why did Sherpa people choose these plants?

2 Material And Methods

2.1 Study sites

Chenthang Township which is the only Sherpa ethnic township in China, located in Mount Everest national nature reserve of southeast Qinghai-Tibet plateau, and the border between China and Nepal (Fig. 1). Its total area is 430.62 square kilometers. There are 133.4 km² virgin forest, and the forest coverage rate is 98 percent, but the arable land area which slope is above 45° is only 59.87 hectares [35]. Based on 2016 demographics, there are 2,387 herdsmen in 513 households in the town, including 2,362 Sherpa, accounting for 99 percent of the total number [36]. The elevation of Chenthang Town is from 2040 to 5,500 meters. And the annual frost-free period is around 200 days, and the annual average rainfall is over 1000mm. The annual average temperature is 13.76°C, and the annual extreme minimum temperature is 1°C. Due to the effect of warm moist air flows in the Indian Ocean, forming a subtropical monsoon climate. All the materials going in and out of Chenthang Town depend on manpower and livestock, because of geographical limitations [35]. Even now, Chenthang Town even haven't a vegetable marketplace. The grain output of Chenthang Town in 2010 was 148.46 tons [35], which is not enough to meet the food demand of Sherpa. Wind damage [37], hail damage [38], earthquake [39] and other natural disasters caused serious damage to farmland and pasture in Xigaze area. Moreover, Xigaze City was one of the three main battlefields for poverty alleviation in the Xizang Autonomous Region [40].

The Sherpa language is a dialect of Dbus-gtsang Tibetan language, which is written in Tibetan alphabet [31]. Sherpa traditional houses are made of timber or bamboo, Sherpa people are housed in sheds while grazing animals. The houses were built in a special form, usually with herringbone roofs, surrounded by thick walls made of stones and covered with thin planks. The main local crops are finger millet, winter wheat, corn, buckwheat, potatoes and other crops. And the stable food is Tsamba made of finger millet. The main economic activities are logging and harvesting of medicinal plants, which are either sold in cash or traded for other goods and services [35]. In 1990s, people in Chenthang exchanged daily necessities in Riwu

town 100 kilometers away. Carrying special products such as timber, medicine and bamboo baskets, they had to walk from Chenthang to Riwu Town about 5 to 7 days.

2.2 Field work and data collections

The field works were carried out in the six Sherpa communities of Chenthang Township (Table 1), from September 2019 to August 2020. First, we visited the township committee for obtaining the field work permission. We explained our purpose to committee leaders and asked for helps which mainly included providing local guides, introducing us to local villagers and other necessary fieldwork assistance. The WEPs and related local knowledge were collected by semi-structured interview and direct observation. All of the field works were carried out with informed consent. Because of the relative backwardness of the educational conditions, most of local people especially the aged community members could not communicate fluently in mainstream Chinese language. Therefore, the field works were performed with the assistance of local guides. The informants of semi-structured interview were selected randomly from the local community members, and we mentally chose older people as the priority informants. The Semi-structured interview was used to get information on the local knowledge of WEPs which was provided by local people. Vernacular names, life forms, use parts, use, collect seasons, economic values, and culture significances of plants were recorded. The direct observation was used to record the image and video data of the local uses of WEPs with digital camera. Meanwhile, the voucher specimens were collected. The semi-structured interviews were performed based on the following questions:

- 1) Would you mind to list some wild plants you often consume and which of them are edible?*
- 2) Where are you collect them and when are their harvest seasons?*
- 3) For these wild edible foods, could you tell us how to cook them for food?*
- 4) Besides foods, do you use them for other purposes? And what are these purposes? Could you tell us some traditional/old story or legend about these plants?*

Table 1
Characteristics of informants

Characteristics	Number	Percentage
Communities		
Tsanggar	12	15.4
Nathang	10	12.8
Xoshongma	14	17.9
Woshoe	16	15.4
Pethang	20	23.1
Sali	12	15.4
Gender		
Female	33	42.3
Male	45	57.7
Age		
Below 20	4	5.1
21–40	19	24.4
41–60	38	48.7
Above 60	17	21.8

2.3 Information document and plant specimen identification and preservation

During the interview, we used a portable notebook to record information, and then organized the information into an Excel sheet (Microsoft Corporation, <http://www.microsoft.com/>) in a unified format, with “one plant to one local name” as a basic unit. We are trying to record all the information provided by the informants into the excel sheet. The entire interviews were conducted in the Sherpa language which were translated into Mandarin by the local guidance. The vernacular name of the plants were recorded in Sherpa language which was written in Tibetan alphabet [31, 41].

During the field survey, with the help of local guides, we collected plant specimens based on the principle of one plant with one vernacular name. Digital photos were also taken for later identify the scientific taxa of plants. The collection of the voucher specimens and the photographing of the photos were obtained with permission of the informants and the local community management department. And the specimen identification was performed and stored in the herbarium of Kunming Institute of Botany, Chinese Academy of Sciences (KUN). Due to objective factors, we did not collect a voucher specimen of *Cardamine purpurascens*. But this specimen was identified based on the video taken by the Sherpa (see additional file

1). The identification of plant species was based on the Flora of Xizang and Flora of China [42, 43]. The proofreading of the Latin name of plants was based on The Plant List [44].

2.4 Data Analysis

We adopted Use-report (UR) and Cultural Important Index (CI) as an ethnobotanical index.

Use-report (UR) was the sum of information on local utilization and knowledge [45, 46]. A use report is that a specific use of an ethno-species cited by an informant. In this study, all the scientific taxa of plants are consistent with the ethno-species.

Cultural Important Index (CI) was defined as the sum of the percentage of respondents who mentioned various uses for a certain useful plant. In this study, we used CI to evaluate the importance of WEPs in the daily diet of Sherpa people. Also, CI considers the various uses of each plant, and the dissemination of knowledge (for each use-category of each plant). In other words, the diversity of the plant's uses and degree of recognition of the informants to each use-category were included. It can evaluate the comprehensive utilization value of each useful plant. When $u = 1$, i.e. when the plant only one use -category, CI and RFC index equal in value, but they refer to different meanings [45]. CI is calculated by the following formula:

$$CI = \sum_{u=u_1}^{u_{NC}} \sum_{l=l_1}^{l_N} \frac{UR_{ul}}{N}$$

In order to evaluate the comprehensive utilization value of each edible plant, we calculated the CI value. In addition, we calculated CI values for different use-categories of each plant in order to understand the acceptance of the unique use-category of a particular plant.

3 Results

3.1 Characteristics of informants

We interviewed 78 people individually, including 45 males and 33 females, from the six communities of Chenthang Township (Table 1). The age range of the informants was 12 to 95 years old.

3.2 Diversity of the wild edible plants

In total, we collected 84 edible species, including 79 angiosperms and five pteridophytes, belonging to 62 genera in 40 families (See additional file 1). The results showed that the most frequently mentioned families are Rosaceae (10 species), following by Urticaceae (8 species), Asparagaceae (5 species), Ericaceae (5 species) and Brassicaceae (4 species). Magnoliaceae and Berberidaceae have three species. Twelve families have two species. Remaining 22 families have only species each. At the genus level, the most common genera are Rubus, Vaccinium, Polygonatum, Urtica, and Schisandra. Forty-six taxa are herbaceous plants, 17 are shrubs, 13 are trees, and 8 are lianas (See additional file 1). All of these plants are native wild plants. In these plants, *Arisaema utile*, *Sorbus cuspidata* and *Elaeagnus umbellata* have been introduced into home gardens by local people.

3.3 WEPs categories

These species were identified into 78 ethno-species by local people, and the vernacular name of each ethno-species was recorded. In this study, we interviewed a total of 78 informants who provided us with 1,199 use-reports. These use-reports were classified into 6 use-categories (Table 2). The most frequent use-category was “fruit” (485 use-reports), followed by “vegetable” (451 use-reports), “substitute grain” (102 use-reports), “healthcare food” (78 use-reports), “seasoning” (36 use-reports) and “beverage” (47 use-reports).

Table 2
Use report and use categories

Criteria	Use-categories	Number of species	Use report (UR)
Plants material what were used to cook dishes (including making salads directly with raw plant material)	Vegetable	38	451
Fruits that were only eaten when they were ripe, similar to apple, pear and strawberry	Fruit	41	485
Not only edible plants, but could also be used by local people to treat diseases	Healthcare food	14	78
Plants that could be used as a direct starch supplement (e.g., tuberous or rhizome of some plants) or processed into starch (e.g., acorns)	Substitute grain	10	102
Plants that could be added to dishes or soups to increase the flavor of food	Seasoning	9	36
Plants what could be processed into home-made liqueurs or alcoholic beverages and processed into herbal teas	Beverage	6	47

3.4 The most popular WEPs

In total, we collected 84 plant taxa and 50 of them exceeded 10 use-reports. But there were only 1 use-report for six plants and 10 plants from 2 to 5 use-reports. The WEPs CI value ranged from 0.01 to 0.77. According to the URs and CI value of ethno-species, the top 5 popular ethno-species were *Solena amplexicaulis*, CI = 0.77), *A. saema utile*, CI = 0.65), *Andinia venosa*, CI = 0.59), *Schisandra grandiflora*, *S. neglecta*, *S. sphaerandra*, CI = 0.58), *Urtica membranifolia*, CI = 0.58) (Table 3). These plants have been used by the Sherpa for a long time, and most of the plants are still being used. For example, until now, from May to July every year, local women went together to collect the tender stems and leaves of *A. utile*, and dried them naturally for winter consumption.

Table 3
The top 5 popular ethno-species

Vernacular name	Scientific name	Life form	Use part	Use	Use category
ལྷོ་ལྷོ་ལྷོ་ལྷོ་	<i>Solena amplexicaulis</i> (Lam.) Gandhi	Liana	Fruit, tubers, leaves	Tuber dried and ground into flour or fresh tuber boiled into porridge, fruit was eaten raw, tender leaves were made into soup	Fruit, substitute grain, vegetable
ལྷོ་ལྷོ་	<i>Arisaema utile</i> Hook.f. ex Schott	Herb	Tubers, tender stems and leaves	Tubers were dried and ground into flour, tender stems and leaves were dried and consumed as a soup	Vegetable, substitute grain
ལྷོ་ལྷོ་ལྷོ་ལྷོ་	<i>Actinidia venosa</i> Rehd.	Liana	Fruit	Eaten raw	Fruit
ལྷོ་ལྷོ་	<i>Schisandra sphaerandra</i> f. pallida	Liana	Fruit	Eaten raw	Fruit
	<i>Schisandra neglecta</i> A. C. Smith				
	<i>Schisandra grandiflora</i> (Wall.) Hook. f. et Thoms.				
ལྷོ་ལྷོ་	<i>Urtica membranifolia</i> C.J.Chen	Herb	Tender stems and leaves	The tender stems and leaves were roasted and then cooked, and finally boiled with oil and salt	Vegetable

3.5 Collecting calendar of WEPs

According to the description of the local people, we recorded the farming season and collection time of each plant, and drew a collecting calendar of WEPs (Fig. 2). There are 8 circles in Fig. 2, corresponding to six use categories and two agricultural activities. The circle is divided into 12 equal parts, one part represents one month. The shade of green to indicate the number of plant species collected in each part of each circle. The deeper the green, the more plant species are collected. The Sherpa collect WEPs almost throughout the year, except for January and February. The most concentrated period of wild vegetable collection was from May to July and wild fruit was mainly from September to October. Substitute grain was mainly collected from July to November. Most of the used parts of spice and healthcare plants are roots or seeds, which are collected from July to November (Fig. 2).

The top 5 ethno-species are displayed outside the circle. The larger the picture, the higher the frequency of being cited. The position of the picture represents the time when the plants were collected. *Solena amplexicaulis* was collected from June to November. *Arisaema utile* was collected from May to October.

Actinidia venosa was collected from September to November. *Schisandra sphaerandra* was collected from August to November. *Urtica membranifolia* was collected from May to July.

4 Discussion

4.1 The important WEPs

Based on the information provided by the informant, we carried out a quantitative analysis and the results showed that there were some WEPs that were very important to the Sherpa people. These plants were collected seasonally and used for multiple purposes or mentioned frequently (Table 3).

“ལྷོ་ལྷོ་ལྷོ་ལྷོ་ལྷོ་” (*Solenia heterophylla*) was the most frequently cited plants in the recorded plants. Local people collect *S. heterophylla* for multiple purposes. The young leaves could be collected and cooked as vegetable, and the matured fruits could be collected as seasonal fresh fruits. It should highlight that the starch-rich tuber root of *S. heterophylla* is one of the important substitute grain sources for Sherpa people during the periodic and aperiodic famine. *S. heterophylla* is also used by other indigenous tribes settle in Himalaya region. Our previous study showed that the species was consumed as fruit by Monpa in eastern Himalaya [47, 48]. Besides, *S. heterophylla* is also used in local medicine. Sherpa people in Nepal consumed small amounts of fruit or root cream to treat throat infections associated with fever, and often ate ripe fruit to ensure that abdominal ulcers were cured [31]. Traditionally, Hani ethnicity took the tuber root of the species in decoction to treat stomachache in south Yunnan, China [49].

“ལྷོ་ལྷོ་ལྷོ་ལྷོ་” (*Arisaema utile*) was the most frequently cited substitute grain ($CI_{\text{Grain}}=0.53$). From August to November, its tubers are collected and prepared as substitute grain to treat seasonal food shortage. The tender stems and leaves of *A. utile* are local wild vegetable, and they were dried naturally and stored for cooking in winter or during major festivals. Sometimes, the Sherpa digs *A. utile* back and plants it in the home garden so that it can be eaten at any time. The fresh fruits of Araceae plants are local herbal medicine to treat flatulence and gastrointestinal discomfort in southern western Ghats, Tamil Nadu, India [50]. Khampa Tibetan people stir-fried young leaves of *Arisaema erubescens* as a supplementary vegetable and used tubers to relieve cough and treat hemoptysis and pneumonia in Northwest Yunnan, China [51].

“ལྷོ་ལྷོ་ལྷོ་ལྷོ་ལྷོ་ལྷོ་ལྷོ་” (*Actinidia venosa*) was the most mentioned wild edible fruit ($UR = 46$, $CI_{\text{Fruit}}=0.59$). It is an important and easily available wild edible fruit for the Sherpa to supplement vitamin C from September to November. Previous studies also showed that many species of *Actinidia* are rich in vitamins [7, 47, 52].

“ལྷོ་ལྷོ་ལྷོ་ལྷོ་” (*Schisandra grandiflora*, *S. neglecta*, *S. sphaerandra*) was another very important wild edible fruit that supplements nutrients seasonally, with 45 use-reports. The local name of “ལྷོ་ལྷོ་ལྷོ་ལྷོ་” has three plant taxa. Sometimes, locals collected a large bag of “ལྷོ་ལྷོ་ལྷོ་ལྷོ་” and ate it when the family rests while working in the farm. In China, *S. chinensis*, a traditional Chinese medicine, has been widely used in medicine and health food in recent years. It contains a variety of chemical components in the treatment of the central nervous system, cardiovascular and cerebrovascular system, hypoglycemic, liver protection and other aspects of potential pharmacological activities [53-55].

“ལྒྱུ་མེད་ལྒྱུ་མེད་” (*Urtica membranifolia*) was the most mentioned wild edible vegetable (UR = 45, $Cl_{Vegetable}=0.58$). It is an important source of vegetables for Sherpa people from May to July every year, and is often processed into a paste and eaten with potatoes.

4.2 Resilience and resistance of Sherpa food systems

WEPs are still an important part of the daily diet in many remote areas and underdeveloped areas, which is especially obvious during seasonal food shortages [22]. Due to the different growth cycles of plants in nature, the collection of wild plants in many places has obvious seasonality [10, 52]. The acquisition of WEPs was closely related to the shortage of cultivated food resources [11]. When normal food supply mechanisms were destroyed, such as famine, wild food was very important for the poor and the landless. The growth of crops takes time, and wild vegetables can grow quickly, which enhances the resistance of the local food system [4].

In the past, the Sherpa in Chenthang lived on hunting, and on this basis, they formed a “hunting culture” suitable for their economic life [35]. Previously, there was no land, and the agricultural management method was slash and burn cultivation. Based on 2010 statistic, Chenthang has a population of 2093 and an annual grain output of 148.46 tons, with an average of about 80 kilograms of per person [36]. Moreover, the native fruit trees only have *Prunus mira* Koehne and Walnut, which are low productivity and seasonal restrictions. And due to the huge altitude gradient, a diverse climate gradient is formed in Chenthang, which creates a diversity of wild plants. Therefore, WEPs are chosen by Sherpa people (and there is no other choice) as an important source of nutrients such as vitamins, minerals, and trace elements. The survey results showed that the diverse WEPs collected at different time periods provided different functions and services for the Chentang Sherpa people at specific time periods (Fig. 3).

4.2.1 Carbohydrate supplement

WEPs played an important role in supplementing staple food under normal circumstances [56]. From January to March, and from August to November, there were a period of food shortage. “When there was a shortage of food, from January to March, we collected ‘ལྒྱུ་མེད་ལྒྱུ་མེད་’ (*Cyclobalanopsis gambleana*) to be processed into flour for consumption. From August to November, we collected ‘ལྒྱུ་མེད་ལྒྱུ་མེད་ལྒྱུ་མེད་’ (*Arisaema utile*) to be processed into flour for consumption” The oldest woman described.

Chentang Town is under heavy snow from January to March, Sherpa people mainly consume the stored grain to survive. So every August and September, Sherpa women collect the nuts of *C. gambleana*, process them into starch and store them, and consume it in winter. Locals told us that the meal made from the starch of *C. gambleana* fills them up all day. In 2009, Liu tested the starch content of *C. gracilis* and *C. glauca*, the former content was 20.9%, and the latter was 26.2% [57]. In Asia and the Mediterranean basin Fagaceae plants were widely used for cooking, pasture, building materials, and the most used parts were nuts [20, 47, 58, 59]. We can speculate that genus of *Cyclobalanopsis* has a certain content of starch.

After July, the staple food of the locals was almost every day potatoes. From August to November, *A. utile* is collected, processed and consumed. In Nepal, tuber of *Arisaema intermedium* was important wild

supplementary food, which could be used as a condiment under normal circumstances and also be used as an emergency food ration during poor harvests and food shortages [60]. In dried tubers of *A. elephas*, *yunnanense* and *erubescens*, the starch content was 15.37%, 61.60% and 52.91%, respectively, among the three kinds of starch, and the amylopectin content ranged from 29.1–32.0% [61]. The starch content of *A. utile* needed further research.

In addition, other WEPs are also used as seasonal alternatives to grain consumption. the roots of *Solena heterophylla* were dug out, mashed, boiled into porridge or dried and ground into flour to make Tsampa. And in winter, Sherpa people also baked the rhizomes of *Polygonatum verticillatum*, *P. oppositifolium*, *P. cirrhifolium* and *Paris polyphylla* as food. Here are a few less-known but not missed alternative grain plants, namely the root tubers of *Equisetum hyemale* and bamboo seed that are also consumed as a source of starch. And the tuber of *E.hyemaleis* first recorded as edible. All of these substitute grain plants provide an important starch supplement to help them survive food shortages.

4.2.2 Nutrition supplement

WEPs are an important alternative source for people in remote and poor areas to obtain nutrients and biologically active compounds, such as vitamin and mineral, in addition to cultivating vegetables and fruits [62]. In remote areas with inconvenient transportation, wild vegetables were the main source of vitamins for local people, especially women and children [63].

Wild vegetables, regarded as healthy and beneficial foods, were rich in trace elements, cellulose, flavonoids, saponins and vitamins [64]. From May to July each year, a large number of wild vegetables are collected and consumed, some of which are consumed as soon as they are collected, while others are processed and stored. Such as the tender stems and leaves of *A. utile*, the tender leaves of *Polygonatum odoratum* and *Pteridium revolutum*, which were naturally dried and stored for consumption when there were no vegetables in the winter or there are in big festival like weddings. And wild fruit also collected.

Some studies had shown that WEPs contributed nutrients to human and revealed the nutrients contained in these plants. Yang analyzed the dry samples of *P. revolutum* and found it contained 29.42% protein, 7.4% soluble sugars, 16.27% crude fiber, 1.05% crude fat, potassium content 3772 mg/100 g, and magnesium content 377 mg/100 g, calcium content 215 mg/100 g, iron content 5.589 mg/100 g, manganese content 10.420 mg/100 g, which were much higher than cabbage and spinach [65]. According to the determination, the leaves of *Urtica laetevirens* from May to July contained from 23.73–34.75% of crude protein and 17 kinds of amino acids. And aspartic acid and serine reached the maximum value (3.33%) in June, and histidine and threonine reached the maximum value (2.52%) in May. Minerals and vitamins had higher levels from May to July, and then showed a downward trend [66]. The analysis of the nutritional components of *Schisandra chinensis* showed that crude protein content of *S. chinensis* was from 10.67–11.69% after entering the mature period, and Schisandrin was from 2.63 to 5.47 g/kg. And it contained 7 amino acids and essential elements (P, K, Mg, Fe, Zn and Cu) that are necessary for the human body [67]. Kiwifruit was rich in minerals and vitamins, which could enhance human immunity, digestion, and metabolism, and improve nutritional status [68].

People in different regions of the world were still consuming WEPs, but the important contribution of these plants to human diet was still not recognized in developed regions [62]. The research of wild edible vegetables could clarify the importance of WEPs to the rural dietary structure, while also providing potential trace element resources for the urban population [69]. The further scientific utilization and development of WEPs would help provide protection for human nutrition, especially people in remote areas.

4.2.3 Healthcare supplement

WEPs usually have the function of medicine and food. And wild vegetables not only provide minerals and vitamins but can be used as medicine for people's food security and health [10, 70]. For example, it was found that WEPs have anti-cancer (especially breast and stomach cancer), anti-inflammatory, anti-oxidant and anti-diabetic effects through the study of 56 kinds of wild vegetables [71]. In our study, 11 WEPs we collected have medicinal functions. The methods of preparation, local names, parts used and the ailments treated of these plants were recorded. The results are consistent with the statistics of common and endemic diseases - dysentery, intestinal parasitic diseases, arthritis and so on - in Chenthang town by Xigaze City and Dingjie County health Station in Xizang Autonomous Region [72, 73]. I have to mention an interesting phenomenon. *Polygonatum verticillatum*, *P. oppositifolium*, *P. cirrhifolium* and *Paris polyphylla* were traditionally used as edible plants instead of herbs in Chenthang. The leaves of these plants were consumed as soup, and rhizomes were roasted in winter to supplement starch. With the opening of Chenthang, Sherpa people learned some medical knowledge from tourists and drug dealers. Now they know how to use the roots of these plants to cook a decoction to treat cold. The exchange of information affects the dissemination of knowledge to some extent.

4.3 Socio-economic supplement

Local people could earn extra income by selling some of the economic WEPs [10]. And local people usually sold wild edible plants to urban residents and tourists in the market to increase their income [74]. With economic and social development, Chenthang Town welcomes tourists from all over the world with an open attitude. With the help of the Chinese government, some wild vegetables and fruits such as *Pteridium revolutum* and *Vaccinium glaucoalbum* were processed into products by Sherpa people and sold to tourists (Fig. 3). Moreover, the long-standing bamboo thangka of Sherpa was also made into products. Although bamboo thangka could be produced only three months in a year, there was a profit of 150,000 yuan in 2016, which helped 15 poor households get rid of poverty [75]. But while wild plants increase local income, excessive collection has caused a certain degree of damage to the local plant community. In recent years, drug dealers had come to Chenthang Town to purchase these medicinal plants in large quantities, resulting in the overharvesting of these plant resources. Studies have shown that because of huge market potential and the uncontrolled collection of medicinal plants, which has led to the disappearance of the herb from its natural habitat [76]. Unsustainable collection had also led to a decrease in the population of some edible plants with high market prices [51]. While WEPs are threatened, the local knowledge associated with them is also under risk. While developing the economy, we must pay attention to sustainable development based on the local ecological environment and biological resources. Therefore, it is necessary and urgent to systematically investigate and record local knowledge of plants and local biological resources.

4.4 cultural implications

Many WEPs also had cultural value, some of which were used in religious and cultural activities and were considered sacred. Some vegetables also had a certain social and cultural carrier function, accompanying their collection and donation activities, as a link to promote internal communication in the community [77]. Sherpa people had a long history of bamboo weaving. With the rise of stainless steel and plastic appliances, bamboo weaving appliances have gradually lost their advantages, so bamboo weaving skills are facing a crisis of loss. They combined traditional bamboo weaving techniques and thangka painting techniques to create bamboo weaving thangkas. The bamboo slices processed by them are as thin as a cicada's wing and as tough as a pampas grass, covering it on the text, and the text is clearly visible. Weaving these thin bamboo slices into thangkas not only retains the true qualities of thangkas, but also adds new agility to the thangkas. It is extremely artistic and this is the inheritance of national culture [35]. The utensils used in their homes, such as fruit baskets, and fruit plates, were all made of bamboo [75]. Therefore, bamboo weaving has become a cultural symbol of the Sherpa. In our research, there are 26 kinds of plants with two or more use-categories, which also demonstrate the importance of these plants for local survival and as a cultural heritage.

The diversity of parts and methods of using WEPs also presents the unique food culture of Sherpas to a certain extent. The purpose of local people using wild plants varies according to their priority of needs [11, 50, 78]. Plants are usually used by people for various purposes, such as food, medicine, fuel, and economic income. In Chenthang, there is a very interesting phenomenon. For example, the *Solena heterophylla* in this study, the Sherpa only developed the function of food. In Yunnan, thousands of miles away, the Hani people use *S. heterophylla* tuber decoction to treat stomachache [51]. The rhizome of *Equisetum hyemale* were found to be eaten for the first time. *Polygonatum verticillatum*, *P. oppositifolium*, *P. cirrhifolium* and *Paris polyphylla* which were famous Traditional Chinese Medicine, were traditionally used as wild vegetable and substitute grain plants instead of herbs by Sherpa people. Although study had shown different geographical conditions, vegetation types and cultures may influence the use of wild plants in different areas [78]. In other words, people in different regions have strong regional and cultural characteristics in the selection and utilization of WEPs. Further research should focus on this issue.

4.5 Detoxification and potential safety hazards

Although WEPs have many advantages, there are also some concerns. Wild species which often contain compounds toxic to humans, such as nitrates, oxalic acid [62], excessive consumption of high levels may give cause problems for human health. Therefore, it is necessary to consider the toxic compounds contained in these wild edible vegetables [79].

In the long-term living practice, Sherpas have also developed special methods to make themselves eat safer. For example, Sherpas call the process of removing tannins from nuts of *Cyclobalanopsis gambleana* "Remove black water". After the collected nuts are shelled and processed into large particles, they are wrapped into leaves of the azalea and washed continuously with water. When the "black water" is removed, the large particles of nuts will turn yellow. "If the harvested nuts are not processed, they will taste bitter. Furthermore, if you eat too much, you will get constipation." the locals told us. The reason may be that the tannins were not completely removed [80].

藏语名 *Arisaema utile*) is a multifunctional plant, and its tuber detoxification process is known to Sherpas as “Squeeze the juice”. Fresh tubers are processed into large pellets and then wrapped in azalea leaves, and then a heavy stone is pressed on them. After about 15 days, there is no juice flowing out and the sourness can be smelled, and the detoxification process is completed. In the process of processing, if you do not take protective measures, your hands will be swollen, itchy, or even peeling. At this time, you need to apply some butter. The cause of the adverse reaction may be that the calcium oxalate needle crystals contained in the Araceae hadn't been removed cleanly [81].

But local knowledge alone is not enough to manage food safety. Some WEPs can still have some side effects after being processed. For example, fresh tubers of the *Solena amplexicaulis* are often processed into porridge by Sherpa people, but even being heated and stewed for a long time, locals still felt the chin itch and stomach upsets after eating the porridge. Therefore, applying modern scientific methods to detect and monitor the toxicity of these edible plants and raising public awareness of food safety based on scientific research can fundamentally solve the problem. Future research could pay more attention to the local knowledge of food safety.

Conclusion

In total, the study examined 84 species of WEPs used by the Sherpas, belonging to 62 genera in 40 families. The local name of each Botanical taxa was recorded. Sometimes a local name has multiple Botanical taxa. The results showed that the most frequently mentioned family by the informants was Rosaceae, following by Urticaceae. According to the URs and CI value of ethno-species, the top five popular plants were 藏语名 *(Solena amplexicaulis)*, 藏语名 *Arisaema utile*, 藏语名 *Actinidia venosa*, 藏语名 *Schisandra grandiflora*, *S. neglecta*, *S. sphaerandra*, 藏语名 *Urtica membranifolia*). We interviewed 78 informants who provided us with 1,199 use-reports. These use-reports were classified into 6 use-categories. the most frequent use-category was “fruit”, followed by “vegetable”, “substitute grain”, “healthcare food”, “seasoning” and “beverage”. According to the description of the Sherpa people, we drew a collecting calendar of WEPs. The Sherpa collect WEPs almost throughout the year, except for January and February.

In our research, WEPs have made a huge contribution to the Sherpa dietary in supplementing carbohydrate, nutrition, and healthcare during the seasonal food shortage. These products and services also showed that the Sherpa had a deep understanding and close connection with the environment in which they lived. Additionally, Sherpa people learned some medical knowledge from tourists and drug dealers with the opening of Chenthang. For some poisonous plants, local people have developed unique detoxification methods, but from the public health perspective it is not enough to rely solely on local knowledge to treat the food healthy of edible plants. Future research could pay more attention to the local knowledge of food safety.

In general, the diversity and products and services of WEPs based on local knowledge enhance the resistance and resilience of local food supply system to treat food shortage which might be the answer to why the locals choose these plants.

Declarations

Acknowledgements

We are very grateful to the informants for sharing their knowledge with us. We also are very glad to say “ཁོ་ཁོ་ཁོ་ཁོ་ཁོ་ཁོ་” (Sherpa language: thank you) to all of the local people who had helped us in the field works. We thank technical guidance of Professor Pei Shengji. Besides, we thank Mr. Zun Zhun and Mr. Duo Ji as auto drivers in the wild works, Mr. Bian Ba and Mr. La Wang as Sherpa translator, and Mr. Yang Tao for fieldwork cooperation, and Mr. Guo Changan for [drawing](#).

Authors' contributions

WYH organized the study team and provided the technical support and guidance. DXY and ZY designed and executed the research plan. DXY wrote the manuscript. WL and ZHF recorded and organized the data. ZY and CWY identified the specimen and checked the information. All authors took part in the field works. All authors were involved in the drafting and revising of the manuscript and approved the final revision.

Funding

The study was funded by “the second Tibetan Plateau Scientific Expedition and research (No. 2019QZKK0502)” Project of China and the Strategic Priority Research Program of Chinese Academy of Sciences (No. XDA20050204, XDA19050301, and XDA19050303).

Availability of data and materials

Please contact the corresponding author for data requests.

Ethics approval and consent to participate

The authors asked for permission from the local authorities and the people interviewed to carry out the study.

Consent for publication

The people interviewed were informed about the study's objectives and the eventual publication of the information gathered, and they were assured that the informants' identities would remain undisclosed.

Competing interests

The authors declare that they have no competing interests.

Author details

¹ Yunnan Key Laboratory for Wild Plant Resources, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, China. ² University of Chinese Academy of Sciences, Beijing, China.

References

1. Su YF, Agrawal NK. "Xǐ mǎ lǎ yǎ dì qū qì hòu biàn huà shì yìng xiàng mù' zhōng guó yán jiū gài shù" "喜马拉雅地区气候适应项目" [Overview of China's research on the Himalayan Region Climate Change Adaptation Project]. *Clim Chang Res*. 2017; doi: CNKI:SUN:QHBH.0.2017-04-008
2. FAO, IFAD, UNICEF, WFP, WHO. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome, FAO.
<http://www.fao.org/documents/card/en/c/ca9692en>, Accessed 14 Jul 2020.
3. Laborde D, Martin W, Swinnen J, Vos R. Covid-19 risks to global food security. *Science*. 2020; 369(6503):500-502; doi: 10.1126/science.abc4765.
4. Zhang LL, Chai ZZ, Zhang Y, Geng YF, Wang YH. Ethnobotanical study of traditional edible plants used by the Naxi people during droughts. *J Ethnobiol Ethnomed*. 2016; 12(1):39; doi: 10.1186/s13002-016-0113-z.
5. Yesil Y, Celik M, Yilmaz B. Wild edible plants in Yesilli (Mardin-Turkey), a multicultural area. *J Ethnobiol Ethnomed*. 2019; 15(1):52; doi: 10.1186/s13002-019-0327-y.
6. Sachula, Geilebagan, Zhang YY, Zhao H, Khasbagan. Wild edible plants collected and consumed by the locals in Daqinggou, Inner Mongolia, China. *J Ethnobiol Ethnomed*. 2020; 16(1):60; doi: 10.1186/s13002-020-00411-2.
7. Luo BS, Liu B, Zhang HZ, Zhang HK, Li X, Ma LJ, et al. Wild edible plants collected by Hani from terraced rice paddy agroecosystem in Honghe Prefecture, Yunnan, China. *J Ethnobiol Ethnomed*. 2019; 15(1):56; doi: 10.1186/s13002-019-0336-x.
8. Fongnzossie EF, Nyangono CFB, Biwole AB, Ebai PNB, Ndifongwa NB, Motove J, et al. Wild edible plants and mushrooms of the Bamenda Highlands in Cameroon: ethnobotanical assessment and potentials for enhancing food security. *J Ethnobiol Ethnomed*. 2020; 16(1):12; doi: 10.1186/s13002-020-00362-8.
9. Benítez G, Molero-Mesa J, González-Tejero MR. Gathering an edible wild plant: food or medicine? A case study on wild edibles and functional foods in Granada, Spain. *Acta Soc Bot Pol Pol Tow Bot*. 2017; 86(3); doi: 10.5586/asbp.3550.
10. Ahmad K, Weckerle SC, Nazir A. Ethnobotanical investigation of wild vegetables used among local communities in northwest Pakistan. *Acta Soc Bot Pol Pol Tow Bot*. 2019; 88(1); doi: 10.5586/asbp.3616.
11. Ahmad K, Pieroni A. Folk knowledge of wild food plants among the tribal communities of Thakht-e-Sulaiman Hills, North-West Pakistan. *J Ethnobiol Ethnomed*. 2016; 12:17; doi: 10.1186/s13002-016-0090-2.
12. Aryal KP, Poudel S, Chaudhary RP, Chettri N, Chaudhary P, Ning W, et al. Diversity and use of wild and non-cultivated edible plants in the Western Himalaya. *J Ethnobiol Ethnomed*. 2018; 14(1):10; doi: 10.1186/s13002-018-0211-1.
13. Ong HG, Kim YD. The role of wild edible plants in household food security among transitioning hunter-gatherers: evidence from the Philippines. *Food Secur*. 2016; 9(1):11-24; doi: 10.1007/s12571-016-0630-6.
14. Singh B, Sultan P, Hassan QP, Gairola S, Bedi YS. Ethnobotany, traditional knowledge, and diversity of wild edible plants and fungi: A case study in the Bandipora District of Kashmir Himalaya, India. *J Herbs*

- Spices Med Plants. 2016; 22(3):247-278; doi: 10.1080/10496475.2016.1193833.
15. Janbaz KH, Akhtar T, Saqib F, Imran I, Zia-Ul-Haq M, Jansakul C, et al. Pharmacological justification of use of *Solena heterophylla* Lour. in gastrointestinal, respiratory and vascular disorders. *J Transl Med*. 2015; 13:134; doi: 10.1186/s12967-015-0470-8.
 16. Turner NJ, Turner KL. "Where our women used to get the food": cumulative effects and loss of ethnobotanical knowledge and practice; case study from coastal British Columbia. *Botany*. 2008; 86(2):103-115; doi: 10.1139/b07-020.
 17. Shirai Y, Rambo AT. Urban demand for wild foods in Northeast Thailand: A survey of edible wild species sold in the Khon Kaen municipal market. *Ethnobot Res Appl*. 2014; 12(1):113-129.
 18. Nanagulyan S, Zakaryan N, Kartashyan N, Piwowarczyk R, Luczaj L. Wild plants and fungi sold in the markets of Yerevan (Armenia). *J Ethnobiol Ethnomed*. 2020; 16(1):26; doi: 10.1186/s13002-020-00375-3.
 19. Dogan, Nedelcheva. Wild plants from open markets on both sides of the Bulgarian-Turkish border. *Indian J Tradit Knowl* 2015; 14(3):351-358.
 20. Rigat M, Gras A, D'Ambrosio U, Garnatje T, Parada M, Valles J. Wild food plants and minor crops in the Ripolles district (Catalonia, Iberian Peninsula): potentialities for developing a local production, consumption and exchange program. *J Ethnobiol Ethnomed*. 2016; 12(1):49; doi: 10.1186/s13002-016-0122-y.
 21. Savy M, Martin-Pre'vel Y, Traissac P, Eymard-Duvernay S, Delpeuch F. Dietary diversity scores and nutritional status of women change during the seasonal food shortage in rural Burkina Faso. *J Nutr*. 2006; (10):2625; doi: doi:10.1111/j.1365-277X.2006.00720.x.
 22. Bortolotto IM, Amorozo MC, Neto GG, Oldeland J, Damasceno-Junior GA. Knowledge and use of wild edible plants in rural communities along Paraguay River, Pantanal, Brazil. *J Ethnobiol Ethnomed*. 2015; 11:46; doi: 10.1186/s13002-015-0026-2.
 23. Myers N, Mittermeier RA, Mittermeier CG, Fonseca GABd, Kent J. Biodiversity hotspots for conservation priorities. *Nature*. 2000; 403(6772):853-858; doi: 10.1038/35002501.
 24. Zhao XF. "Shēng tài huán jìng bǎo hù yǔ jīng jì shè huì fā zhǎn de xié tiáo tǒng yī—yǐ pān dé bā zì rán bǎo hù yǔ shè qū fā zhǎn xiàng mù wéi lì" 生态环境保护与经济社会发展相协调——以潘德巴自然保护区项目为例 [Coordination and unit ecological and environmental protection and economic and social development—A Case study of Pandpa Nature Conservation and Community development project]. *Marx Reality*. 2014; (2); doi: 10.15894/j.cnki.cn11-3040/a.2014.02.001.
 25. Chen L, Zhang B, Chu WG. The happiness and expectation of Chenthang Town. <https://www.tibet3.com/news/zangqu/xz/2018-03-25/73334.html>, Accessed 25 Mar 2018.
 26. Bhandari S, Cavalleri GL. Population History and Altitude-Related Adaptation in the Sherpa. *Front Physiol*. 2019; 10:1116; doi: 10.3389/fphys.2019.01116.
 27. Sherpa PY. Sherpa perceptions of climate change and institutional responses in the Everest region of Nepal. Thesis. Dissertations & Theses - Gradworks; 2013.
 28. Devkota S, Chaudhary RP, Werth S, Scheidegger C. Indigenous knowledge and use of lichens by the lichenophilic communities of the Nepal Himalaya. *J Ethnobiol Ethnomed*. 2017; 13(1):15; doi:

10.1186/s13002-017-0142-2.

29. Giri A, Rana R. Ethnomycological Knowledge and Nutritional Analysis of Some Wild Edible Mushrooms of Sagarmatha National Park (SNP), Nepal. *J Nat Hist Mus.* 2009; 23:65-77; doi: 10.3126/jnhm.v23i0.1841.
30. Nepal M. Ethnobotany of the Rai and the Sherpa Communities in the Makalu-Barun Conservation Area. M.Sc. Thesis. Tribhuvan University, Cent Dept Bot.; 1999.
31. Bhattarai NK. Traditional phytotherapy among the sherpas of helambu, Central Nepal. *J Ethnopharmacol.* 1989; 27(1989):45-54.
32. Aranya J, Vanya J, Ajeya J. Study on ethnomedicinal plants of Sherpas of Sikkim, Himalayas. *J Tradit Folk Pract.* 2016; 02,03,04(1):174-177.
33. Shen L, Shi SL, Li JJ, Peng PH, Chen WD. Community diversity of Alpine Rhododendron in Qomolangma National Nature Reserve. *Acta Bot Boreali-Occidentalia Sin.* 2014; 34(12):2553-2561; doi: 10.7606/j.issn.1000-4025.2014.12.2553.
34. Ladio AH, Lozada M. Patterns of use and knowledge of wild edible plants in distinct ecological environments: a case study of a Mapuche community from northwestern Patagonia. *Biodivers Conserv.* 2004; 13(6):1153-1173; doi: 10.1023/b:Bioc.0000018150.79156.50.
35. Liu YJ. Research to the development of the Sherpa people in Chentang under the general layout of "Five in One". M.Sc. Thesis. Tibet university, School of Marxism; 2018.
36. Zhang L, Zuo M. "Rì kā zé dìng jié xiàn chén táng zhèn xià ěr bā rén tè sè chǎn yè fā zhǎn lù jìng yán jiū" 西藏日喀则定结县陈塘镇特色产业发展的路径研究 [Research on the development path of Sherpa characteristic industries in Chenthang Town, Dingjie County, Xigaze]. *Econ pract.* doi: CNKI:SUN:JMSA.0.2018-09-007.
37. Zhang HZ. "Xī zàng dà fēng fēn bù tè zhēng jí fēng zāi qū yù de chū bù huà fēn" 西藏大风风灾分布特征及防治对策 [Distribution characteristics of gales in Xizang province and preliminary classification of wind disaster areas]. *Tibet's Sci Technol.* 2006; 6; doi: CNKI:SUN:XZKJ.0.2006-06-016
38. Ni JG, Xie P. "Lì shǐ shí qī (1797-1958) xī zàng dì qū de báo zāi jí qí yìng duì kǎo shù—yǐ xī zàng dì fāng lì shǐ dǎng àn zī liào yán jiū wéi zhōng xīn" 西藏(1797-1958)暴风雪及其应对考述——以西藏地方历史档案资料研究为中心 [Study hailstorm and its response in Xizang during the historical period (1797-1958)—Based on the study of Tibetan local historical archives]. *Agric Archaeol.* 2007; (1); doi: 10.3969/j.issn.1006-2335.2007.01.033
39. Wen SL, Guo CM, Wu JL. Influence of collapsed buildings in Dingjie county in Xizang in China caused by Xijianbang 6.8 earthquake in India. *Plateau Earthq Res.* 2012; 24(3); doi: 10.3969/j.issn.1005-586X.2012.03.016
40. Chen L. The main measures and basic experience of poverty alleviation in Xigaze city, Xizang Province. http://www.tibet.cn/cn/fp/202005/t20200526_6788551.html, Accessed 26 May 2020.
41. Ager S. Tibetan writing system in Omniglot: an encyclopedia of writing systems and languages. <https://www.omniglot.com/writing/tibetan.htm>, Accessed in 2019.
42. Editorial Committee of Flora of Xizang, Flora of Xizang. Beijing, Science Press; 2013.
43. Editorial Committee of Flora of China, Flora of China. Beijing, Science Press; 2013.

44. The Plant List. Version 1.1. published on the internet. <http://www.theplantlist.org/>, Accessed 1st Jan 2013.
45. Tardío J, Pardo-de-Santayana M. Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria. *Econ Bot.* 2008; 62:24-39; doi: 10.1007/s12231-007-9004-5
46. Kufer J, Forther H, Poll E, Heinrich M. Historical and modern medicinal plant uses—the example of the Ch'orti' Maya and Ladinos in Eastern Guatemala. *J Pharm Pharmacol.* 2005; 57(9):1127-1152; doi: 10.1211/jpp.57.9.0008.
47. Li S, Zhang Y, Guo YJ, Yang LX, Wang YH. Monpa, memory, and change: an ethnobotanical study of plant use in Medog County, South-east Tibet, China. *J Ethnobiol Ethnomed.* 2020; 16(1):5; doi: 10.1186/s13002-020-0355-7.
48. Chen J, Su YC, Chen GQ, Wang WD. Ethnobotanical studies on wild edible fruits in southern Yunnan: folk names; nutritional value and uses. *Econ Bot.* 1999:2-14; doi: 10.1007/BF02860785
49. Ghorbani A, Langenberger G, Feng L, Sauerborn J. Ethnobotanical study of medicinal plants utilised by Hani ethnicity in Naban River Watershed National Nature Reserve, Yunnan, China. *J Ethnopharmacol.* 2011; 134(3):651-667; doi: 10.1016/j.jep.2011.01.011.
50. Aadhan K, Anand SP. Survey of wild aromatic plants and utilize Paliyar tribes ethnomedicinal of Sadhuragiri hills, southern western Ghats, Tamil Nadu, India. *Int J Bon Stud.* 2017; 2(6):18-24.
51. Ju Y, Zhuo JX, Liu B, Long CL. Eating from the wild: diversity of wild edible plants used by Tibetans in Shangri-la region, Yunnan, China. *J Ethnobiol Ethnomed.* 2013; 9:28; doi: 10.1186/1746-4269-9-28.
52. Jing W, Seyler BC, Ticktin T, Zeng YG, Ayu K. An ethnobotanical survey of wild edible plants used by the Yi people of Liangshan Prefecture, Sichuan Province, China. *J Ethnobiol Ethnomed.* 2020; 16(1); doi: 10.1186/s13002-019-0349-5.
53. Song F, Zeng K, Liao L, Yu Q, Tu P, Wang X. Schizandrin a inhibits Microglia-Mediated neuroninflammation through inhibiting TRAF6-NF-kappaB and Jak2-Stat3 Signaling Pathways. *PLoS One.* 2016; 11(2):e0149991; doi: 10.1371/journal.pone.0149991.
54. Kwon DY, Kim DS, Yang HJ, Park S. The lignan-rich fractions of Fructus Schisandrae improve insulin sensitivity via the PPAR-gamma pathways in in vitro and in vivo studies. *J Ethnopharmacol.* 2011; 135(2):455-462; doi: 10.1016/j.jep.2011.03.037.
55. Yun YR, Kim JH, Kim JH, Jung MH. Protective effects of gomisins against hepatic steatosis through AMPK activation. *Biochem Biophys Res Commun.* 2017; 482(4):1095-1101; doi: 10.1016/j.bbrc.2016.11.164.
56. Tardío J, Santayana MPd, Morales R. Ethnobotanical review of wild edible plants in Spain. *Bot J Linn Soc.* 2006; 152:27–71; doi: 10.1111/j.1095-8339.2006.00549.x.
57. Liu RL, Wang J, Liao WM. Comparative analysis of major nutrition ingredients of fruits of 10 species belonging to Fagaceae. *Acta Agric Univ Jiangxiensis.* 2009; 31(5).
58. Süleyman A, Mehmet T, Mustafa K, Muhsin K. Ethnobotanical survey of plants used in Afyonkarahisar-Turkey. *J Ethnobiol Ethnomed.* 2015; 11:84; doi: 10.1186/s13002-015-0067-6.

59. Li FF, Zhuo JX, Liu B, Jarvis D, Long CL. Ethnobotanical study on wild plants used by Lhoba people in Milin County, Tibet. *J Ethnobiol Ethnomed*. 2015; 11:23; doi: 10.1186/s13002-015-0009-3.
60. Sacherer J. The high altitude ethnobotany of the Rolwaling Sherpas. *Contrib Nepalese Stud*. 1979; VI(2).
61. Fan XX, Zhang SC, Lin LS, Zhao LX, Liu AZ, Wei CX. Properties of new starches from tubers of *Arisaema elephas*, *yunnanense* and *erubescens*. *Food Hydrocoll*. 2016; 61:183-190; doi: 10.1016/j.foodhyd.2016.05.015.
62. Pinela J, Carvalho AM, Ferreira ICFR. Wild edible plants: Nutritional and toxicological characteristics, retrieval strategies and importance for today's society. *Food Chem Toxicol*. 2017; 110:165-188; doi: 10.1016/j.fct.2017.10.020.
63. Ogle BM, Hung PH, Tuyet HT. Significance of wild vegetables in micronutrient intakes of women in Vietnam: an analysis of food variety. *Asia Pac J Clin Nutr*. 2001; 10(1):21-30; doi: 10.1046/j.1440-6047.2001.00206.x.
64. Luczaj L, Dolina K. A hundred years of change in wild vegetable use in southern Herzegovina. *J Ethnopharmacol*. 2015; 166:297-304; doi: 10.1016/j.jep.2015.02.033.
65. Yang X, Yue JW, Su C, Meng ZC, Chen HJ. Nutrient composition analysis of five kinds of wild edible ferns in Yunnan. *Hubei Agric Sci*. 2020; 59(14):153-155; doi: 10.14088/j.cnki.issn0439-8114.2020.14.031.
66. Zou YL, Wang N. Nutrients analysis of different harvesting time of *Urtica laetevirens* Maxim in Qinghai Plateau. *North Hortic*. 2011; 000(021):169-171; doi: CNKI:SUN:BFYY.0.2011-21-068.
67. Li AM, Wang YF, Li CY, Wang YF, Sun CH, Lin DH. A study on variation of nutritional ingredient in fruit ripe period of *Schisandra chinensis*(Turcz) Baill. *Spec Wild Econ Anim Plant Res*. 2004; (3); doi: 10.3969/j.issn.1001-4721.2004.03.003.
68. Richardson DP, Ansell J, Drummond LN. The nutritional and health attributes of kiwifruit: a review. *Eur J Nutr*. 2018; 57(8):2659-2676; doi: 10.1007/s00394-018-1627-z.
69. Flyman MA, Afolayan AJ. The suitability of wild vegetables for alleviating human dietary deficiencies. *S Afr J Bot*. 2006; 72(4):492-497; doi: 10.1016/j.sajb.2006.02.003.
70. Pieroni A, Houlihan L, Ansari N, Hussain B, Aslam S. Medicinal perceptions of vegetables traditionally consumed by South-Asian migrants living in Bradford, Northern England. *J Ethnopharmacol*. 2007; 113(1):100-110; doi: 10.1016/j.jep.2007.05.009.
71. Ju HM, Yu KW, Cho SD, Cheong SH, Kwon KH. Anti-cancer effects of traditional Korean wild vegetables in complementary and alternative medicine. *Complement Ther Med*. 2016; 24:47-54; doi: 10.1016/j.ctim.2015.11.004.
72. Sonam Tsering. "Dìng jié xiàn chén kuàng qū wèi shēng fáng yì gōng zuò de zōng hé diào chá" 定结县陈仓区卫生防疫工作综合调查报告 [Comprehensive investigation report on health and epidemic prevention in Chenthang Town, Dingjie County]. *Tibetan J Med*. 1993; (2).
73. Tsering Dundrug. "Dìng jié xiàn chén táng zhèn shí wù zhòng dú diào chá bào gào" 定结县陈塘镇食物中毒调查报告 [Investigation report on food poisoning in Chenthang Town, Dingjie County]. *Tibetan J Med*. 2004; 25(3); doi: CNKI:SUN:XZYY.0.2004-03-030

74. Cao YL, Li R, Zhou SS, Song L, Quan RC, Hu HB. Ethnobotanical study on wild edible plants used by three trans-boundary ethnic groups in Jiangcheng County, Pu'er, Southwest China. *J Ethnobiol Ethnomed*. 2020; 16(1):66; doi: 10.1186/s13002-020-00420-1.
75. He PL. "zhú biān táng kǎ dài dòng xī zàng chén táng gōu xià ěr bā rén tuō pín" 竹编唐卡带动西藏陈塘沟下鄂巴人脱贫 [Bamboo woven Thangka drives Sherpas from poverty in Chenthang valley, Xizang province]. <http://www.chinanews.com/cul/2017/04-27/8210704.shtml>, Accessed 27 Apr 2017.
76. Lohani N, Kumar R, Tewari LM, Joshi GC. Effect of different organic treatments on ex situ conservation of *Polygonatum cirrhifolium* Royle. *Int J Biodivers Sci Ecosyst Serv Manag*. 2011; 7(2):134-140; doi: 10.1080/21513732.2011.625370.
77. Kaliszewska I, Kolodziejska-Degorska I. The social context of wild leafy vegetables uses in Shiri, Daghestan. *J Ethnobiol Ethnomed*. 2015; 11:63; doi: 10.1186/s13002-015-0047-x.
78. Yang J, Chen WY, Fu Y, Yang T, Luo XD, Wang YH, et al. Medicinal and edible plants used by the Lhoba people in Medog County, Tibet, China. *J Ethnopharmacol*. 2020; 249(2020):112430; doi: 10.1016/j.jep.2019.112430.
79. Guil-Guerrero JL. The safety of edible wild plants: Fuller discussion may be needed. *J Food Compost Anal*. 2014; 35(1):18-20; doi: 10.1016/j.jfca.2014.05.002.
80. Huang LQ, Chen SF, Liu YP. Overview of Acorn research. *Amino Acids and Biotic resour*. 1998; 20:51-55; doi: CNKI:SUN:AJSH.0.1998-01-013.
81. Wu H, Zhong LY. Study on irritation of calcium oxalate crystal in Araceae plants. *China J Chin Mater Med*. 2008; 33(4).

Figures

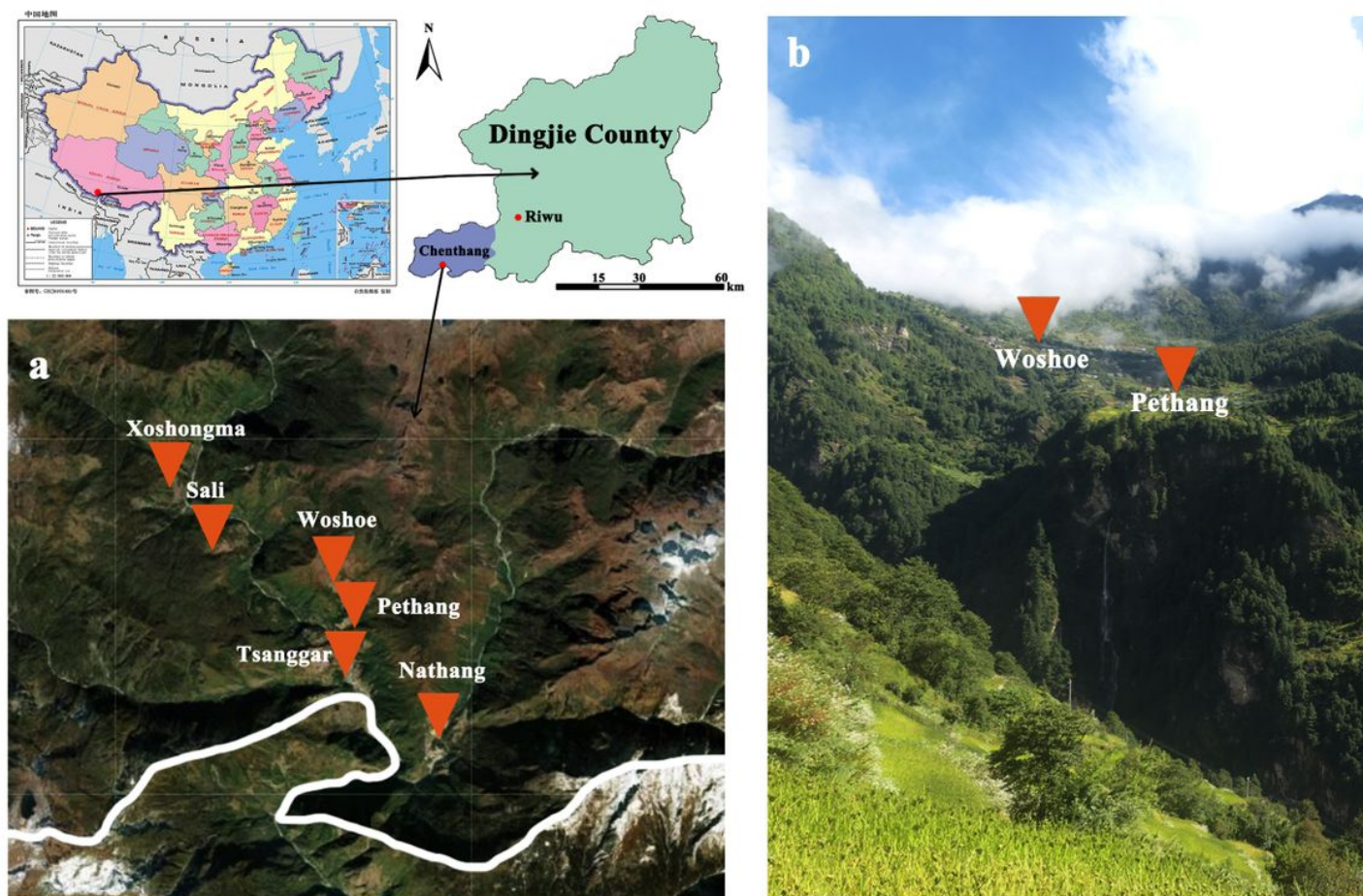


Figure 1

The location of study communities. Notes: a: a satellite image of six villages in Chentang Town. b: the natural landscape of Pethang Village and Woshoe Village, taken by Xiaoyong Ding. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

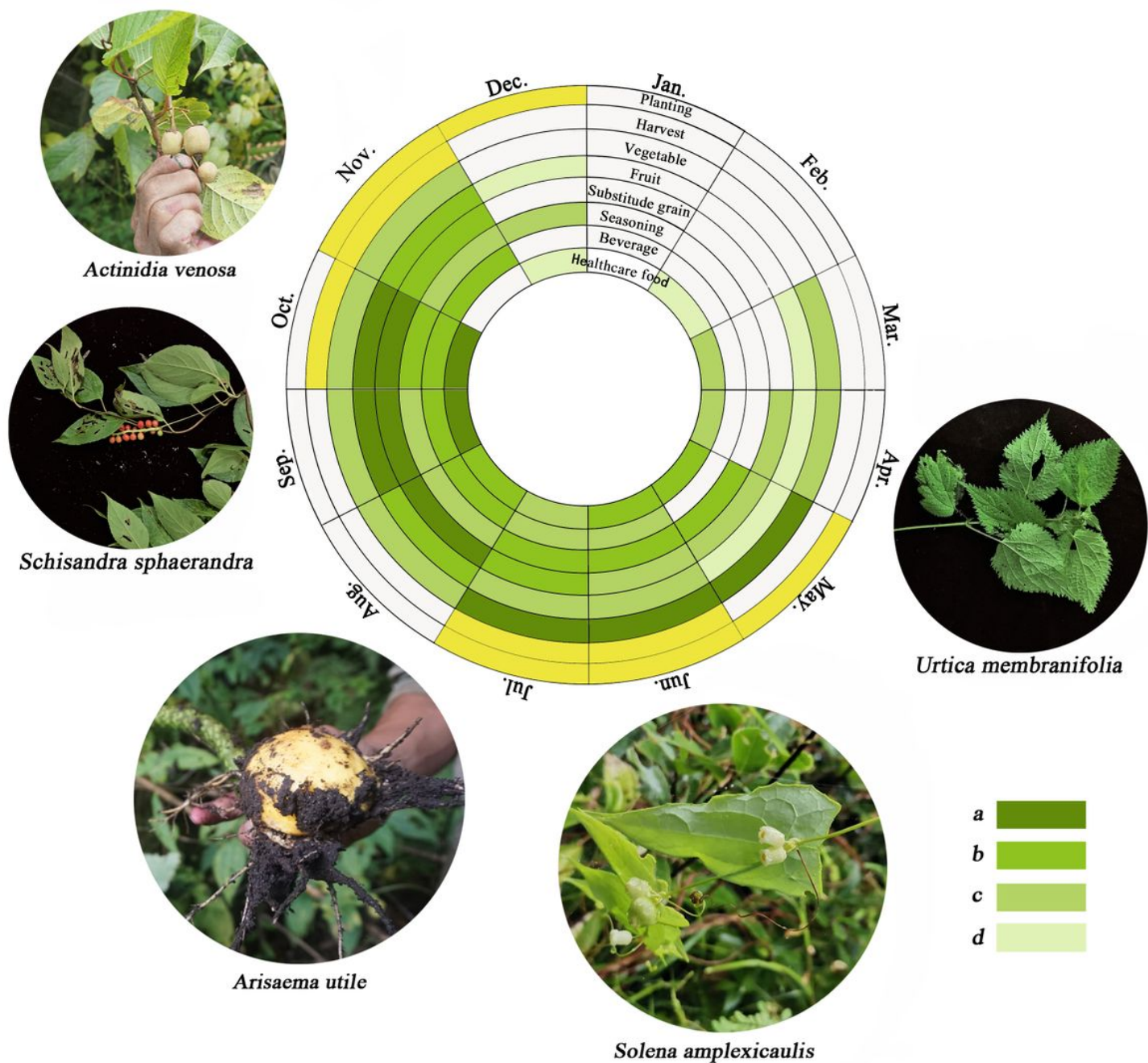


Figure 2

Collecting calendar of WEPs in Chenthang Town. Notes: 1: The shade of green is expressed as percentage. 2: $Y(\%) = A/B$ (A: Number of plants collected per month for each use category, B: The total number of plants collected in each use category). 3: a, b, c, and d indicate that $Y > 60\%$, $30\% \leq Y \leq 60\%$, $10\% \leq Y < 30\%$ and $Y < 10\%$, respectively. 4: Yellow indicates the time of Sherpa' agricultural activities.



Figure 3

Three wild economic plant products. 1 wild dried *Vaccinium glaucoalbum* and *V. gaultheriifolium* fruits. 2 dried young *Pteridium revolutum* leaves. 3 bamboo woven Thangka.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Additionalfile1.xlsx](#)