An ethnobotanical study of wild edible plants used by the Tibetan in the Rongjia river valley, Tibet, China

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Abstract

Background

Wild edible plants (It is abbreviated as WEPs below) play a crucial role in communities with limited communication with the outside world, where unstable factors like poor food supply and insufficient access to timely nutritional supplementation are common, such as the Himalaya region. To document the traditional WEPs knowledge and explore the significance of WEPs for communities with minimal global economic exchange, an ethnobotanical study was conducted in Rongjia Town which lies in a narrow valley near Mount Everest, Tibet, China.

Methods

This ethnobotanical study was conducted in three villages in Rongjia river valley between August 2021 to June 2023. Semi-structured interviews and participatory observations were used to collect the WEPs and related knowledge. The field works were performed with the assistance of local guides. We collected voucher specimens for each documented plant species for taxonomic identification. In this study, we use relative frequency of citation (RFC) to evaluate the comprehensive utilization value of WEPs.

Results

We interviewed 161 informants who provided us with 2499 use reports. In total, we collected 50 WEPs belonging to 28 families and 42 genera used by Tibetan people in Rongjia river valley. The WEPs are used as vegetable, fruit, seasoning, healthcare food, substitute grain and beverage. Among them, wild vegetable is the most commonly used categories, followed by wild fruit. And leaf is the most commonly consumed parts. The top three important WEPs are *Rosa sericea* f. *glandulosa*, *Zanthoxylum bungeanum* and *Urtica hyperborea*. Other than that, we also documented the current use situation of WEPs. The results shows that while some plants that were once important substitute grains are no longer used, these plants remain vivid in the memories of older people.

Conclusions

WEPs provided wild vegetable, fruit, seasoning, healthcare food, and ubstitute grain for Tibetan people in Rongjia river valley. And some WEPs become a important cultural carrier of older people, which can help to understand the relation of plant and local people in the past. In addition, WEPs can still increase resilience for local people lived in remote area when they face sudden destabilizing events in the future. Therefore, we suggest that future studies should focus more on WEPs in communities with limited communication with the world in order to improve their resilience.

1 Background

Mount Everest Reserve, the world's highest mountain nature reserve, is one of the world's biodiversity hotspots [1, 2]. The core region of the Mount Everest Reserve is one of the most remote and underdeveloped areas in both China and the world. Residents in this area have long been distributed in the harsh ecological environment of high altitude, strong ultraviolet light, lack of oxygen, low temperature and having to cultivate barren land [2]. Faced with this survival conditions entails heavy dependence of native people on natural resources for their livelihoods [3]. When normal food supplies insufficiency, wild edible plants (WEPs), which are identified as non-cultivated and non-domesticated plants play an indispensable role of the daily diet in many remote and underdeveloped regions [4–9].

Extreme geographical and ecological conditions not only isolate plant populations [10] and result in culturally unique biodiversity [11–13], but also shape traditional uses of WEPs [9, 14]. In recent years, researchers have carried out many ethnobotanical studies on the southern slope of the Himalayas [4–8, 15, 16], including Mêdog County [17], Chenthang Township [5], Burang Township [7], Yadong River Valley [4], Gyirong River Valley [6, 8] and other areas [16, 18–20]. For example, a field survey was conducted on the Monpa people in Mêdog County, using the changes of the plant knowledge mastered by the Monpa people to explore the changes of the local social and economic areas [17]; in order to cope with the seasonal food shortage caused by traffic blockage and scarce arable land, Chenthang Sherpa people use WEPs as seasonal food supplement [5]; WEPs were provide a survival guarantee for the local Tibetan and daman people in Gyirong River Valley [6, 8]. All these studies suggest that, in underdeveloped and remote areas, WEPs play an important role in a stable food supply and in the nutritional value of a balanced diet.

Rongjia river valley, located in the core area of the Mount Everest Reserve, is a rare Xanadu on the Qinghai-Tibet Platea [21]. It is one of the China-Nepal and South Asia channels from China to Nepal [22]. It has a high mountain and deep valley terrain, the elevation span is more than 5,000 meters and features a distinctive and diverse ecology, resulting in a unique three-dimensional climate, abundant plant resources, and high levels of biodiversity [23]. Because of the complex terrain and high altitude, the cultivated land area in Rongjia river valley is quite limited and its agricultural yield is low. In addition, the supply of external vegetables and fruits is also unstable due to inconvenient roads and the accidental influence of natural disasters. As a result, over their long history, the Tibetan people combining their environmental conditions, religious beliefs and cultural customs, formed a set of unique traditional food culture with a benign interaction with the natural ecological environment [24]. Even now, to enter the area of had to climb 5,400 meters of snow mountain, access to goods, materials and information from the outside world is still limited by environmental conditions. It is necessary to understand how local Tibetans recognize and use the plants in the surrounding environment to improve their survival resilience. As a consequence, the purpose of this research is to investigate, collect and document the WEPs and their traditional knowledge in the Rongjia river valley. The aims are to understand why the Tibetan people in the Rongjia river valley choose these plants and explore the significance of WEPs for communities with minimal global economic exchange.

2 Methods

2.1 Study area

Rongjia Township is located in the Mount Qomolangma National Nature Reserve in the southeast of the Qinghai-Tibet Plateau on the China-Nepal border, southwest of Dingri County, Xigaze City, Tibet Autonomous Region (Fig. 1). The total area is nearly 980 square kilometers, the forest coverage rate of 60%, the forest area of 12252.87 hectares. The cultivated land area is 48.6 hectares, and the grain sown area is only 24.93 hectares.

The terrain of Rongjia river valley is high mountain and deep valley landform, with an elevation from 2500m to 7400m[25]. The whole area of township is greatly affected by the warm and humid air flow of the Indian Ocean[25]. It belongs to the valley cutting climate area, which is a typical humid climate area of subtropical to alpine ice source. The area has abundant rainfall in summer and is warm in winter. The vertical differentiation of the mountain forest ecology of the rural areas is obvious, and the mountain is obviously divided into four sections from low to high: temperate trees, cold-resistant shrubs, bare rock, frozen peaks and snow all the year round, and it has rich plant resources and high biological diversity due to three-dimensional climate and unique landform[13, 25].

The Tibetan is a nation with a long history, mainly living on the Qinghai-Tibet Plateau, with rich knowledge of traditional culture. Plants occupy an important position in the Tibetan culture, and are used in medicine, food, architecture, textiles, and religious rituals [19, 25, 27]. The Tibetans in Rongjia river valley have a rich and unique knowledge of the local environment. All the residents of the township are Tibetan, the local Tibetans language is the Wei-Tibetan dialect. The income of Tibetan people in Rongjia Township mainly comes from grazing, labor export, border trade, mining of cordyceps, and national subsidies for border residents. Rongjia river valley residents live in Cang-mu-jian village, Da-cang village and Chenthang village (Fig. 1). Cang-mu-jian village is located in the middle of Rongjia Township, against a huge mountain, about 3400m altitude, alpine canyon landform, the main river in the territory from the northeast to the southwest. Da-cang village is located in the southwest of Dingri County, about 4060m above altitude. It has an alpine ecosystem and is rich in plant resources. At an altitude of 3667m above altitude, Chenthang village is distributed with rich ecosystem types, it is a key area for biodiversity conservation.

Before the construction of the pavement in 2015, the road conditions in and out of the Rongjia river valley were very poor, and the traffic was inconvenient. Even now, there is no vegetable market in Ronjia river valley. Therefore, the Rongjia river valley was less affected by the outside world, and the traditional knowledge was well preserved.

Figure 1 The location of study communities

2.2 Ethnobotanical surveys

Ethnobotanical field surveys were conducted from August 2021 to June 2023. This research was conducted after obtaining permission from the local government and community committee. During the survey, we explained our purpose to the community leaders and requested their assistance, which included providing local guides, translators, and other necessary aid. We interviewed 161 informants (93 men and 68 women) used the snowball method. All of them provided informed consent before the interviews. Semi-structured interviews, and participatory observations were used to conduct ethnobotanical field surveys. Semi-structured interviews were carried out among local people, and questions asked were as follows:

(1) Would you mind listing some wild plants you often consume, and which of them are edible?

(2) Which parts were used, such as root, stem, leaf or other part?

(3) why do you use this species?

(4) how do you cook those plant?

(5) where and when do you collect it?

(6) How are these plants used beyond just food? Can you share any traditional stories or legends associated with them?

We documented the ethnobotanical information for each plant, including scientific name, vernacular name, parts used, habitat, process method and other use purposes and tabulated a documented information about these plants (Table 2). We collected 1–3 voucher specimens for each species, the specimens were identified and preserved in the herbarium of the Kunming Institute of Botany, Chinese Academy of Sciences (KUN), and the attributed scientific names were checked using “plants of the world online” (https://powo.science.kew.org/).

2.3 Statistical analysis

Ethnobotanical quantitative indices relative frequency of citation (It is abbreviated as RFC below) was adopted in this study.

The RFC was used to quantify the frequency of use of certain species, which was determined using the following formula:

$$RFC = \frac{FC}{N}$$

FC refers to the number of informants who mentioned a particular wild edible plant and N represents the number of all informants participating in the survey. The RFC values vary from 0 to 1, and the higher the RFC value, the more important and valuable the plant is in the area. The FC value was used to indicate the importance of each wild edible plant, and allowed for all surveyed WEPs to be ranked in order of significance. [26–28].

3 Result

3.1 Characteristics of informants

This study interviewed 161 informants from the three communities of Rongjia Township (Table 1). Among the informants, 106 were men and 55 were women. The number of male informants (65.84%) was almost twice as high as female informants (34.16%). When we use the snowball method to select the informants, the informants mostly recommend men for us. In addition to, in the process of our household interviews, men in the family usually come forward to interviewed by us, while women often do not come forward. The age of the informants ranged from 18 to 99. Their average age was 51 years old.

Table 1 Demographic details of the informants

3.2 Diversity of wildedible plants in Rongjia river valley

In total, 50 wild edible plant species were documented, belonging to 28 families and 42 genera (Table 2). The results showed that the most frequently mentioned families are Rosaceae (7 species), followed by Amaryllidaceae (4 species). Brassicaceae, Ericaceae, Grossulariaceae, and Polygonaceae have three species. Five families have two species. The remaining 17 families have only one species each (Table 2). At the genus level, the most common genus was Allium, followed by Ribes, Lindera, Rosa and Zanthoxylum. The life forms of these WEPs are mostly herb (29) and shrub (13) (Fig. 2).

Many parts of plants are consumed, such as leaves, fruits, stems, seeds and roots, among which the most commonly consumed parts are leaves, followed by fruits and stems (Fig. 3). Wild vegetables and fruits are the two main categories of WEPs, and the used parts of wild vegetables are leaves, while the parts used parts of wild fruits are fruits.

Based on the information provided by the informants, we summarized WEPs into six use categories (Table 3). The WEPs used by Tibetan people in Rongjia river valley include vegetable (Ve), fruit (Fr), seasoning (Se), healthcare food (Hf), substitute grain (Sg) and beverage (Be). Among these, wild vegetables are the most commonly comsumed (24 species), followed by wild fruits (12 species) (Table 3).

WEPs are usually collected from April to September. The collection time of WEPs depends on the maturation of the parts used. Most of wild vegetables are collected from June to July. The collection time of wild fruits is mainly from July to September (Fig. 4).

Table 2 Wild edible plants in Rongjia river valley

Fig. 2 Life forms of WEPs

Fig. 3 Edible parts of WEPs

Table 3 Use reports and use categories

Fig. 4 Months of collection for WEPs

3.3 Vegetables

Half of all species are wild vegetables (24 species), they belong to 17 families, Brassicaceae and Polygonaceae have three species, Amaranthaceae, Apiaceae and Ericaceae have two species, the remaining families each have one species. The main edible parts of them are tender leaves and stems. It is usually collected from April to September and used only for the family's own consumption, not for sale. Its processing method is simple, usually boiling and then stir-fried or used to make soup. The most frequently mentioned three species were *U. hyperborean* (RFC=0.71), *Heracleum nyalamense* (RFC=0.56), and *Chenopodium album* (RFC=0.52) by Tibetan people in Rongjia river valley.

U. hyperborea is a seasonal vegetable. The Tibetans in Rongjia river valley only collected and consumed it from April to May. Because the *U. hyperborea* stems and leaves have a sharp thorn hair, thus, it has unique acquisition and processing methods. Most locals wear gloves and use scissors to collect the tender leaves of *U. hyperborea* for consumption. To handle the sharp thorn hair of *U. hyperborea,* rinse them slightly into boiling water before cooking. After boiling, the prickly hair of the *U. hyperborea*does not cause any irritation to the skin, at this point, add the *U. hyperborea* to the broth and cook it into a thick soup. During the interview, many informants (n=64) said they had to eat *U. hyperborea* once a year.

*H. nyalamense*is a plant endemic to Tibet. The Tibetans in Rongjia river valley collect it from June to August every year. It can peel the stem and then eat it raw directly, when the local people go up to the mountain, they use the *H. nyalamense* as a snack.

C. album can eat in many ways. After collection from April to May, its tender leaves can be cooked, fried, make steamed stuffed bun stuffing, and can be added into the broth like *U. hyperborea* to make a thick soup.

3.4 Fruits

Fruits (12 species) are the second largest use categories of WEPs, they belong to five families, Rosaceae have six species, Grossulariaceae have three species, the remaining families each have one species. Wild fruits are available from June to September, all fruits only for the family's own consumption, not for sale. They were consumed as fresh fruits like snacks and the main edible parts of them are fruit. The most frequently mentioned three species were *R. sericea*

f. *glandulosa* (RFC=0.76), *Rosa macrophylla* var.*glandulifera*(RFC=0.68) and *Fragaria nubicola* (RFC=0.68), which can be seen everywhere around Rongjia river valley.

R. sericea f. *glandulosa* and *R.macrophylla* var.*glandulifera* are all wild fruits of the Rosaceae and are ripe in July. In terms of the appearance of the two wild fruits are very similar, but *R.macrophylla* var.*glandulifera* needs to peel the fruit and remove the small thorns inside to eat, *R. sericea* f. *glandulosa*can eat directly.

F. nubicola maturity in September, grows in the ditch side, under the forest and hillside grass, ripe fruit can be directly eaten as wild fruit. These three plants are important and easily available wild fruits for vitamin C supplementation in July and September.

3.5 Seasoning

Seasoning is a very important food categories of WEPs in Rongjia river valley, documented 10 species. They belong to five families, Amaryllidaceae have four species, Lauraceae and Rutaceae have two species, the remaining families each have one species. These can be collected from April to September. The main edible parts of them are fruit. The most frequently mentioned three seasonings species were*Z. bungeanum* RFC=0.75 , *Z. acanthopodium* RFC=0.66 and *Allium wallichii* RFC=0.53 .

The local people have basically the same usage of the 10 spice plants, add chili peppers and grind plants into a seasoning (Fig. 5). In Rongjia river valley, the main food crop is potatoes, eating potatoes with this homemade seasoning is the most common way to eat by locals. In addition to potatoes, locals also use homemade seasonings to match their various staple. Although the eating method is the same, but different plants and different proportions, produce different styles of delicious in the collocation wisdom of the local people. The *A. wallichii* with an excellent flavor have been introduced into home gardens by local people.

Fig. 5 A: The most used seasoning – *Zanthoxylum bungeanum.* B: Tools used for grinding the wild seasoning. C: A homemade seasoning used for serving with flatbread.

3.6 Substitute grain

Three substitute grains were documented. They are *Arisaema erubescens* (RFC=0.18), *Pinellia ternata* (RFC=0.17) and *Satyrium nepalense* var. *ciliatum* (RFC=0.17).

In June to September, *A. erubescens* tubers will be collected by local people, peel and serve. An informant report said that "after eating *A. erubescens* once, we have completed a great event in our life". Before the liberation of Rongjia Township, some farmers would go to the landlord's house to help them hoe the fields for free in order to collect *A. erubescens* from the land. At that time, the people of Rongjia river valley were very fond of and dependent on *A. erubescens*.

The consumption of *P. ternata* is special, collect its seeds in July to August, wash them and grind them, wrap it up and bury it down for seven days. Finally, stir it together with Highland barley flour to make a dough bread.

Although the informants was reported (n=11), about *A. erubescens* and *P. ternata* collection and utilization is no longer available now. But in the former Rongjia river valley, these are very important two substitute grain plants.

S. nepalense var. *ciliatum* is eaten in a special way. Locals collect its tubers from August to September every year, wash them and steam them, remove the skin of the tubers, and grind it into a cylindrical shape similar to the sausage before eating it.

3.7 Other categories (Healthcare food and Beverage)

In total, 5 WEPs from other food categories, including healthcare food and beverage were present.A total of 4 species were found to have medicinal value and are used to treat rheumatism, sore throat, toothache, rhinitis, cold and begma. Among them, the most frequently mentioned three healthcare food were *Z. bungeanum* (RFC=0.75), *Z. acanthopodium* (RFC=0.66) and *R. anthopogon* (RFC=0.32).

Z. bungeanum and *Z. acanthopodium* at the same time as seasoning and healthcare food by the Tibetans in Rongjia river valley. After chewing *Z. bungeanum* a few times in the mouth, applied it in the toothache has the effect of analgesia, soaking water can prevent rheumatism. Some informants(n=6) mentioned that if people who has hypertension disease, it is necessary to use *Z. bungeanum* as little as possible. *Z. bungeanum c*an lead to increased blood pressure.

R. anthopogon leaves, collect in June and July each year, are chewed as a snack by Tibetans in Rongjia river valley. At the same time, soak the leaves of *R. anthopogon* in water can treatment cold and begma. These medicinal dietary plants are important for residents to improve health and prevent diseases.

As beverage, there is only one wild plant used by the Tibetans in Rongjia river valley. It is the *B. edgeworthii*. Local people collect *B. edgeworthii* leaves in May and June each year, dried and stored and soak in water for drink.

4 Discussion

4.1 Plant used in the past mirrors the fading life memories

There is very little documents that we can retrieve about the Tibetan people living in Rongjia Township, only in the local county records and a small number of documents found in part of the content [29]. Plants as a carrier of human understanding of nature carry people's past experiences and practices. From the interaction between plants and human beings, we can see a part of the microcosm of historical development, and give a reasonable explanation for the motive force of social evolution and its mechanism of action [30].

In the course of the investigation, we asked the informants to freely list the WEPs they used. The informants (n = 6) who are older will actively tell us a lot of its story when referring to *A. erubescens*. Before Rongjia Township was liberated, local people would voluntarily apply to plough the land for the landlords, and they would not ask the landlords to pay for their work, is the reason is that they wanted to collect the *A. erubescens* for consumption. Although *A. erubescens* was developed and used as a drug[31], with a bitter and astringent taste and toxicity, studies have proved that *A. erubescens* tuber starch content of 28%, but toxic and not edible[32–34]. It's actually not suitable for consumption. However, in their opinion, *A. erubescens* is the most delicious food and it is a great event in their life that they can eat *A. erubescens* once for their lifetime.

In the limited literature, we understand that local people were once in a system of serfdom. The oppressed locals, in order to survive, made efforts to discover certain plants in nature that could serve as important substitutes for grains. To ensure an adequate food supply while reducing the risk of food supply, it is best to eat as many plant species as possible[30]. We can use *A. erubescens* as the medium, from the stories of free labor and the descriptions of *A. erubescens* as the most delicious, we can see how hard it was for people to survive in the past and how important WEPs was to them, the use of these plants has formed a social memory in the memory of that generation.

Therefore, although now, *A. erubescens*, *P. ternata* and *S. nepalense* var. *ciliatum* has lost the habit of collecting and using this kind of plant as food substitute, we still think this document is meaningful, because these traditional knowledge can be seen as a kind of social memory, which reflects the close relationship between people and plants. We also suggest that, for plants that were used in the past but are no longer used or even barely remembered, we need to take into account the social context of the past to understand the story in depth, because the study of the interactions between humans and plants is one of the subject objectives of ethnobotany.

4.2 Services provided by WEPs collected by locals

Wild edible plants are an important part of the daily diet in many remote and underdeveloped areas [35, 36]. The demand for wild edible plants is closely related to the shortage of cultivated food resources. According to the information provided by the township head, the per capita grain output in Rongjia Township is 189.04 kg, far below the standard set by the World Food Program (WFP) for about 400 kg of grain per capita per year to maintain a healthy living and work. Under normal circumstances, when the food supply mechanism is destroyed by events such as famine, extreme weather, and earthquakes, WEPs play an important role in supplementing staple food [37]. The tubers of *A. erubescens* had been used as a food substitute to supplement carbohydrates in times of poverty and food shortages as emergency rations by the Tibetans in Rongjia river valley. Some studies have shown that in the dried tubers of *A. erubescens*, the starch content is 52.91% and the amylopectin content is 29.1%~32.0%[38]. These substitute grains are crucial for Tibetans in Rongjia river valley to deal with food shortage. The collection and utilization of WEPs by the local people can enhance their resistance to the local food system[21].

In remote areas where transportation is difficult, a variety of wild fruits and vegetables are used as vitamin, mineral and dietary fiber supplements [39]. Due to the barrier of snow mountains, it is difficult for residents in Rongjia Township to reach the county market. Many vitamins, minerals, plant proteins, and other nutrients need to be obtained from the surrounding natural environment. From April to September every year, many WEPs are collected and eaten by Tibetans in Rongjia river valley. Several studies have shown that WEPs provide nutrients to humans and have revealed the nutrients contained in these plants. For example, the most commonly used plant *U. hyperborea*, have high nutritional value. Studies show that the crude protein content up to 36.4%[40, 41], it is rich in essential amino acids such as lysine and tryptophan, which cannot be synthesized and indispensable for human body and animals, and large amounts of minerals such as Ca, Mg, K, Fe and Zn[41], carotene and vitamin B[42].

In addition to wild vegetables, wild fruits also provide local people with vitamins, minerals and other nutrients. Due to the rare cultivated land area, there is only one cultivated fruit trees – *Prunus mira Koehne*, this situation is very similar to several other Himalayan River valley regions [4–6, 8, 21], such as Yadong River Valley [4] and Gyirong River Valley [6, 8], local people in these area can only rely on wild fruit to supplement their need for wild fruit species and nutrition. For example, Rongjia river valley is rich in the plant of the genus Ribes wild fruit resources. The nutrient content of the wild fruits of the genus Ribes is characterized by low fat, high VC, VE and high potassium [43, 44]. For example, the ripe fruit of *R. sericea* f. *glandulosa* and *R. macrophylla* var. *glandulifera* is rich in vitamins and dietary fiber. Their fruits contained 16 kinds of amino acids, including 7 kinds of human Essential amino acid. The total amount of amino acids was more than 3500mg 100g, the fruit is rich in mineral elements, especially Ca, k, Fe and Zn [45]. The fruit is rich in a large amount of VC and moderate sugar-acid ratio, and the rich essential amino acids and trace elements can meet the nutrients needed by human body, and is a high-quality wild fruit with both taste and nutrition[46]. At the same time, some kinds of wild vegetables also contain unique physiologically active substances, and it also have extremely high medicinal value and corresponding health care function[48–50]. A previous pharmacological study showed that extracts of *U. hyperborea* significantly reduced the uric acid level of [50]. Hyperuricemia and gout affect human life in the worldwide. More importantly, the plants of *U. hyperborea* also contains a variety of bioactive substances, such as polyphenols, flavonoids, and polysaccharides[51]. So that it has the anti-inflammatory, antibacterial, improve immunity and other important physiological functions. This plant has the important effect of keep healthy, reducing uric acid and supplementing nutrition, and it is widely distributed in the plateau area of the yield is huge, and has the potential to develop into a plateau healthy food.

Some WEPs not only can make a positive contribution to the dietary structure and nutritional supplement, but also serve as medicines for health care[35, 52]. The leaves of *R. anthopogon* and *S. bifolia* documented can be used to treat cold and cough. The fruits of *Z. bungeanum* documented can be used to treat rheumatism and sore throat, The fruits of *Z. acanthopodium* documented can be used to treat toothache and rhinitis. Modern studies have also demonstrated that aqueous extracts of *Z. bungeanum* may play a therapeutic role in rheumatoid arthritis[53, 54]. About *R. anthopogon, S. bifolia* and *Z. acanthopodium* have never been used as a cure for any condition.

WEPs also contain cultural value. Vegetables have a certain social and cultural carrier function, play a role in promoting the communication within the community[55]. Rongjia river valley is the place of death for Master Milarepa who is the founder of the Kagyu School of Tibetan Buddhism[56]. It is said that Master Milarepa ate on wild *U. hyperborea* every day during his penance. Nowadays, the Tibetan people in Rongjia river valley must eat *U. hyperborea* once a year to commemorate Master Milarepa. People in different regions have strong regional and cultural characteristics, which influence their choice and use of wild edible plants[5]. Wild plants provide food for the community, and the tradition of use WEP become a part of the culture and traditions of these communities[57].

Compared with other studies on WEPs, fewer plant species were documented in this study [5, 7, 18], but for the locals, all of these species are important, the result of long-term adaptation, and a valuable cultural heritage. Tibetans lived in Rongjia river valley, one of the most remote and under-developed areas in the world, has received many benefits from WEPs, such as vegetables, fruits and substitute grain to support the daily life.

4.3 WEPs still can provided many benefits in the future

Nowadays, with China's rapid economic development, the government is paying more and more attention to the development of border and remote areas. In the context of China poverty alleviation in an all-round way, the living conditions of the residents have been greatly improved. In 2015 into the pavement was completed and opened to traffic, external materials can be transported to the ditch, these goods transported into the Rongjia Township slowly appeared on the dining tables of local Tibetans, the arrival of rice and white flour also makes the locals stop collection and utilization of *A. erubescens*, *P. ternata* and *S. nepalense* var. *ciliatum*.

With the help of the government and the efforts of the locals, the growing of tourism industry raised the incomes and living standards of residents of Rongjia river valley. Despite the improvement in living conditions, the Tibetan in Rongjia River valley have to encounter and overcome many unstable factors, Rongjia Township was hit by a 5.9-magnitude earthquake in 2015, even in May 2023, when we entered the Rongjia river valley still encountered the situation of heavy snow blocking the mountain, access to and from Rongjia river valley remains hampered by extreme weather. There is still instability in relying solely on external market supply, local residents also need to rely on WEPs to supplement their living needs. When suffer these effects of sudden factors, Mother Nature can help the locals. The wild substitute grains, vegetables, fruits and other benefits from nature can rise the resilience of survival. Therefore, it is important to document the traditional knowledge of WEPs for communities with minimal global economic exchange, whether in the past, now and future.

Conclusion

This study conducted in Rongjia river valley which is one of the most remote and least developed areas in China and the world. In total, 161 informants were interviewed and 50 wild edible plant species belonging to 28 families and 42 genera were documented. These plants not only provided grains, vegetables and fruits to maintain local people's daily life and adapt to special environment, but also the fading memory of local life story in the past.

Moreover, we believe that local WEPs can still increase resilience in the face of sudden destabilizing events in the future. Therefore, this study is of great significance for the documenting of traditional WEPs and related knowledge by Tibetan people in Rongjia river valley. The study also suggests that traditional food systems in communities with limited economic interaction with the world should be investigated to increase local resilience when suffer destabilizing events.

Abbreviations

WEPs Wild edible plants

RFC Relative frequency of citation

Declarations

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Authors' contributions

WYH organized the study team and provided technical support and guidance. WJ and DXY designed and executed the research plan. GCA and WJ identified the specimen and checked the information. WJ wrote the manuscript. WJ, DXY, GCA, ZX, FHW and WYH collected the data. YHZ plotted the distribution of the study sites. WYH reviewed the manuscript. All authors were involved in the drafting and revision of the manuscript and approved the final revision.

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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 no competing interests.

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Tables

Table 1 Demographic details of the informants

Characteristics	Number	Percentage%
Communities		
Chenthang Village	63	39
Cang-mu-jian Village	50	31
Da-cang Village	48	30
gender		
Male	106	66
Female	55	34
age		
18—30	9	6
31—40	21	13
41—50	29	18
51—60	48	30
61—70	30	18
71—80	12	7
81—90	8	5
90	4	3

Table 2 Wild edible plants in Rongjia river valley

Family	Scientific name	Chinese name	Vernacular name	use part	Life form	collect months	Food categories	Local use	Additional local use(s)	F
Amaranthaceae	*Chenopodium album* L.		ni-nei	leaves	herb	4—5	Vegetable	Made into soup or stir-fried		C
Amaranthaceae	*Dysphania schraderiana* (Roemer & Schultes) Mosyakin & Clemants		zheng-jiong-chei-du-ba	leaves	herb	6—7	Vegetable	Stir-fried		C
Amaryllidaceae	*Allium wallichii* Kunth		guo-ba-rang-dang-ma	aerial part	herb	4—5	Seasoning	Add chili peppers and grind them into a seasoning		C
Amaryllidaceae	*Allium przewalskianum* Regel		guo-ba-rang-ba	aerial part	herb	4—5	Seasoning	Add chili peppers and grind them into a seasoning		C
Amaryllidaceae	*Allium paepalanthoides* Airy-Shaw		sei-bu-lei	roots	herb	7	Seasoning	Add chili peppers and grind them into a seasoning		C
Amaryllidaceae	*Allium fasciculatum* Rendle		ru-guo	aerial part	herb	4—5	Seasoning	Add chili peppers and grind them into a seasoning		C
Apiaceae	*Heracleum nyalamense* Shan et T. S. Wang		kong-dang	stems	herb	6—8	Vegetable	Eat it directly after peeling		C
Apiaceae	*Eriocycla nuda* var. *purpurescens* Shan et Yuan		mang-gei	leaves	herb	6—7	Vegetable	Make steamed stuffed bun stuffing		C
Apocynaceae	*Cynanchum auriculatum* Royle ex Wight		wo-ma-jiong-jiong	fruit	shurb	9	Fruit	Eaten freshly		C
Araceae	*Arisaema erubescens* (Wall.) Schott		tuo-jiong	stems	herb	6—9	Substitute grain	Eat it directly after peeling		C
Araceae	*Pinellia ternata* (Thunb.) Breit.		tuo-jie	seeds	herb	7—8	Substitute grain	Making cakes		C
Brassicaceae	*Capsella bursa-pastoris* (L.) Medic.		ou-jia	roots and leaves	herb	6—7	Vegetable	Boiled		C
Brassicaceae	*Eutrema scapiflorum* (Hook. f. & Thomson) Al-Shehbaz, G. Q. Hao & J. Quan Liu		qia-ma-la-mu	leaves	herb	6—8	Vegetable	Stir-fried		C
Brassicaceae	*Cardamine lyrata* Bunge		cha-bu-jiu	stems	herb	4—6	Vegetable	Stir-fried		C
Caprifoliaceae	*Nardostachys jatamansi* (D. Don) DC.		bang-bu	stem and leaves	herb	6—7	Seasoning	Add chili peppers and grind them into a seasoning	Cultural: Ritual(leaves)	C
Caryophyllaceae	*Stellaria aquatica* (L.) Scop.		jia-ba-la-mu	leaves	herb	4—5	Vegetable	Made into soup or make steamed stuffed		C

							bun stuffing		
Coriariaceae	*Coriaria terminalis* Hemsl.	guo-ma-en-jiong	fruit	herb	9	Fruit	Eaten freshly		C
Cucurbitaceae	*Momordica cochinchinensis* (Lour.) Spreng.	gu-jiu-ru-bai	aerial part	liana	7—8	Vegetable	Made into soup or stir-fried		C
Dennstaedtiaceae	*Pteridium* Gled. ex Scop.	tong-xia	leaves	herb	5—8	Vegetable	Stir-fried		C
Dryopteridaceae	*Dryopteris barbigera* (T. Moore et Hook.) O. Ktze.	che-jiu-wa	leaves	herb	6—7	Vegetable	Stir-fried		C
Ericaceae	*Rhododendron anthopogon* D. Don	po-lu	stem and leaves	shurb	6—7	Vegetable	Eat it directly	Cultural: Ritual(leaves); Medicine: Cold(leaves), Begma(leaves)	C
Ericaceae	*Cassiope fastigiat*a (Wall.) D. Don	ba-jia-ba	aerial part	shurb	5—6	Vegetable	Boiled		C
Ericaceae	*Vaccinium fragile* Franch.	na-mu-di-di	fruit	shurb	9	Fruit	Eaten freshly		C
Fabaceae	*Caragana bicolor* Kom.	cha-ma	leaves	shurb	5—8	Vegetable	Boiled		C
Gentianaceae	*Swertia bifolia* Batal.	gei-duo-ba	whole plants	herb	8—9	Vegetable; Healthcare food	Boiled	Medicine: Cold(leaves), Begma(leaves)	C
Grossulariaceae	*Ribes alpestre* Wall. ex Decne.	giu-lu	fruit	shurb	8—9	Fruit	Eaten freshly	Cultural: Dyes(fruits)	C
Grossulariaceae	*Ribes orientale* Desfontaines	a-kang-bu	fruit	shurb	9	Fruit	Eaten freshly		C
Grossulariaceae	*Ribes takare* var. *desmocarpum* (J.D.Hooker & Thomson) L.T.Lu in L.T.Lu & S.M.Hwan	yi-bi-rang-bu	fruit	trees	8—9	Fruit	Eaten freshly		C
Lamiaceae	*Thymus quinquecostatus* Čêlak.	ga-ruo-ma-zi	fruit	shurb	7—8	Seasoning	Add chili peppers and grind them into a seasoning		C
Lauraceae	*Lindera nacusua* (D. Don) Merr.	lu-guo	fruit	trees	9	Seasoning	Add chili peppers and grind them into a seasoning		C
Lauraceae	*Lindera kariensis* W. W. Smith	rang-dang-ma	fruit	shurb	9	Seasoning	Add chili peppers and grind them into a seasoning		C
Malvaceae	*Malva pusilla* Smith	jiang-ba-la-mu	leaves	herb	7—8	Vegetable	Stir-fried		C
Ophioglossaceae	*Sceptridium daucifolium* (Wall. ex Hook. et Grev.) Y. X. Lin	pie-la-ba	leaves	herb	5—8	Vegetable	Boiled		C

Orchidaceae	*Satyrium nepalense* var. *ciliatum* (Lindl.) Hook. f.	tu	stems	herb	8—9	Substitute grain	Eat it directly after peeling		(
Polygonaceae	*Koenigia polystachya* (Wall. ex Meisn.) T. M. Schust. & Reveal	long-ma	leaves	shurb	6—7	Vegetable	Boiled	Animal Food: Fodder(aerial part)	(
Polygonaceae	*Rheum nobile* Hook. f. et Thoms.	cha-ba	stems	herb	7—8	Vegetable	Eat it directly after peeling		(
Polygonaceae	*Bistorta macrophylla* (D. Don) Sojak	ren-bu	leaves	herb	6—7	Vegetable	Stir-fried		(
Pteridaceae	*Coniogramme japonica* (Thunb.) Diels	a-wu-di-wu	leaves	herb	6—7	Vegetable	Boiled		(
Ranunculaceae	*Thalictrum foetidum* L.	gu-bu	aerial part	herb	6—7	Vegetable	Made into soup or stir-fried		(
Rhamnaceae	*Berchemia edgeworthii* Laws.	pie-shi-zi	leaves	shurb	5—6	Beverage	Soak water to drink		(
Rosaceae	*Rosa sericea* f. *glandulosa* Yü et Ku	sei-ri-ma	fruit	trees	7	Fruit	Eaten freshly	Fuel: Firewood(roots)	(
Rosaceae	*Rosa macrophylla* var. *glandulifera* Yü et Ku	sei-bang-duo	fruit roots	shurb	7	Fruit	Eat it directly after peeling	Construction: Thatch(roots)	(
Rosaceae	*Fragaria nubicola* (Hook. f.) Lindl. ex Lacaita	ding-ba-jia-luo	fruit	herb	9	Fruit	Eaten freshly		(
Rosaceae	*Prunus mira* (Koehne) Yü et Lu	kang-bu	fruit	trees	8—9	Fruit	Eaten freshly		(
Rosaceae	*Rubus* L.	nia-niu-ma	fruit	shurb	9	Fruit	Eaten freshly		(
Rosaceae	*Potentilla* L.	rang-ba	leaves	herb	6—7	Vegetable	Boiled		(
Rosaceae	*Sorbus vestita* (Wall. ex G. Don) S. Schauer	ge-ru-bai	fruit	trees	8—9	Fruit	Eaten freshly		(
Rutaceae	*Zanthoxylum bungeanum* Maxim.	ei-ma	fruit	trees	9	Seasoning; Healthcare food	Add chili peppers and grind them into a seasoning	Medicine: Rheumatism(fruits), Sore throat(fruits)	(
Rutaceae	*Zanthoxylum acanthopodium* DC.	cha-dong	fruit	trees	6—7	Seasoning; Healthcare food	Add chili peppers and grind them into a seasoning	Medicine: Toothache(fruits), Rhinitis(fruits)	(
Urticaceae	*Urtica hyperborea* Jacq. ex Wedd.	sa-du-ba	leaves	herb	4—5	Vegetable	Consumed as a soup		(

Note: The * plants are no longer in use

Table 3 Use reports 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	24	1009
Fruits that were only eaten when they were ripe, similar to apple, pear and strawberry	Fruit	12	831
Plants that could be added to dishes or soups to increase the flavor of food	Seasoning	10	317
Not only edible plants, but could also be used by local people to treat diseases	Healthcare food	3	241
Plants that could be used as a direct starch supplement or processed into starch	Substitute grain	3	89
Plants that could be processed into home-made liqueurs or alcoholic beverages and processed into herbal teas	Beverage	1	12

Figures

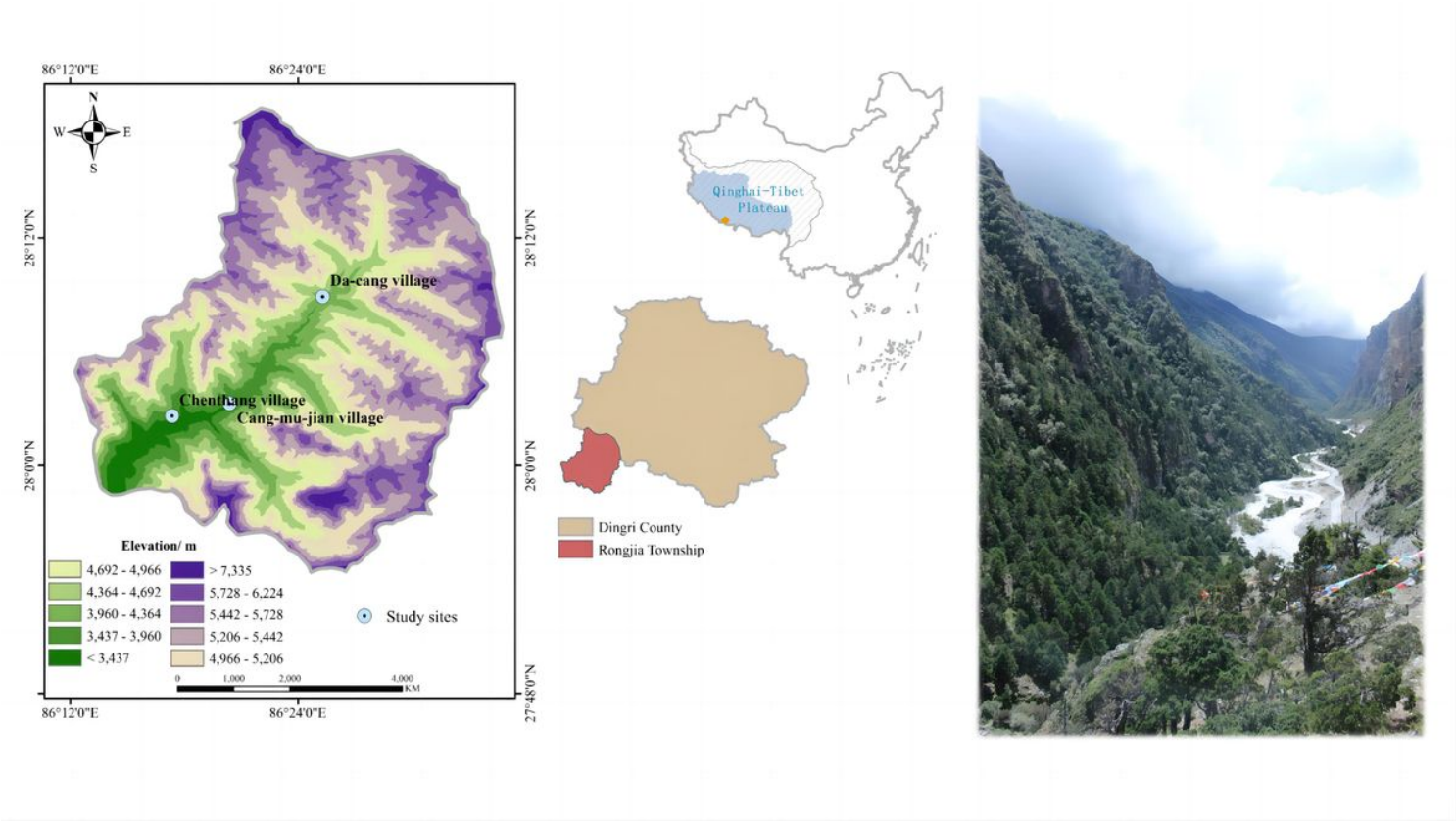

Figure 1

The location of study communities

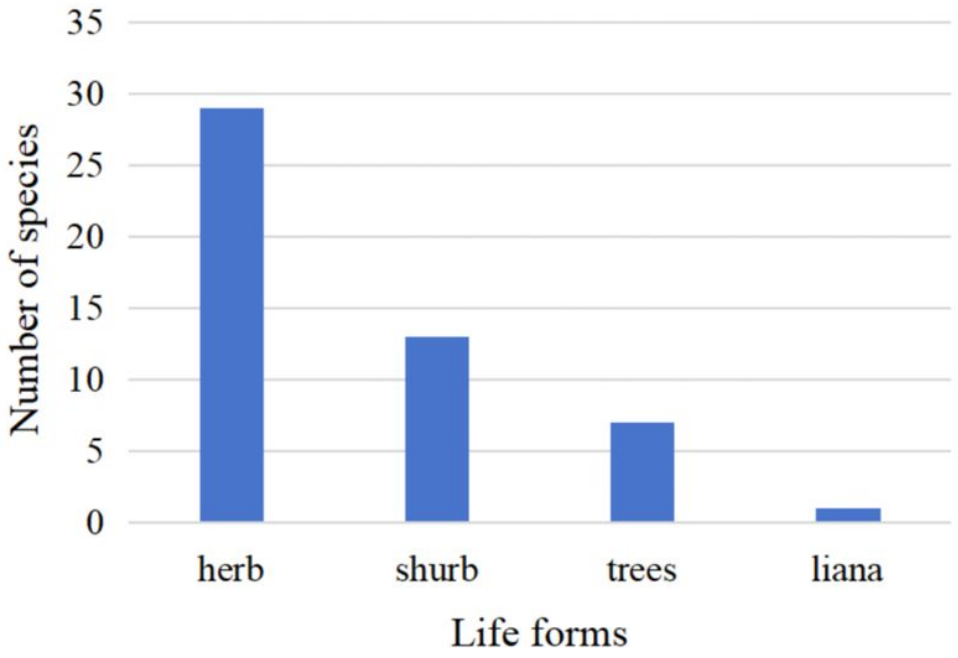

Figure 2

Life forms of WEPs

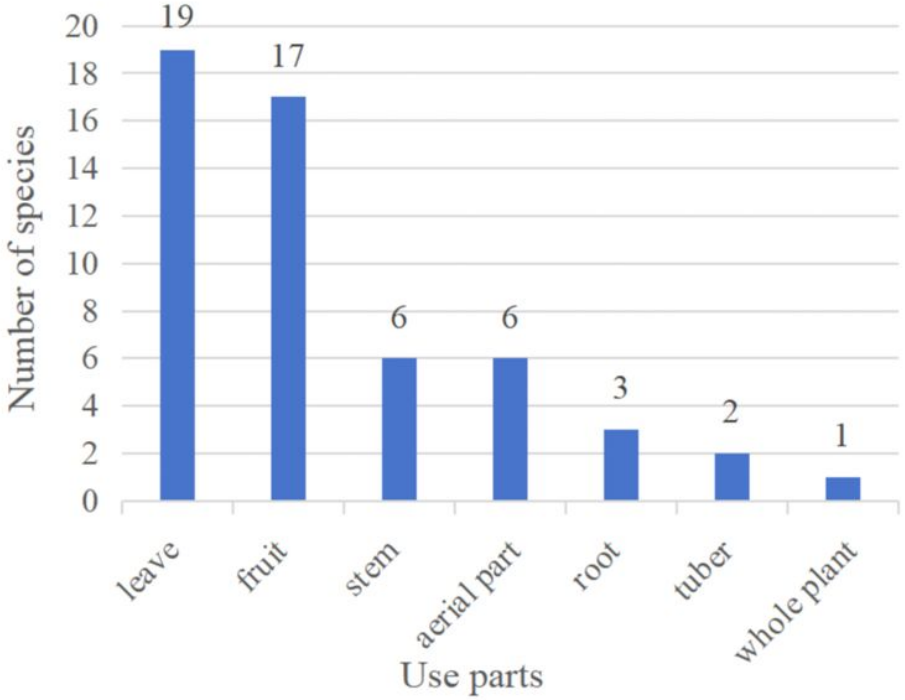

Figure 3

Edible parts of WEPs

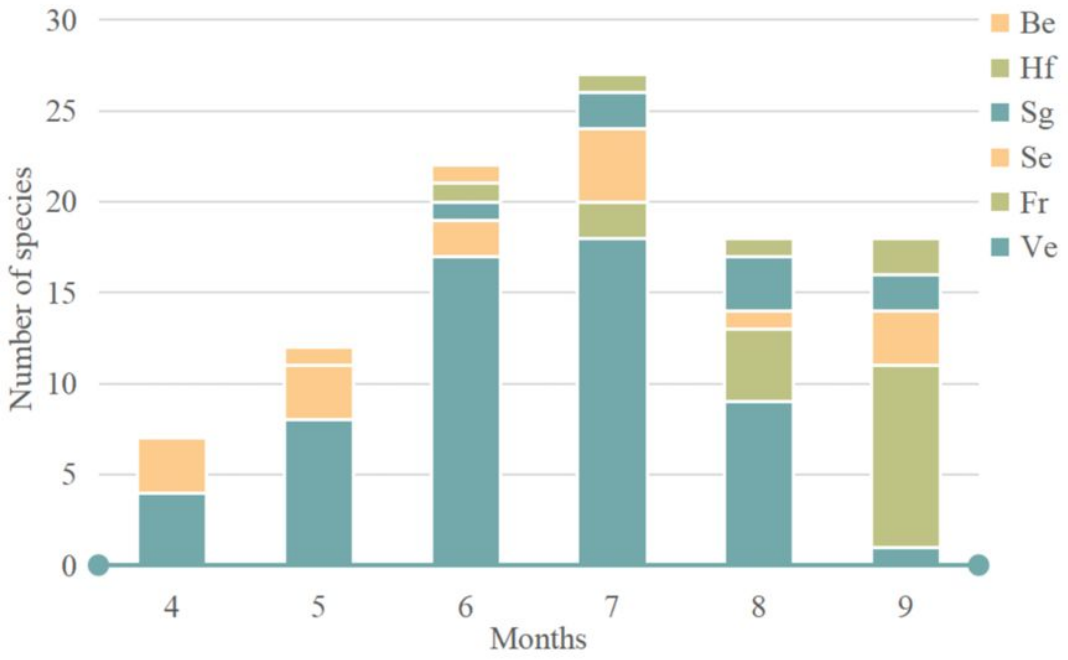

Figure 4

Months of collection for WEPs

Figure 5

A: The most used seasoning – *Zanthoxylum bungeanum.* B: Tools used for grinding the wild seasoning. C: A homemade seasoning used for serving with flatbread.