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Survey and Analysis of Vegetable Germplasm Resources in Hubei Province

Yanxu YIN^{1,Δ}, Minghua YAO^{1,Δ}, Fei WANG¹, Ning LI¹, Chunhai JIAO^{1,2*}

1. Institute of Economic Crops, Hubei Academy of Agricultural Sciences, Wuhan 430064, China; 2. Hubei Academy of Agricultural Sciences, Wuhan 430064, China

Abstract Based on the general survey of crop germplasm resources in Hubei Province, the third survey and collection of crop germplasm resources was conducted in 199 villages of 19 counties (cities/districts) of Hubei Province during 2015–2017. A total of 1 072 accessions of vegetables were collected. The taxonomy, distribution, agronomic traits and preservation of the vegetable germplasm resources, as well as the main vegetable resources and characteristic resources in the 19 counties (cities/districts) were analyzed. The results showed that the local vegetable landraces cover 26 families. Hong'an County, Zhongxiang City, Gucheng County, Nanzhang County and Yuan'an County have more vegetable landraces than other counties (cities/districts). The local landraces are characterized by good quality, strong resistance and tolerance to barrenness, but most of them are distributed in remote areas with low purity, low yield and serious threat of degradation. The local vegetable landraces are mostly preserved by some well-educated elder farmers. The vegetable cultivars of Cruciferae, Solanaceae, Cucurbitaceae, Liliaceae and Leguminosae account for 71.46% of the total vegetable resources. The characteristic vegetable resources such as pearl flower (*Staghylea bumalda* DC.), scallion (*Allium paepalanthoides*) and elephant-foot yam (*Amorphophallus* spp.) are scattered in the mountainous areas of Hubei Province. This study can provide reference for the protection and utilization of local resources of vegetables in Hubei Province.

Key words Vegetables, Germplasm resources, Local cultivars, Resource survey

1 Introduction

Biodiversity plays an important role in the biosphere life support system. Statistics show that in the past 50 years, species have been extinct rapidly, and up to 75% of crop genetic diversity has disappeared. Biodiversity is seriously threatened^[1]. Crops and their closely related wild plants are an important part of biodiversity. They are important material basis for crop breeding, theoretical research and agricultural production, with strategic significance^[2-3]. The practice of contemporary crop breeding proves that the achievement of breakthrough breeding achievements is often the mining, development and utilization of key genetic resources^[4]. Therefore, foreign research institutions attach great importance to the research, collection and evaluation of vegetable resources. For example, the French Zaragoza vegetable genebank has collected wild and domesticated pepper from all continents. In addition, the landraces of *Capsicum annuum* L. are collected to enrich the vegetable germplasm resources. Identification of these resources revealed that after natural selection and manual selection, the landraces have distinct regional characteristics in fruit

shape, fruit size and capsaicin content^[5]. The Korean pepper research institute has completed the diversity analysis of genetic resources among different cultivars of pepper and constructed the core genebank of pepper, achieving remarkable results in the development and utilization of germplasm resources^[6]. Chinese government and scientists have also attached great importance to the collection, preservation and utilization of crop germplasm resources. Since the 1950s, two systematic surveys have been conducted on China's crop germplasm resources or regional special surveys have been carried out in some areas^[7-8], and in situ or ex situ protection measures have been formulated for the resources already collected^[9-10]. However, with the rapid development of rural social economy, the increase in migrant workers and the accelerated speed of land transfer, many local varieties have disappeared. The status of vegetable germplasm resources in China is still unclear, and the collection, development and utilization of germplasm resources are relatively lagging behind. Therefore, carrying out the third survey on crop germplasm resources is conducive to revealing the status and promoting better the protection and utilization of crop germplasm resources in China, providing flexible technical support for agricultural supply-side reform.

Hubei is located in the middle reach of the Yangtze River and the north of Dongting Lake, and its terrain is in the transition zone from the second step to the third step. There are various types of landforms such as mountains, hills, mounds and plains, of which mountains account for 55.5%, hills and mounds account for 24.5% and plains account for 20% of the total area of Hubei Province. The terrain in the region is very different, and the maximum altitude difference is 3 105 m. The west, north and east

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ΔThese authors equally contributed to this paper.

* Corresponding author. E-mail: jiaoch@hotmail.com

sides of Hubei Province are surrounded by Wuling Mountain, Wushan mountain, Daba Mountain, Wudang Mountain, Tongbai Mountain, Dabie Mountain and Mufu Mountain, along with hills and mounds. The Jiangnan Plain is located in the south of Hubei Province, and it is connected with the Dongting Lake plain in Hunan Province. The annual average temperature is 15 – 17°C, and the annual precipitation is 860 – 2 100 mm. The climate is dominated by the subtropical monsoon climate in the north, with a characteristic of transition from subtropical to warm temperate zones. The province has sufficient sunshine, abundant heat and long frost-free period. Complex terrain and alternating climates endow diverse biological resources and abundant vegetable germplasm resources to Hubei Province^[11–14]. At the same time, there are 53 ethnic minorities gathered here, and their unique traditional culture and customs provide a basis for the preservation and utilization of specific resources, so ethnic areas have become the focus of resource collection^[15]. Therefore, the survey of vegetable germplasm resources was carried out in counties and cities where the Dabie Mountain, Mufu Mountain and Wuling Mountain are located. Throughout the survey, the vegetable germplasm or local varieties with the characteristics of Hubei Province were collected to lay a foundation for the study of the diversity of vegetable genetic resources in Hubei Province.

2 Survey method and content

2.1 Survey method In July 2015, the "Third National Survey and Collection Action on Crop germplasm Resources" was held in Wuhan, Hubei Province, and resource survey work in Hubei Province was started. The survey work was carried out in Tongshan County, Yunxi County, Nanzhang County, Xianfeng County, Tongcheng County, Yangxin County, Qichun County, Wuxue City, Xishui County, Hong'an County, Macheng County, Fang County, Yuan'an County, Songzi City, Zhongxiang City, Gucheng County, Luotian County, Huangmei County and Yingshan County of Hubei Province. The townships surveyed were shown in Table 1.

In accordance with the technical specifications of the "Third National Survey and Collection Action on Crop Germplasm Resources", the survey on crop germplasm resources was conducted. Three townships (towns), with at least three representative villages in each township (town) were selected from each county surveyed. Due to the seasonality of crop germplasm resources, two surveys in summer and autumn were carried out in some areas. For the loss of resources caused by sudden disasters, re-collection of relevant resources was conducted to ensure the smooth development of the identification work.

Table 1 Townships (towns) surveyed and regional distribution of local vegetable germplasm resources or characteristic (excellent) vegetable germplasm resources in Hubei Province

Surveyed counties (cities/districts)	Surveyed townships (towns) or districts	Number of accessions	Excellent germplasm
Tongshan County	Dalu Township, Chuangwang Town, Jiugongshan Management District, Jiugongshan Town, Yangfanglin Township, Xiapu Town, Farmers' market of Tongshan County, Dafan Town of Tongshan County, Honggang Town, Cikou Township, Damu Mountain forest farm, Huangshapu Town	57	
Yunxi County	Anjia Township, Xiangkou Township, Hubeikou Township, Huaishulin special forest farm	29	
Nanzhang County	Wu'an Town, Limiao Town, Xunjian Town	68	
Xianfeng County	Huolongping Township, Pingbaying Town, Gaoleshan Town, Zhongbao Town, Xiaocun Township, Horticultural field of Xianfeng County	51	Scallion, Elephant-foot yam
Tongcheng County	Tanghu Town, Daping Township, Guandao Town, Sizhuang Township, Shadui Town, Horticulture field of Jiugongshan, Maishi Town, Wuli Town	44	<i>P. sibiricum</i>
Yangxin County	Huangsangkou Town	22	<i>K. indica</i>
Qichun County	Datong Town, Liuhe Town, Guanyao Town, Tanlin Town, Qingshi Town	56	Yam
Wuxue County	Shifosi Town, Yuchuan Town, Dafasi Town, Kanjiang office of Wuxue City, Meichuan Town	60	Yam
Xishui County	Lvyang Township, Triangle Mountain management committee, Caihe Town, Bailian Town, Guankou Town, Tuanpo Town	38	
Hong'an County	Tiantai Mountain Scenic Area, Qiliping Town, Huajiahe Town, Shangxinji Town	139	Pearl flower, <i>L. lucidus</i>
Macheng County	Sanhekou Town, Guishan Town, Yantianhe Town	63	
Fang County	Yerengu Town, Damuchang Town, Shangkan Township, Research center for dry grain crops of Fangxian County	61	Amaranth
Yuan'an County	Hekou Township, Jiuxian Town, Maopingchang Town, Mingfeng Town, Jushui River of Yuan'an County	66	Chinese mallow
Songzi City	Liujiachang Town, Xiejiaping Township, Weishui Town	58	
Zhongxiang City	Wenji Town, Yangzi Town, Jiuli Township, Dongqiao Town, Kedian Town, Zhangji Town	82	<i>Stachys sieboldi</i> Miq.
Gucheng County	Shihua Town, Wushan Town, Zijin Town, Xie Mountain forest farm of Gucheng County	72	
Luotian County	Fengshan Town, Hepu Town, Dahe'an Town, Baimiaohe Town, Jiuzihe Town	37	Radish
Huangmei County	Liulin Township, Tingqian Town, Wuzu Town, Kuzhu Township, Dahe Town	38	Pearl flower
Yingshan County	Fangjiazui Township, Shitouzui Town, Caopandi Town, Leijiadian Town	31	

2.2 Survey content In this survey of crop germplasm resources, wild vegetable germplasm resources and local vegetable germplasm resources were mainly collected. Based on the questionnaire of the "Third National Survey and Collection Action on Crop Germplasm Resources", the collection location, biological characteristics, source, planting time, habitat information, planting reasons, special use and characteristics, utilized position, quality, sowing date, cropping arrangement, cultivation and management conditions, seed retention methods and some characteristic information or farmers' recognition of the varieties surveyed were recorded in detail. According to the content of the questionnaire and relevant literature, the collected germplasm resources of the vegetables were classified preliminarily.

3 Survey results and analysis

3.1 Taxonomy of vegetable germplasm resources in Hubei Province

The results of the systematic survey show that the diversity of vegetable germplasm resources in Hubei Province is high. The 1 072 accessions of vegetables belong to 72 species or subspecies of 54 genera in 26 families. Among the various types of vegetable germplasm resources collected, 766 accessions of vegetables belong to Cruciferae, Solanaceae, Cucurbitaceae, Liliaceae and Leguminosae (asparagus bean, excluding kidney bean, the same below) (Table 2). They constitute the main body of vegetable germplasm resources in Hubei Province, accounting for 71.46% of the total germplasm resources surveyed. The families of Cruciferae, Solanaceae, Cucurbitaceae, Liliaceae and Leguminosae contain 143, 161, 236, 114 and 112 accessions of vegetables, respectively, accounting for 13.34%, 15.02%, 22.01%, 10.63% and 10.45% of total local vegetable resources in the province. The family Cruciferae mainly contains radish and cabbage, which cover the 62 and 46 accessions, accounting for 5.78% and 4.29% of the total vegetable germplasm resources in the province; the family Solanaceae mainly contains pepper, which covers the 134 accessions, accounting for 12.5% of the total vegetable germplasm resources in the province; the main local varieties in the family Cucurbitaceae mainly contains are pumpkin, cucumber and loofah, with a total of 76, 56 and 50 accessions, respectively, accounting for 7.09%, 5.22% and 4.66% of the total local vegetable resources in the province. The main local varieties in the family Liliaceae are garlic and onion, with 37 and 40 accessions, accounting for 3.45% and 3.73% of the total local vegetable resources in the province. The family Leguminosae mainly contains asparagus bean, with 112 accessions, accounting for 10.45% of the total local vegetable germplasm resources in the province. Among these germplasm resources, the proportion of perennial vegetable resources is small, accounting for 12.97% of the total vegetable germplasm resources. Annual or biennial vegetable germplasm resources account for 87.03% of the total vegetable resources.

3.2 Characteristics of local vegetable germplasm resources in Hubei Province

3.2.1 Distribution characteristics of local vegetable germplasm resources in Hubei Province. The vegetable resources in the 19 counties (cities/districts) were surveyed, and it was found that

Hong'an County, Zhongxiang City, Gucheng County, Nanzhang County and Yuan'an County have abundant local germplasm resources. In terms of distribution, Hong'an County is rich in local varieties such as pepper, pumpkin, asparagus bean and water melon (seed watermelon, named locally as Da Gua) (Table 2); Tongshan County, Wuxue City and Zhongxiang County are rich in mustard resources; Xianfeng, Qichun and Wuxue have rich yam resources; Local varieties such as radish, Chinese cabbage, pepper, cucumber, asparagus bean, leeks, garlic, pumpkin, winter melon, loofah, gourd, amaranth and taro are distributed in all counties and cities in Hubei Province; and characteristic vegetables such as Chinese mallow, *P. sibiricum*, *Sonchus oleraceus* L., *Kalimeris indica* (Linn.) Sch., *Memoralis hirta*, pearl flower, scallion, *Bergenia purpurascens* (Hook. f. et Thoms.) Engl. and mustard (*Brassica juncea* (L.)) are scattered in Hubei Province.

3.2.2 Characteristics of the growth and decline of local vegetable germplasm resources in Hubei Province. The local vegetable germplasm resources preserved in Hubei Province (Table 1) have the following characteristics. (i) The quality and taste are both excellent. (ii) The yield is low. (iii) In individual areas, local varieties are resistant to barrenness and have strong adaptability. (iv) The resistance is strong, and drug is not used during the growth period except the seedling stage. (v) The purity of local varieties of cross-pollination is low. (vi) The degradation of local varieties is more serious. (vii) They are mostly of dual-use type of medicine and food. (viii) They are transformed from wild type to domestication and cultivation type. (ix) Most of them are distributed in remote areas where the promotion of new varieties is weak and local varieties are scattered. (x) Most of them are preserved for local customs and habits, such as Qian Sui Gu (seed amaranth) in Fang County. (xi) The preservation amount of local vegetable varieties is small, and they are kept by single plant in some areas.

Compared with the results of previous resource surveys, the local germplasm resources in Hubei Province have disappeared rapidly for the following reasons. (i) The varieties have defects themselves, such as long production cycle and poor disease resistance. (ii) The promotion of new varieties is great. (iii) The urbanization process is accelerating, some places have been relocated or the germplasm preservation personnel are old, so that some local varieties have nobody to preserve. The survey results show that the local vegetable germplasm resources in Hubei Province are mostly preserved in old farmers with certain culture. In Xianfeng County, among the 35 households, the number of farmers over the age of 50 accounted for 94.29%, but they saved 28.86% of the local crop resources, accounting for 86% of the local vegetable varieties.

3.3 Current status of germplasm resources utilization and characteristics and utilization of characteristic resources in Hubei Province

The planting area or scale of local varieties in Hubei Province is decreasing day by day. In Macheng, according to the statistics of local varieties in 1956, the planting scale of Aizibai and local Heiyebai and other local Chinese cabbage varieties reached 400 ha; to 1981, this number declined to 40 ha; and in the survey conducted in 2014, it was found that the planting area was less than 0.67 ha. The planting area has dropped sharply.

Many statistical results show that the planting area of mountain cucumber in Fang County is still maintained in a relatively large area. The statistical area in 2014 was 200 ha. Most varieties of yam are domesticated from wild ones, and the planting scale is small. The characteristic vegetable varieties that can be preserved smoothly and drive local economy mainly include Maanshan pepper (*Capsicum annuum* L. var. *conoides* (Mill.) Irish) and elephant-

foot yam in Huolongping Township, Xianfeng County, radish in Hepu Town, Luotian County, taro (domesticated from wild) in Fang County, yam in Wuxue, pearl flower, pumpkin, pepper and seed watermelon in Hong'an County and *Allium chinese*, scallion and ginger in various places. Among them, the characteristics (Table 1), utilization and farmers' perceptions of some characteristic resources in Hubei Province are as follows.

Table 2 Taxonomy of main local vegetable germplasm resources in Hubei Province

Family	Genus	Species	Number of accessions	
Cruciferae	<i>Raphanus</i> L.	<i>Raphanus sativus</i> L.	62	
	<i>Brassica</i> L.	<i>Brassica rapa</i> var. <i>glabra</i> Regel	46	
		<i>Brassica juncea</i> (L.) Czern.	26	
		<i>Brassica napus</i> L.	4	
		<i>Brassica campestris</i> L. subsp. <i>chinensis</i> var. <i>utilis</i> Tsen et Lee	2	
Solanaceae	<i>Capsella</i> Medic.	<i>Capsella bursa-pastoris</i> (L.) Medic.	3	
	<i>Capsicum</i> L.	<i>Capsicum annuum</i> L. or <i>Capsicum frutescens</i> L.	134	
	<i>Solanum</i> L.	<i>Solanum melongena</i> L.	24	
	<i>Lycopersicon</i> Mill.	<i>Lycopersicon esculentum</i> Mill.	3	
Cucurbitaceae	<i>Cucurbita</i> L.	<i>Cucurbita moschata</i> Duchesne D	76	
		<i>Cucurbita pepo</i> L.	2	
	Not clear	NCI	1	
	<i>Cucumis</i> L.	<i>Cucumis sativus</i> L.	56	
			<i>Cucumis melo</i> L.	10
		<i>Cucumis melo</i> L. var. <i>flexuosus</i> (L.) Pangalo	4	
	<i>Luffa</i> Mill.	<i>Luffa cylindrica</i> (L.) M. Roem.	50	
	<i>Benincasa</i> Savi	<i>Benincasa hispida</i> (Thunb.) Cogn.	27	
	<i>Momordica</i> L.	<i>Momordica charantia</i> L.	22	
	<i>Lagenaria</i> Ser.	<i>Lagenaria siceraria</i> (Molina) Standl. var. <i>hispida</i> (Thunb.) H. Hara	11	
		<i>Lagenaria siceraria</i> (Molina) Standl. var. <i>siceraria</i>	33	
	<i>Sechium</i> P. Browne	<i>Sechium edule</i> (Jacq.) Sw. S	1	
	<i>Citrullus</i> Schrad.	<i>Citrullus lanatus</i> (Thunb.) Matsum. et Nakai	10	
	<i>Trichosanthes</i> L.	<i>Trichosanthes kirilowii</i> Maxim.	7	
<i>Trichosanthes anguina</i> L.		2		
Liliaceae	<i>Allium</i> L.	<i>Allium fistulosum</i> L.	40	
		<i>Allium sativum</i> L.	37	
		<i>Allium tuberosum</i> Rottler Rex Spreng.	23	
		<i>Allium paepalanthoides</i> Airy Shaw	1	
		<i>Allium cepa</i> L.	1	
	<i>Hemerocallis</i> L.	<i>Hemerocallis</i> sp. Baroni	6	
	<i>Lilium</i> L.	<i>Lilium brownii</i> v Brown	5	
	<i>Polygonatum</i> Mill.	<i>Polygonatum sibiricum</i> Redouté	1	
Leguminosae	<i>Vigna</i> Savi	<i>Vigna sesquipedalis</i> (L.) Fruw.	112	

(i) Pearl flower (Fig. 1A). The common name is Yu Hua Cai, which is a species of Staphyleaceae with strong rooting and tillering ability. The main root is developed. The planting height is 2–5 m. It usually takes 4–5 years from planting to flowering, with panicles at the top of the stem. The flower buds are like pearls and the flowers are white. It blooms in April–May, and fruits in July. The fruit is capsules. It is scattered in Hong'an County and Huangmei County. Occasionally, it is dug from the nearby mountains for concentrated planting. Its young leaves and branches can be eaten. The pearl flower in Hong'an County has long ears, fragrant taste and fresh color. Pearl flower contains a

variety of proteins, vitamins and trace elements. In local areas, dried pearl flower is usually used to make soup, cold salad and side dishes, and it can be purchased in the local market. Farmers believe that pearl flower has the effects of weight loss, beauty, lipid lowering and blood pressure reduction.

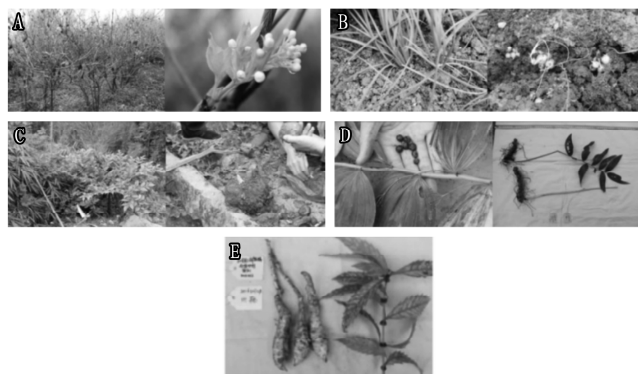
(ii) Scallion (Fig. 1B), commonly known as Ku Cong. It has been planted in Xianfeng for more than 60 years, with plant height of 25–30 cm, plant width of 30–36 cm, tiller number of 6–8, and leaf number per plant of 5–6. The root system is developed, and the leaves are drooping. The leaf posture is mainly curved. The leaf length is 30–38 cm. The transverse diameter is

0.5 cm. The leaf color is light green. There is a little amount of wax powder on the surface of leaves. The leaf nodes are dense. The pseudo stems are greenish white and compact. The base of the stem is chicken-legged. The base of the pseudo stem is highly swollen and slightly curved. The cut surface is oval. The flesh is green and white. There is no twitching. The spicy taste is medium. It is planted in late autumn and harvested in May of the following year, belonging to a biennial herb. It is propagated by bulbs or ramets. In Xianfeng County, it is usually used to make kimchi or raw food, and local farmers believe that it has the effects of detoxification, summer heat relief and blood pressure lowering.

(iii) Elephant-foot yam (Fig. 1C), commonly known as Hua Mo Yu, with a plant height of 160 cm, and a plant width of 184 cm. It is a perennial herb and usually propagated by tubers. After grading, large tubers are sold, and small ones are used for breeding. In Xianfeng, it has been planted for about 100 years, with an area of nearly 2 000 ha. The yield is high, and the yield per plant is 2.5–5.0 kg, and the maximum yield per plant reaches 10.0–15.0 kg. The yield per ha is 45 000 kg, and the maximum yield per ha reaches 90 000 kg. It prefers cold weather, and is not resistant to low temperature or drought. Cold damage will occur when air temperature is below 5°C. In Xianfeng, elephant-foot yam is mainly used to make elephant-foot yam tofu.

(iv) *P. sibiricum* Redouté (Fig. 1D), commonly known as Huang Jin, with a plant height of 40–92 cm, a diameter of 1–2 cm, verticillate leaves, umbellate inflorescences, and 4–7 black berries per plant. It mostly grows in the high-altitude hillside shade of the forest-grain intercropping area, and the surrounding plants include wild yam, torreyia, perilla, wild kiwi, *etc.* It is distributed in mountainous areas. At present, due to frequent mining, wild in the mountains is extremely difficult to find. Usually in the early spring or late autumn, disease-free roots or stems are taken off for propagation. The local farmers also use the seeds preserved in sand to breed. The farmers often use it to make wine or stew. The farmers mostly clean the rhizome of *P. sibiricum*, steam it in the steamer until it appears oily, and dry it, which is repeated seven times before use. In folks, it is used as both medicine and food to treat high blood pressure. Sometimes, it is used to cook. It is sweet in taste and loved by local children.

(v) *Lycopus lucidus* Turcz. ex Benth. T (Fig. 1E) (Labiatae), commonly known as Di Ou, a perennial herb with a plant height of 1.5–1.7 m, quadrangular stems, a leaf length of 5–10 cm, a leaf width of 1.5–4.0 cm, small seeds, hard fruit, flowering period from July to September, verticillasters, and fruiting period from September to November. It is more tolerant to cold, but is sensitive to drought. It prefers high fertility. Under conditions of domestication and cultivation, shading net is required. In local areas, it is usually used as medicine and food dually, or for ornamentation. At present, it is dominated by wild cultivars and scattered in Hong'an County. It is rarely used for domestication and cultivation. In local areas, its rhizome is taken in autumn for direct eating, stew or fired food, and sometimes for pickle. Occasionally, its tender stems and leaves are taken for eating.



Note: A. *Staghylea bumalda* DC; B. *Allium paepalanthoides*; C. *Amor-pho-phallus* spp.; D. *Polygonatum sibiricum* Redouté; E. *Lycopus lucidus* Turcz. ex Benth. T

Fig. 1 Characteristic vegetable germplasm resources

4 Countermeasures and suggestions

4.1 Increasing the intensity of collection of germplasm resources It was found that, in the survey, local breeding farms, horticultural stations, nature reserves, forest farms, and remote farmer gathering areas are the main sources of resources. Well-educated old farmers of age of 50–80 years in the remote mountainous areas are the focus of preservation and collection of germplasm resources. In the process of resource collection, only through increasing publicity efforts and employing experienced agricultural technology extension personnel or retired cadres in the agricultural sector as guides can the rare and excellent local varieties be found. In Hong'an County, up to 139 local vegetable resources are collected under the leadership of the head of the agricultural technology station, who led the survey team to the homes of the local farmers who had preserved scarce germplasm resources and Qiliping Town that is rich in vegetable germplasm resources. Thus, a lot of local resources were discovered. Therefore, taking the opportunity of the national survey of germplasm resources, the collection of germplasm resources should be increased, and the collected resources must be transferred timely to the hands of professionals for processing. As the scope of this survey was limited, and only representative counties and cities were visited, some resources have not yet been collected. Therefore, it is necessary to normalize the collection of resources.

4.2 Increasing research and development of excellent germplasm resources Local vegetable germplasm resources are mostly mixed groups, containing rich genetic information. Many local varieties have excellent quality, disease resistance and cold tolerance, and are products of long-term natural selection and artificial selection. They are an important resource for modern breeding. However, in the long-term cultivation of local varieties, the specie has been seriously degraded, and it needs to be purified and rejuvenated in order to exert its excellent characteristics. Combining the research institutes of the municipal colleges and universities, the scientific research efforts can be increased to promote the development and utilization of resources. The local varieties that have been collected need to be detoxified or purified and rejuvenated to promote their use as conventional species or construct a core

bank of local germplasm resources, followed by a target trait genetic group, thus mining the special functional genes and laying a foundation for local resource development.

4.3 Raising awareness of characteristic vegetable resources and developing rationalized development plan for characteristic vegetable resources

In Luotian County, micro-business platform has been constructed to sell local specialties (dried radish, wild vegetables). At present, Luotian County has carried out e-commerce targeted poverty alleviation strategies to drive local farmers to get rid of poverty and get rich. Other cities can build similar platforms. Local specialties such as yam, pearl flower, *Osmunda japonica* Thunb, scallion, *P. sibiricum* have high nutritional value. However, yam diseases are serious, and pearl flower cuttings have a low survival rate. Considering key technologies that constrain local resources, the technology of tissue culture can be used to solve the problem of seedling preservation, purification and detoxification under the assistance of universities and research institutes. At the same time, functional deep processing products or fruit and vegetable health foods should be developed through the combination with modern science and technology to improve the development and utilization of characteristic vegetable resources^[16-17]. Of course, attention must be paid to development and protection simultaneously in order to promote the healthy development of the characteristic vegetable industry.

References

- [1] ACOB SR, TYAGI V, AGRAWAL A, *et al.* Indian plant germplasm on the global platter: an analysis[J]. PLoS ONE, 2015, 10(5): e0126634.
- [2] SHEN D, LI XX, FENG LX, *et al.* Evaluation on resistance of cucurbitaceae germplasm resources to root-knot nematode[J]. Journal of Plant Genetic Resources, 2007, 8(3): 340-342. (in Chinese).
- [3] SI HP. Study on crop germplasm resources investigation information system[D]. Beijing: Chinese Academy of Agricultural Sciences, 2011. (in Chinese).
- [4] LI WF, LIN LF, QIN R, *et al.* Preliminary discussion of germplasm resources of local vegetable varieties in Yunnan[J]. Southwest China Journal of Agricultural Sciences, 2010, 23(6): 2133-2136. (in Chinese).
- [5] GONZALEZ-PEREZ S, GARCES-CLAVER A, MALLOR C, *et al.* New

- insights into capsicum spp relatedness and the diversification process of *Capsicum annuum* in Spain[J]. PLoS ONE, 2014, 9(12): e116276.
- [6] LEE HY, RO NY, JEONG HJ, *et al.* Genetic diversity and population structure analysis to construct a core collection from a large *Capsicum* germplasm[J]. BMC Genetics, 2016, 17(1): 142.
- [7] ZHENG DS, WU BL. Crop germplasm resources of Shennongjia and three gorges area[J]. China Seeds, 1992, 11(1): 1-3. (in Chinese).
- [8] YANG MJ, GONG YJ, ZHANG LQ, *et al.* Investigation and research of wild vegetables in Yunnan Province[J]. Southwest China Journal of Agricultural Sciences, 2004, 17(1): 90-96. (in Chinese).
- [9] WANG YJ. Study on the relationship between local protection and traditional culture in Yunnan Qiangui nationality area agricultural family of crop genetic resources [D]. Beijing: Minzu University of China, 2015. (in Chinese).
- [10] LI HY, LI J, HUANG F, *et al.* Phenotypic diversity of 78 accessions of wild allium species in Inner Mongolia[J]. Journal of Plant Genetic Resources, 2017, 18(4): 620-628. (in Chinese).
- [11] WANG QF, XU YH, HE XJ. Investigation and usability evaluation of chestnut germplasm resources in Dabie Mountains of Hubei Province [J]. South China Fruits, 2011, 40(3): 44-47. (in Chinese).
- [12] WANG FR, HE HP, GONG LZ, *et al.* Collection, evaluation and breeding utilization of red-flesh peach germplasm resources in Hubei Province[J]. Hubei Agricultural Sciences, 2013, 52(15): 3562-3565. (in Chinese).
- [13] ZHANG HZ, WANG L, HUANG HW, *et al.* Germplasm investigation and protectives strategy of the genus *Actinidia* in south foot of the peak of Shennongjia Mountains[J]. Resources and Environment in the Yangtze Basin, 2002, 11(5): 442-445. (in Chinese).
- [14] LIU FZ, DU WF. General situation of vegetable germplasm resources in Shennongjia and three gorges area[J]. China Seeds, 1993, 36(1): 17-19. (in Chinese).
- [15] ZHENG DS, FANG W, RUAN RC, *et al.* Diversity of agro-biological resources in Guizhou Province[J]. Journal of Plant Genetic Resources, 2017, 18(2): 367-371. (in Chinese).
- [16] GAO HY, YU ZY, ZHU MY, *et al.* The development of the functional factor in fruits and vegetables and health food[J]. Food and Nutrition in China, 2005, 11(5): 20-23. (in Chinese).
- [17] WANG XH, XU LW. Research on the processing techniques of rhizoma dioscoreae series beverage[J]. Agricultural Science & Technology and Equipment, 2011, 33(5): 31-32. (in Chinese).

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- [5] WOODS DL, CAPCARA JJ, DOWNEY RK. The potential of mustard [*Brassica juncea* (L.) Coss] as an edible oil crop on the Canadian Prairies[J]. Canadian Journal of Plant Science, 1991, 71(1): 195-198.
- [6] MALEK MA, BEGUM HA, BEGUM M, *et al.* Development of two high yielding mutant varieties of mustard [*Brassica juncea* (L.) Czern.] through gamma rays irradiation[J]. AJCS, 2012, 6(5): 922-927.
- [7] ENTANG T, ROSLINSKY V, BIFANG C. Molecular marker-assisted

- breeding for improved Ogura cms restorer line (*RfoRfo*) and mapping of the restorer gene (*Rfo*) in *Brassica juncea* [J]. Molecular Breeding, 2014, 34(3): 1361-1371.
- [8] HUANG Z, BAN Y, YANG L, *et al.* Fine mapping of the yellow seed locus in *Brassica juncea* L[J]. Genome, 2012, 55(1): 8-14.
- [9] LOVE HK, RAKOW G, RANNEY JP, *et al.* Breeding improvements towards canola quality *Brassica juncea* [M]. Saskatoon, Canada; Proc 8th Int Rapeseed Congress, 1991: 164-169.