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Geographical Indication of Unique Production Technology of Bahu Lotus Root

Huaen YANG[1*], Yangang LIU[2], Shiliang LIU[1], Zhaotang SHEN[3], Jing WANG[2], Hui ZUO[4], Chunguang LI[2], Xiugang YU[5], Deyou LIU[2]

1. Agricultural Technology Extension Center of Hedong District, Linyi City, Linyi 276034, China; 2. Linyi Academy of Agricultural Sciences, Linyi 276012, China; 3. Agricultural Comprehensive Service Center of Shizi Road Street, Junan County, Junan 276600, China; 4. Linyi Agricultural Quality Inspection Center, Linyi 276000, China; 5. Agricultural Comprehensive Service Center of Guichang Township, Tancheng County, Tancheng 276122, China

Abstract Bahu lotus root is a specialty of Hedong District, Linyi City, Shandong Province. It was recognized as a national product of geographical indication in 2011. This article describes the specific production area, unique production environment, rich cultural history and unique quality of Bahu lotus root, and summarizes its unique production from four aspects: selection of origin, selection of variety, production management and timely harvest, aiming to maintain the brand of Bahu lotus root to the greatest extent and further enhance the brand value and influence.

Key words Bahu lotus root, Geographical indication, Production technology, Linyi City, Shandong Province

1 Introduction

Bahu lotus root is a specialty of Hedong District, Linyi City, Shandong Province, known for its rare varieties, obvious characteristics and unique flavors, as well as rich medicinal, food therapy and ornamental value. Coupled with specific production environment conditions, special cultivation and management methods and rich cultural history, on December 20, 2011, the former Ministry of Agriculture of the People's Republic of China approved the implementation of the registration and protection of geographical indications of agricultural products for the "Bahu Lotus Root"[1]. Bahu lotus root cultivation has a long history. Because it was first produced in Bahu Town, Hedong District, Linyi City, it was named "Bahu Lotus Root". Lotus root planting has become the agricultural feature and leading industry of Bahu Town. It is an important channel for local agriculture to increase efficiency and farmers' income. The Lotus Pond Demonstration Park in Jingangling has developed into the fourth largest lotus root contiguous development demonstration base in China. Bahu lotus root has smooth and shiny skin, and fat, fine, crisp, tender, sweet and delicious flesh, without residue. It has high nutritional value, and can be eaten raw and cooked. Bahu lotus root is rich in trace elements such as iron, and has the function of replenishing qi and blood and enhancing immunity. It is the best vegetable product[2]. Since 2000, Hedong District has successively held three Linyi Hedong Lotus Calligraphy and Painting Festivals in the Bahu Lotus Root Production Base. In 2002, the lotus root brand of "Yuhu" registered in the Shandong Provincial Administration for Industry and Commerce passed the certification of pollution-free agricultural product. In 2006, the Bahu lotus root base was named Linyi Ecological Demonstration Base, and Bahu Town was named the "Hometown of Lotus Roots in Yimeng" by the former Linyi Municipal Agriculture Bureau and Linyi Municipal Organic Agricultural Products Association. In 2008, Bahu Town was named "Hometown of Lotus Roots in China" by the China Vegetable Circulation Association, and was named the National Agricultural Products Processing Demonstration Base by the former Ministry of Agriculture[2-3]. In 2011, the Bahu lotus root base was named the National Agricultural Standardization Demonstration Zone by the National Standardization Committee. In 2015, the value of Bahu lotus roots was evaluated as 33 million yuan by the regional public brand value of China's agricultural products. In 2017, the Bahu lotus root won the gold medal of the 5th Yimeng High-quality Agricultural Products Fair. In this article, the specific production area, unique production environment, cultural history and unique quality of Bahu lotus root are described, the unique production methods are summarized from aspects of production area selection, variety selection, production management process, and timely harvest, aiming to promote the leap-forward development of the lotus root industry in Hedong District, maintain the brand of Bahu Lotus Root to the greatest extent, and further enhance the brand value and influence of Bahu Lotus Root.

2 Specific production areas

The Bahu lotus root production area is located in Jingangling, Bahu Town, Hedong District, Linyi City, Shandong Province. It extends to Zhangbahu Village in the east, Tongfo Guanzhuang Vil-

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* Corresponding author. Huaen YANG, senior agronomist, engaged in agricultural technology research and promotion.
Editorial Office E-mail: asiaar@163.com

lage in the west, Guyizhuang Village in the south, and Zhangwuhu Village in the north, including 14 administrative villages such as Jingangling and Shaobahu. It is located in the northeast of Hedong District, Linyi City (118°30′ – 118°31′ E, 35°10′ – 35°13′ N), 12.5 km long from north to south, 2.6 km wide from east to west, with an altitude of about 70 m. The protected area is 720 ha, the production area is 720 ha, the annual output is 16 200 t, and the output value is 64.8 million yuan.

3 Unique production environment and rich cultural history

3.1 Unique natural ecological environment

3.1.1 Soil and topography. The production area is located on Jingangling Mountain, Bahu Town, Hedong District, Linyi City. The surface is sticky sandy loam, and the layer 60 – 70 cm below the ground is brown mortarized clay, with poor permeability and strong water retention, suitable for planting lotus root.

3.1.2 Soil nutrients. Bahu Town, Hedong District, Linyi City is a famous dehydrated vegetable processing city. There are 135 dehydrated vegetable enterprises in the town, with an annual output of nearly 200 000 t of garlic peel, onion root and other scraps, which contain a lot of organic matter and can be used as a base fertilizer for lotus root after simple retting, solving the problem of environmental pollution and loosening the soil. In addition, the garlic skin contains bactericidal substances that can improve the disease resistance and insect resistance of lotus roots, reducing the occurrence of rot disease and root-knot nematodes. This greatly improves the nutritional quality of lotus roots, while saving fertilizer input and reducing production cost, which is an incomparable production advantage of lotus roots from other producing areas[4-5].

3.1.3 Hydrology. The production area is rich in groundwater resources. The water is sweet and pollution-free, and can fully meet the production needs of lotus root.

3.1.4 Climate. The production area belongs to the semi-humid continental climate in the warm temperate monsoon zone with four distinct seasons. The annual average temperature is 13.3 ℃, the annual average temperature range is 27.7 ℃, and the daily range is 10.2 ℃. The temperature is suitable, and the temperature difference between day and night is large. The frost-free period is about 202 d. The average annual sunshine duration is 2 357.5 h, and the sunlight is sufficient. The average annual precipitation is 880.2 mm, mostly in summer. In the production area, raining and hot are at the same period, conducive to the growth and development of lotus root.

3.2 Long human history Bahu lotus root has a long history of development, with more than 200 years of cultivation history[5]. According to Linyi County Annals[6], Bahu lotus roots are planted in Jingangling, which has the highest altitude in the Bahu Town. The surface is sticky sandy loam, and the layer 60 – 70 cm below the ground is brown mortarized clay, with poor permeability and strong water retention. If rice, wheat and other food crops are planted in it, there is almost no production. In 1995, local people dug a pond manually in the low-lying land of Jingangling and planted lotus root. The lotus root produced is crispy and has long nodes and good taste, arousing the enthusiasm of the masses to develop the Bahu lotus root[2,7]. Since the 1990s, the party committee and government of Bahu Town successively invested more than 20 million yuan to comprehensively develop the 666-ha lotus pond in Jingangling, and insist on comprehensive management of ridges, water, forests, fields, roads, canals and ponds. Relying on the Jingangling Lotus Root Planting Cooperative in Hedong District, a lotus root planting base was established. Technical standards such as *Technical Regulations for Planting Lotus Roots and Technical Regulations for Storage and Transportation of Lotus Roots* have been formulated, forming a three-dimensional planting and breeding model of "fruits above pond, vegetables in pond slope, lotus roots in pond and fish in water". In July and August, when the lotus is in full bloom, it attracts a large number of tourists to enjoy the lotus flowers[2,7-10].

4 Unique product quality

Bahu lotus root has created its excellent quality characteristics due to its unique natural ecological environment and specific production methods.

4.1 External sensory characteristics Bahu lotus root has a beautiful appearance, and the surface is smooth, white and tender and translucent, with 4 – 5 nodes. The lotus root is fat, about 18 cm long, with 9 holes in the middle. Bahu lotus root is crispy, tender and free of residue. It is sweet and crunchy with sticky feeling.

4.2 Intrinsic quality indicators Bahu lotus root is rich in a variety of nutrients. The general moisture, sugar, starch, protein and crude fiber contents are 80.0% – 85.0%, 2.5% – 3.5%, 9.0% – 11.0%, 1.5% – 2.0% and 0.5% – 1.0%, respectively. It is very popular.

4.3 Product quality safety regulations During the production and processing of Bahu lotus root, it strictly implements the *Technical Specification for Quality Control of Agricultural Products of Geographical Indication: Bahu Lotus Root*, and the product quality meets the requirements of relevant national mandatory technical specifications.

(i) Packaging. The mark should be obvious. The product name, brand name, grade, weight (gross weight, net weight), and the name and code of the inspector all should be marked. Packaging should use hard cardboard boxes that are light, strong, not easy to deform, easy to stack and transport, and have a smooth and flat interior. (ii) Marking. Mark users should uniformly use geographical indications of agricultural products on their products or packaging (the combination of the name of the Bahu lotus root and the public identification pattern). (iii) During transportation, care should be taken to prevent rain. It is strictly forbidden to use warehouses and carriages that contain residual poisonous substances. It is not allowed to mix with toxic substances. The

packages should be stored in a ventilated and dry room to prevent mold.

4.4 Regulations on the use of special signs The production and operation enterprises within the area of Bahu lotus root shall comply with the requirements of the *Regulations on the Use of Public Marks for Agro-product Geographical Indications* and the authorization regulations of the Public Marks of the Agricultural Products Quality Safety Center of the Ministry of Agriculture. On the product or product packaging, national unified public logo is used correctly. A management system is established for the use of signs. The use of signs is recorded truthfully, registered and archived (for 3 years).

5 Specific production methods

5.1 Origin selection The production area of Bahu lotus root is located in 14 administrative villages including Jingangling and Shaobahu in Bahu Town, Hedong District, Linyi City. The environment of the production area meets the requirements of *Environmental Conditions for the Production Area of Pollution-free Agricultural Products* (NY/T 5010-2016)[11].

5.2 Variety selection The varieties with long and short nodes are widely planted. These varieties are crispy and tender, rich in iron element, and have good quality, high yield, storage resistance and good commercial properties.

5.3 Production management process

5.3.1 Pond preparation. (i) Preparation of lotus pond. The lotus pond is dug to the impermeable clay layer, generally no less than 60 cm deep. (ii) Preparation of pond bottom. Mellow soil (20 cm thick) is spread at the bottom of the pond, along with chicken manure (3 000 kg) and garlic processing leftovers (5 000 kg, including garlic slices, minced garlic flesh, *etc.*). The thickness of the soil layer reaches 20 – 30 cm.

5.3.2 Planting. (i) Variety selection. The quality of variety plays a vital role in the disease resistance and growth of lotus root. The selected lotus root variety contains two or more nodes, and the bud length is about 8 cm, without damage or broken buds. The lotus roots are plump, white and flawless[12]. (ii) Planting. The suitable period for planting is generally around Qingming Festival. Water is poured before planting to ensure that the water just drenches the mellow soil and just reaches the bottom of the pond. The planting density is 2 400 – 3 750 holes/ha, with one lotus root per hole. The amount of seed used is 3 750 – 4 500 kg/ha. The planting depth of lotus root is 10 – 13 cm. There are generally two ways to grow lotus root. ① Side by side. The lotus rhizomes are in the same direction, and each row is separated by 2 m. The positions of each row of lotus roots should be staggered to facilitate the uniform distribution of lotus sprouts and lotus leaves in the future. The lotus buds near the wall of the pond should face the inside of the pond to prevent the lotus roots from extending outside the pond. ② Triangular. Three lotus root holes point to the center. The two adjacent lotus roots should be staggered to facilitate the uniform distribution of lotus sprouts and lotus leaves in the future. The lotus roots planted should be turned up at a 15-degree angle to facilitate the rooting of lotus roots and avoid floating. After planting, irrigation is carried out and the water level is kept at 5 – 10 cm. After planting, they should be checked frequently. In case of floating, replanting is needed.

5.3.3 Management. (i) Water level adjustment. The water level adjustment adopts the mode of "shallow-deep-shallow"[13]. In the early stage of planting, the water level is kept shallow (5 – 10 cm), which is conducive to the rise of ground temperature and promotes the survival of lotus roots and the growth of young lotus roots. After the lotus leaf grows, as the temperature increases, the water level should gradually increase. When the summer temperature is higher than 35 ℃, the water level should not be less than 60 cm, otherwise the lotus root will stop growing. In the lotus rooting period, the water level is dropped to 5 – 7 cm to promote lotus root hypertrophy and enrichment. (ii) Topdressing. (i) Standing leaf fertilizer. After 2 – 3 floating leaves appear from each lotus plant and the first leaf does not completely spread, nitrogen, phosphorus and potassium compound fertilizer (450 kg/ha) is applied. (ii) Lotus rhizome enlargement fertilizer. When the leaves grow later, nitrogen phosphorus potassium compound fertilizer (300 kg/ha) is applied. During fertilization, it is necessary to shallow the field water properly. Fertilizers should not be sprinkled on the leaves, otherwise they should be poured with clean water. After fertilization, irrigation is carried out properly to the proper water level. (iii) Daily management. It is necessary to prevent the lotus sprouts from breaking and the lotus leaves from being damaged by external factors such as strong wind and man-made factors. After the lotus leaf is damaged, it affects the photosynthesis of the lotus root, thereby affecting its normal growth. If lotus sprout is broken, rain water will enter the inside of the lotus root hole, causing the lotus root to rot.

5.3.4 Disease and pest control. The main pests and diseases are rot disease and root knot nematode disease. (i) Rot disease. Garlic processing leftovers not only contain organic matter that can loosen the soil, but also contain sulfur that can be used for disinfection. Lotus root has strong disease resistance. When enhancing fertilizer and water management, there will be very rare rot disease in lotus root. In hot and rainy years, 40% carbendazim suspending agent (300 g/ha, 800 ×) can be sprayed for disease and pest control. (ii) Root knot nematode disease. It can be prevented by mixing garlic scraps in the soil before planting lotus roots, or, the pond is let idle and sun-dried for one year every after 5 – 7 years.

5.4 Timely harvest According to market conditions, lotus root is harvested timely. Generally, lotus root should be harvested after the lotus flowers have fallen off and before the coming of the next spring. When digging lotus root, the back leaf and the terminal leaf should be found first, and the front of the line between the two is the implantation position of lotus root[14]. When digging lotus root, the mud around the lotus root is first hollowed out to make it expose, then, the lotus sprout is broken downward towards the

back leaf, and finally, the whole lotus root is dragged backward by hand[15].

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(From page 37)

of territorial spatial planning is supervised and controlled, and a service system for all levels of government agencies and the public is established to effectively support the entire process of formulation, approval, implementation, monitoring, evaluation and early warning of spatial planning.

5 Conclusions

The territorial spatial planning system in the new era, as an important means for the Central People's Government to comprehensively deepen the reform of territorial space governance, will be completely different from the traditional space planning system. It is not a simple "multi-regulation integration", but a reconstruction of the existing spatial planning system[11]. It is a major reform of China's spatial planning system. It will fundamentally solve the contradiction of multiple regulations, completely change the thinking centered on economic construction, emphasize the concept of people-oriented, harmonious development of man and nature, and reflect the strategic, scientific and coordinated nature of territorial spatial planning. Combined with the reform of national institutions and the transformation of functions, the focus is on the supervision and control of the entire process of approval, implementation, management and operation, and the guiding and restrictive role of territorial spatial planning on the economic development of various regions, realizing the modernization of governance system and governance capabilities.

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