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Huayi 7: A New Cultivar of Collectible Walnut (Wenwan Walnut) with Profound Chinese Cultural Background

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Walnut (genus *Juglans*) is one of the oldest trees with harvestable products known to humans and has a history dating to 7000 BC in Persia (Vahdati et al. 2019). All parts of walnut trees have different uses, such as the trunk for timber production, roots and leaves for medicine, and walnut kernels for delicious foods. In addition, walnuts have a long history in popular culture, customs, and games in Silk Road countries (Vahdati 2014).

The genus *Juglans* contains 20 species, some of which are rare tree species (Karimi et al. 2010). In China, collectible walnuts (Wenwan walnuts) have high artistic and economic value, mainly referring to Ma walnuts (*Juglans hopeiensis* Hu). "Wen" and "wan" in "Wenwan" respectively mean "traditional culture" and "playing, viewing, and admiring." *Juglans hopeiensis*, a rare species endemic to northern China, is mainly distributed in the hilly, midelevation area of Hebei, Beijing, Tianjin, and Shaanxi. At present, there are still some disputes about the phylogenetic position of *J. hopeiensis* in phylogenomics of the walnut family. According to the species' geographical distribution and leaf, flower, and fruit morphology, *J. hopeiensis* is considered as a well-defined lineage and a sister clade to *Juglans mandshurica* Maxim., *Juglans cathayensis* Dode and *Juglans ailantifolia* Carr. belong to *Juglans*, the section *Cardiocaryon* (Aradhya et al. 2007; Stanford et al. 2000); however, variety identification based on phenotype observations may have a certain degree of uncertainty (Nickravesh and Vahdati 2023). The evidence from randomly amplified polymorphic DNA (RAPD) markers, chloroplast simple sequence repeat (cp-SSR) analysis suggested that *J. hopeiensis* has arisen by the hybridization of *J. mandshurica* and *Juglans regia* (Qi et al. 2014; Wu et al. 1999).

J. hopeiensis is also an endangered tree species and its natural population has been severely declining due to artificial logging and habitat destruction. The nutshell is thick and hard, and the kernel yield is low, making it unsuitable for consumption as a dry fruit; however, the appearance of the nuts is beautiful with deep grooves and varied veins, making them suitable for playing with and appreciating. Wenwan walnuts originated from the Han and Sui dynasties, became popular in the Tang and Song dynasties, and flourished in the Ming and Qing dynasties, with a history of more than 2000 years. In the process of historical sedimentation, Wenwan walnuts have gradually formed four main types, represented by "lion head," "chicken heart," "official cap," and "young master hat" (Fig. 1). While playing with them, it implies the eastern philosophy of peace and harmony, unity of heaven and humanity, which can calm the impetuous heart, and form a gentle and modest temperament. This reflects the cultural value of Wenwan walnuts, and to some extent, reflects traditional Chinese culture. In 2015, the Si Zuo Lou (a cultivar of Wenwan walnuts named after its origin place) Wenwan walnut production system in Pinggu, Beijing has been recognized by the Ministry of Agriculture as an important agricultural cultural heritage in China. In modern society, with the enhancement of health care awareness, the understanding of Wenwan walnuts as fitness products has gradually deepened. The walnuts rotate gently in the hands, where they are believed to stimulate or massage many acupuncture points, improve blood flow, and even impart spiritual satisfaction, thus achieving fitness and therapeutic purposes (Zhang 2016). As nutshell is not easy to crack, Wenwan walnuts are also used for fruit pit carving. Based on the diverse natural veins, exquisite handicrafts could be carved in various patterns such as human figures, animals, architecture and landscapes. It is precisely because Wenwan walnuts have cultural, health, and artistic value that they also have great economic value. A pair of good-looking and rare Wenwan walnuts could be traded for hundreds to tens of thousands of Chinese Yuan. The price depends on rarity, size, texture, vein, and color. At present, the domestic market size of Wenwan walnuts exceeds 1 billion Chinese Yuan per year. With the gradual revival of folk collections, the market potential is enormous.

The main breeding objectives of Wenwan walnuts are distinctive nut characteristics, scarcity, and health benefits. Since 2003, the Wenwan walnut breeding programs have been carried out. Through the construction of clonal orchard and the implementation of ecological adaptability testing, Wenwan walnut cultivars with different nut traits have been bred. The Wenwan walnut cultivar Huayi 7 was released in 2015, with the cultivar No. Jing S-SV-JH-048–2015.

Origin

In 2007, the wild resource of Wenwan walnut, originally numbered 'M116', was selected from the Qinling Mountains of Baoji, Shaanxi. It was preliminarily selected as an excellent genotype based on its strong resistance to disease and cold, attractive nut appearance with deep grooves, and prickly veins on the nutshell. A regional experiment was conducted during 2007 to 2014; scions of the clone were collected and top-grafted on 5- to 6-year walnut trees into the walnut breeding base (flat land) in Shunyi District, Beijing. Two other 1 hm^2 grafting experimental gardens (hilly land) were also built in Fenshuiling Village, Yanshou Town, Changping District, Beijing, and Diaowo Village, Huangsongyu Town, Pinggu District, Beijing. To identify the performance of M116, 50 replicates (i.e., scions) of trail cultivar were grafted in each location. No cold protection treatment was carried out in the winter of the grafting year for investigating the freeze injury symptoms of 1-year branches. Only a few branches of 'M116' have shoot shriveling, indicating strong cold resistance and good overwintering ability. 'Huayi 7' belongs to the late-fruiting walnut type, and it takes at least 3 years to bear fruits after grafting. The few disease spots on the surface of the walnut husk indicate its strong disease resistance. According to "The national standard of the People's Republic of China: Guidelines for the conduct of tests for distinctness, uniformity and stability—Juglans (*Juglans* L.)" (Pei et al. 2011), the nut characteristics of 'M116' were continuously measured and analyzed for 4 years (2011–14). As expected, there was no significant difference in nut appearance among the three experimental gardens. Compared with the reference cultivar of Huayi 1, M116 has a heavier single nut weight, bigger nut size, and lower kernel percentage. In 2014, it was identified as an excellent strain and named 'Huayi 7'.

Description

'Huayi 7' trees present strong vigor, are upright, and have a naturally open shape (Fig. 2A). The budding rate is relatively low and the shoot ability is strong. The proportion of lateral buds is not high, and mainly terminal buds could bear fruit. Odd-pinnately

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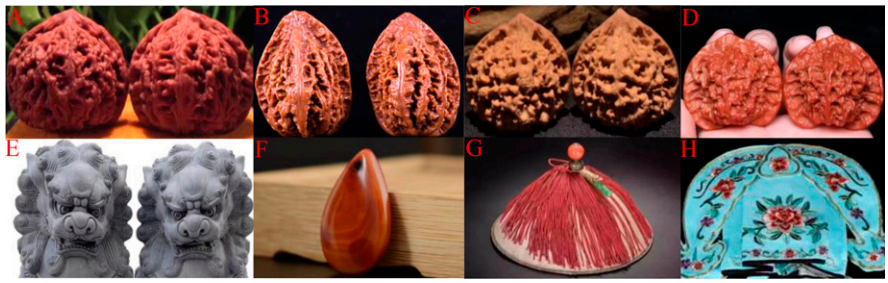

Fig. 1. The four main types of Wenwan walnut: (**A**) "lion head," (**B**) "chicken heart," (**C**) "official cap," and (**D**) "young master hat," and the derivation of four types: (**E**) "lion head," (**F**) "chicken heart," (**G**) "official cap," and (**H**) "young master hat."

compound leaves with a length of ∼59 cm, nine to 13 leaflets, mostly 11 leaflets. The leaflets are long elliptic, deep green, apex acuminate, margin entire. Female flower clusters generally consist of up to four to five flowers (Fig. 2B). Each fruiting spike has one to three fruits, mostly one fruit (Fig. 2D), and the fruiting rate is ∼20% under the natural pollination conditions. Young trees (5–7 years old) have moderate fruiting ability (five to 30 fruits per tree), whereas adult trees (more than 8 years old) have stronger and continuous fruiting ability (more than 50 fruits per tree). In the region of Beijing in North China, leafing occurs in early April, and leaf shedding is from late October to early November. The flowering is protogynous, and the female flowering period is from mid to late April, ∼10 d earlier than the male flowering period. The male and female flowers overlap for ∼3 d. The fruits ripen in late August, and the harvest date is usually in the mid-September. This cultivar has strong adaptability and multiresistance, and is suitable for planting in shallow mountains or plains with thick soil layers in Beijing and similar ecological areas. We recommend 6-m × 6- to 8-m spacing for 'Huayi 7' plantations with pollination by those walnut trees with the pollen shedding period in mid-April, such as *J. regia* 'Meixiang' and *J. regia* 'Jingxiang 1'.

The fruit of 'Huayi 7' is elliptic to broadly elliptic with a big size. The thick husk (0.76 cm) (Fig. 2E) is easily removed when the fruit is ripe. The nuts are also large, with a long elliptic shape. The nut base is flat or concave, oblique, and the nut apex is pointed. The nutshell is thick (3.32 mm), and very hard and rough in texture. There are two prominent ridges on the nut, and the sutures are tightly bonded and not prone to cracking. The position of the pad on the suture could be found along the entire suture, the prominence of the pad on the suture is strong, the width of the pad is broad, and the depth of the groove along the pad on the suture is deep. The structure of the surface of the 'Huayi 7' nutshell has deep pits and depressions (Fig. 2E–G). The longitudinal prickly veins formed by the grooves are very obvious and beautiful. The single nut weight of 'Huayi 7' is ∼25.32 g, with a longitudinal diameter of ∼5.0 cm, a transverse diameter of ∼4.1 cm, and a lateral diameter of ∼4.0 cm, and the kernel percentage is 12.48%. It belongs to the "official hat" series, commonly known as "thorny official hat." The nut characteristics of Huayi 7 are significantly different from other Wenwan walnut cultivars, mainly manifested in its large size, long elliptic shape, and prickly veins. These nut traits make it more suitable for massaging hand acupoints. Overall, it is not only a cultural collectible but also a good health product.

Fig. 2. A view of 'Huayi 7' tree, flower, fruit, and nuts taken at the walnut breeding base in 2014: (**A**) tree; (**B**) female flowers; (**C**) male flowers; (**D**) fruit; (**E**) nuts with husk; (**F**) front view of nuts; and (**G**) top, side, and front view of nuts.

Availability

A limited quantity of 'Huayi 7' scions could be provided for trial and research purposes only. For requests for scions, please contact via e-mail: qijx@263.net.

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