

Article

Collection, Evaluation, and New Cultivar Breeding of *Actinidia chinensis* var. *chinensis* in Wudang Mountains, China

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Abstract

To develop new kiwifruit cultivars (*Actinidia chinensis* var. *chinensis*) with desirable traits, we conducted wild resource surveys in the Wudang Mountains region of China. Seven promising accessions were identified through preliminary screening, exhibiting fruit weights ranging from 50.46 g to 75.06 g and a soluble solids content (SSC) between 14.33% and 16.32%. The accession ‘WD-03-1’ stood out by meeting the dual selection criteria of fruit weight exceeding 70 g and a SSC above 15%. After a decade-long evaluation, this elite genotype was officially certified as a superior cultivar by the Hubei Provincial Variety Committee for Forestry in 2016, receiving the registered name ‘Wudang 1’. Distinguished as a rare green-fleshed variety in the *A. chinensis* var. *chinensis*, ‘Wudang 1’ produces uniform elliptical fruits (shape index of 1.34) with an average weight of 83.22 g. Its flesh combines sweet and tart flavors with exceptional nutritional parameters: 16.33% SSC, 15.28% dry matter, 12.10% soluble sugars, 1.24% titratable acidity, 132.10 mg/100 g vitamin C, and 7.77 mg/g amino acids. Comparative analysis with established cultivars ‘Jinnong’ and ‘Cuiyu’ revealed that ‘Wudang 1’ matures earlier and demonstrates superior performance in three key quality metrics (SSC, dry matter, and vitamin C). Further analysis of aromatic profiles during the prime consumption stage identified 41 volatile compounds, predominantly comprising aldehydes, esters, alcohols, and ketones, which collectively contribute to its distinctive fragrance.

Keywords: cultivar; fruit aroma; germplasm resources; kiwifruit; Wudang 1



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1. Introduction

Kiwifruit is an emerging yet ancient fruit, originating from China. In Chinese historical documents, it was listed as a wild fruit found in the mountains. Only in the past century has it been domesticated and utilized, rapidly becoming one of the world’s most popular fruits [1]. In nature, the kiwifruit genus (*Actinidia* Lindl.) contains 54 species and 21 varieties, totaling 75 classification units [2]. China has the richest germplasm resources of kiwifruit, with 52 species growing naturally, 44 of which are endemic to China [3]. These resources have contributed to the prosperity of the global kiwifruit industry. The kiwifruit

variety Hayward, cultivated widely worldwide, originates from wild kiwifruit seeds in Yichang, Hubei, China [4]. Currently, more than 200 kiwifruit varieties are grown in the world, many of which have been obtained directly or indirectly from wild sources [5–7].

Among these numerous varieties, the vast majority belong to the *A. chinensis* species, known for their large, tangy-sweet fruits ideal for commercialization [8]. In terms of flesh color, *A. chinensis* varieties come in only two colors: yellow or green [9]. Yellow-fleshed varieties belong to *A. chinensis* var. *chinensis* variants, while green-fleshed types are mostly found in the *A. chinensis* var. *deliciosa* variants [10]. Exceptions include the ‘Cuiyu’ variety in China and the ‘Ac 459 011’ variety in Italy, both green-fleshed varieties classified under the *A. chinensis* var. *chinensis* category; ‘Cuiyu’ originates from wild resources in Hunan [8], while ‘Ac 459 011’ is a hybrid cultivar [11]. Thus, developing green-fleshed varieties within *A. chinensis* var. *chinensis* or yellow-fleshed varieties within *A. chinensis* var. *deliciosa* holds promising market prospects, offering breeders and consumers more choices, particularly concerning color preferences.

Wild kiwifruit resources are a natural treasure, and researchers are very interested in them; for example, there are many resources with strong disease resistance in wild germplasm [12]. As the center of origin for kiwifruit germplasm [13], China has long prioritized the collection and evaluation of its wild *Actinidia* genetic resources. Systematic resource collection has been conducted in regions including the Wumeng, Gaoligong, and Dawei Mountains in Yunnan [14]; the Wuling Mountains in Hubei [4]; and the Luxiao [15] and Magu [16] Mountains in Jiangxi, leading to the discovery of numerous superior resources. The Qinling-Daba Mountains area boasts exceptionally rich wild kiwifruit germplasm resources, with significant research focused on areas such as the Funiu Mountains [17] in Henan and the Daba Mountains in Shaanxi [18]. To protect these resources, the Kiwifruit Germplasm Conservation Nursery in the Qinba Mountain Area (KGCN-QMA) was established and certified by the Hubei Provincial Department of Agriculture as a provincial-level conservation garden. It currently preserves over 300 kiwifruit accessions spanning nine species. While the world’s largest kiwifruit germplasm repository is located in Wuhan, China [19], many kiwifruit varieties are unsuited to Wuhan’s climate. The Qinling-Daba Mountains perfectly compensate for this limitation, offering a suitable climate and broad elevation range, making it a paradise for kiwifruit cultivation [20,21]. Thus, the KGCN-QMA plays an irreplaceable role.

The Wudang Mountains, a prominent peak within the Qinling-Daba Mountains area with a maximum elevation of 1612 m, is a sacred site of Taoism in China [22]. Characterized by a subtropical monsoon climate with distinct vertical climate zones, temperatures decrease with increasing altitude; the area receives 900–1200 mm of annual precipitation, with an average annual temperature of 15.6–16.0 °C, supporting rich biodiversity [23]. Numerous wild *A. chinensis* resources grow on the Wudang Mountains. To identify superior varieties from these wild resources, we conducted surveys and collection efforts on the mountain. These resources were preserved through ex situ conservation via grafting, and their phenology, growth characteristics, and fruit quality were observed and evaluated. Through continuous multi-year documentation, we developed a new *A. chinensis* var. *chinensis* cultivar distinguished by light green flesh and an intense fruity aroma (Figure S1 shows the history of the breed). This research provides an exemplary case study for the development and utilization of wild *A. chinensis* resources in the Wudang Mountains.

2. Materials and Methods

2.1. Collection and Identification of Wild *A. chinensis* var. *chinensis*

The Wudang Mountains in Hubei Province are an extension of the eastern section of the Qinling-Bashan Mountains. It serves as a mixed natural distribution area for *A.*

chinensis var. *chinensis* and *A. chinensis* var. *deliciosa*, boasting abundant wild kiwifruit germplasm resources. In August 2002, we conducted a search along the valleys of the Wudang Mountains to find high-quality kiwifruit germplasm resources. The selection criterion was a single fruit weight exceeding 50 g; these resources were further used for screening top-quality varieties.

2.2. Propagation of Excellent Selections

In the spring of 2003, we preserved these seven resources through grafting at the orchard base located at the foot of the Wudang Mountains (110.98° E, 32.58° N, altitude 400 m). We used 2-year-old *A. chinensis* var. *deliciosa* seedlings as rootstocks, with 3 grafts for each resource, resulting in 21 grafted plants. These plants began fruiting in 2004, and production was further increased in 2005. Based on the two key indicators of a single fruit weight exceeding 70 g and a soluble solids content exceeding 15%, we identified the optimal option, which was ultimately labeled as 'WD-03-01', meeting both criteria. In 2006, branches of 'WD-03-01' were grafted in various regions, using 5-year-old healthy and vigorous *A. chinensis* var. *deliciosa* trees as rootstocks, with the grafts positioned at the base of branches at higher positions. Additionally, we selected two *A. chinensis* var. *chinensis* varieties, 'Jinnong' and 'Cuiyu', as control varieties for phenological observations and quality assessments. 'Jinnong' originated in the same region as 'WD-03-01', while 'Cuiyu' and 'WD-03-01' are very rare *A. chinensis* var. *chinensis* varieties with green flesh.

2.3. Investigation of Growth Habits and Phenological Aspects

We conducted an investigation into the growth habits of 'WD-03-01' and the control varieties, focusing on parameters such as the bud burst rate, the shoot rate, the fruit shoot rate, and the fruit set rate. Specifically, the bud burst rate was defined as the proportion of buds that sprout of the total buds; the shoot rate referred to the probability of sprouted buds growing into healthy branches; the fruit shoot rate represented the proportion of fruiting branches among healthy branches; and the fruit set rate denoted the probability of ovaries developing into fruits under natural pollination conditions. Additionally, we recorded the phenological stages of the three varieties, encompassing the bud burst period (the bud tip breaks through the bud scale, exposing the green tissue), leaf expansion period (the new leaf blade extends completely from the bud), flowering period (flowers open until petals wither), expansion period (the stage of rapid development of fruit from fruiting to ripening), maturity period (the stage when fruits can be harvested after maturity), and deciduous period (the stage of concentrated leaf abscission).

2.4. Fruit Size and Quality

All fruits used for fruit quality testing were harvested with soluble solids between 6.5% and 7.0%. The single fruit mass was measured by an electronic scale with an accuracy of 0.01 g, the vertical diameter, horizontal diameter, and lateral diameter of the fruit were measured using a 0.001 mm precision vernier caliper, and the calculated results were converted to the cm level. The SSC was measured with a PAL-1 refractometer (ATAGO®, Tokyo, Japan). The dry matter content was determined by drying a 2-mm transverse slice from the middle of the fruit at 65 °C for approximately 24 h according to Burdon et al. [24]. The soluble sugar content was determined using anthrone-sulfuric acid colorimetry following the protocol described by Cao et al. [25]. The titratable acidity was measured by titration with NaOH following the protocol described by Cao et al. [25]. The vitamin C was measured with the 2,6-dichloroindophenol sodium salt hydrate titration method according to Ordóñez-Santos et al. [26]. The concentration of free amino acids was determined according to the national standard GB 5009.124-2016 [27]. The aroma was determined

by gas chromatography-mass spectrometry (GC-MS) following the protocol described by Mota et al. [28].

2.5. Data Processing and Analysis

The statistical analysis of all experimental data was performed using SPSS 26.0 software (SPSS, Chicago, IL, USA) by LSD and Duncan's multiple range test ($p < 0.05$).

3. Results

3.1. Collection and Selection of Wild Resources

During our expedition to the Wudang Mountains, we collected seven *A. chinensis* var. *chinensis* germplasm resources with single fruit weights exceeding 50 g. Due to variations in altitude, the maturity levels of these fruits differed, making single fruit weight the most crucial criterion for our field selection of these germplasms. The field sampling information and single fruit weights of these seven germplasm resources are presented in Table 1. Their altitudes ranged from 331 m to 766 m, and their single fruit weights in the wild ranged from 50.46 g to 75.06 g; among them, 'WD-03-1', 'WD-03-3', and 'WD-03-5' showed the highest single fruit weight, all exceeding 70 g, and 'WD-03-4' the lowest. These germplasms were grafted in the same orchard and, after normal growth, harvest, and ripening, were tested to have a soluble solid content (SSC) ranging from 14.33% to 16.32%. 'WD-03-6' performed best in terms of SSC, closely followed by 'WD-03-1'. 'WD-03-1' met both criteria: a single fruit weight greater than 70 g and a SSC greater than 15%, making it a prime candidate for further evaluation, including cultivation trials across different years and locations.

Table 1. Wild *A. chinensis* var. *chinensis* information from the Wudang Mountains.

Code	Geographic Origins			Key Indicators for Screening	
	Altitude/m	Longitude/°E	Latitude/°N	Single Fruit Weight/g	Soluble Solids Content/%
WD-03-1	730	111.04	32.44	74.52 ± 1.76 a	15.89 ± 0.57 ab
WD-03-2	766	111.06	32.45	66.50 ± 1.74 b	15.03 ± 0.51 ab
WD-03-3	620	111.09	32.45	75.06 ± 1.65 a	14.36 ± 0.28 b
WD-03-4	422	111.10	32.42	50.46 ± 1.18 d	15.51 ± 0.32 ab
WD-03-5	331	111.08	32.38	72.00 ± 2.70 a	15.60 ± 0.88 ab
WD-03-6	338	111.04	32.35	57.36 ± 1.17 c	16.32 ± 0.75 a
WD-03-7	355	111.11	32.37	63.71 ± 1.72 b	14.77 ± 0.19 ab

Means in the same column, followed by the same letter, are not significantly different ($p < 0.05$), determined by Tukey's LSD test.

After more than a decade of systematic evaluation and cultivation trials across multiple regions, 'WD-03-1' performance was outstanding, named 'Wudang 1' due to its origin in the Wudang Mountains, Shiyan city; it was officially certified by the Hubei Provincial Variety Committee for Forestry in 2016 (Figure S2). Figure 1 illustrates the characteristics of 'Wudang 1' and includes its branches, leaves, flowers, and fruits. In recent years, 'Wudang 1' has been licensed to grow in the Hubei, Shaanxi, and Henan provinces, all close to the Qinling-Daba Mountains. The origin and development of 'Wudang 1' is illustrated in detail in Figure S1.

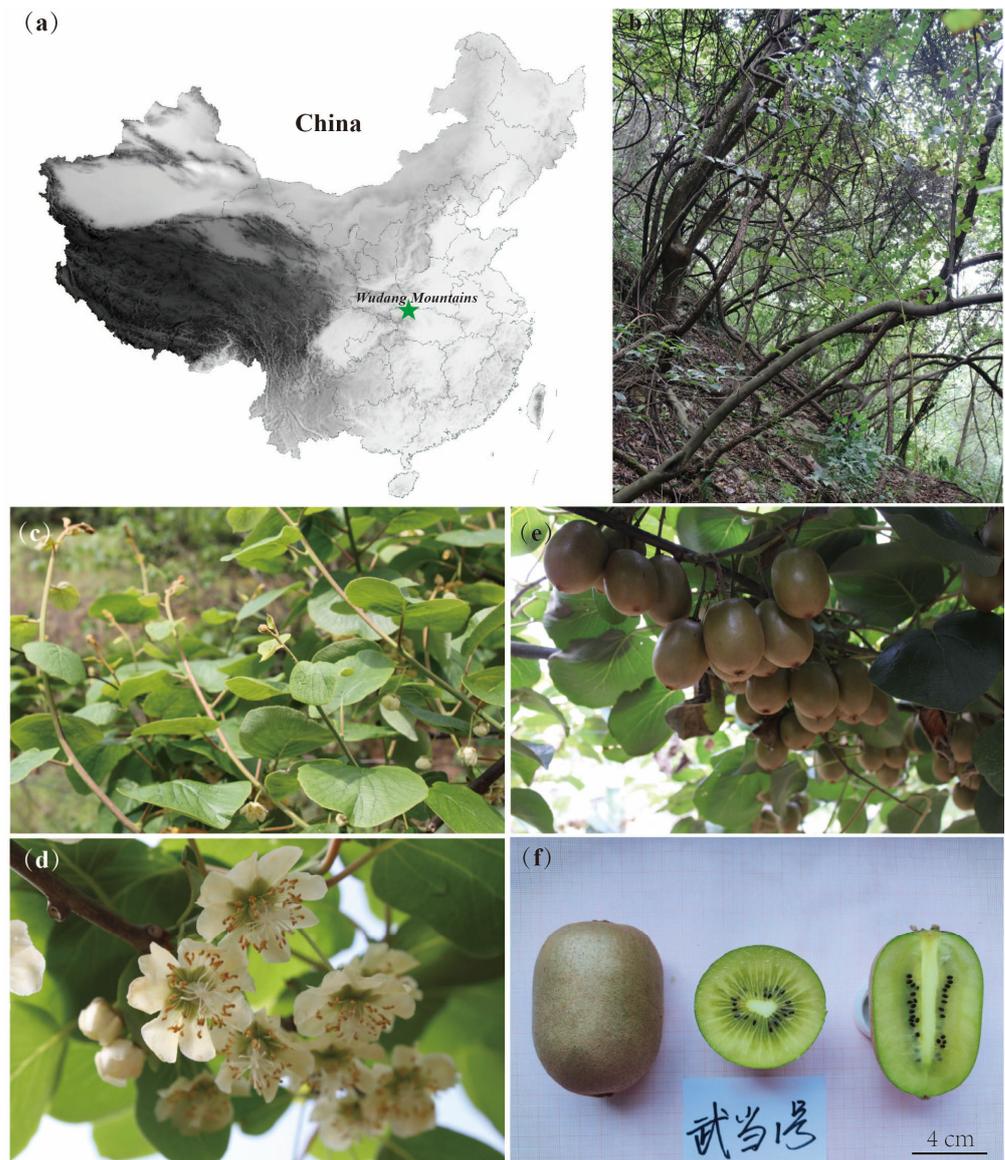


Figure 1. *A. chinensis* var. *chinensis* green flesh kiwifruit cultivar ‘Wudang 1’. (a) ‘Wudang 1’ kiwifruit geographically originated in Wudang Mountains, China (places with pentagrams); (b) Wilderness living environment of ‘WD-03-1’; (c) New tree branches and leaves; (d) Blooming flowers; (e) Fruits hanging on branches; (f) Fruits and cross sections during the edible period, ‘武当号’ is the Chinese name for ‘Wudang 1’.

3.2. The Growth Habits and Phenological Aspect of ‘Wudang 1’ Kiwifruit

In terms of its phenological period, ‘Wudang 1’ starts to sprout in early March of a typical year, forms leaves and buds in late March, blossoms in late April, develops fruits from mid-May to early August, matures fruits in early September, and has a fruit growth period of about 130 days. It is an early-ripening variety, and the leaves begin to fall in early December. In terms of phenology, it is significantly earlier than the two control cultivars, ‘Cuiyu’ and ‘Jinnong’ (Table 2).

‘Wudang 1’ has a bud burst rate of 70.00%, a shoot rate of 93.00%, a fruit shoot rate of 94.67%, and a fruit set rate of 79.67%. Table 3 shows that ‘Wudang 1’ has a lower bud burst rate than ‘Cuiyu’, a higher shoot rate than ‘Cuiyu’, and a higher fruit shoot rate than ‘Jinnong’. There is no significant difference in the fruit-setting rate between the three cultivars.

Table 2. Phenological investigation of ‘Wudang 1’ kiwifruit and its control cultivars.

Cultivars	Bud Burst Period	Leaf Expansion Period	Flowering Period	Expansion Period	Maturity Period	Deciduous Period
Wudang 1	11/03–19/03	18/03–24/03	14/04–26/04	Early May to early June	Early September	Early to mid December
Jinnong	12/03–20/03	19/3–26/03	16/04–28/04	Early May to early June	Late September	Mid to late December
Cuiyu	26/03–6/04	5/04–12/04	25/04–7/05	Mid May to mid June	Late October	Mid to late December

Data were collected 2023.

Table 3. Growth habits survey of ‘Wudang 1’ kiwifruit and its control cultivars.

Cultivars	Bud Burst Rate/%	Shoot Rate/%	Fruit Shoot Rate/%	Fruit Set Rate/%
Wudang 1	70.00 ± 1.53 b	93.00 ± 1.73 a	94.67 ± 0.88 a	79.67 ± 1.76 a
Jinnong	72.00 ± 1.53 b	90.00 ± 0.58 ab	90.00 ± 1.00 b	77.67 ± 1.33 a
Cuiyu	80.33 ± 3.28 a	89.00 ± 0.58 b	94.00 ± 0.58 a	75.67 ± 0.33 a

Data were collected 2023. Means in the same column, followed by the same letter, are not significantly different ($p < 0.05$), determined by Tukey’s LSD test.

3.3. Pomological and Quality Aspects of ‘Wudang 1’ Kiwifruit

‘Wudang 1’ fruit is oval in shape and uniform in size, with a fruit shape index of 1.34 and an average single fruit mass of 83.22 g. The flesh of the fruit is delicate, sweet, and sour, with a SSC of 16.33%, a dry matter content of 15.28%, a soluble sugar content of 12.10%, a titratable acidity of 1.24%, a vitamin C content of 132.10 mg/100 g, and an amino acid content of 7.77 mg/g. Table 4 shows that there are no significant differences in many parameters between the fruits of ‘Wudang 1’ and the two control cultivars, but the dry matter content and vitamin C content of ‘Wudang 1’ are significantly higher than those of ‘Jinnong’.

Table 4. Appearance characteristics and intrinsic quality of fruits of ‘Wudang 1’ and its control cultivars.

Indexes	Cultivars		
	Wudang 1	Jinnong	Cuiyu
Appearance quality			
Single fruit mass/g	83.22 ± 2.84 ab	77.19 ± 1.56 b	89.74 ± 1.82 a
Vertical diameter/cm	62.65 ± 0.66 b	58.77 ± 1.08 c	66.40 ± 0.72 a
Horizontal diameter/cm	46.77 ± 0.68 b	49.06 ± 1.07 b	53.87 ± 0.87 a
Lateral diameter/cm	42.26 ± 0.64 b	45.31 ± 0.45 a	47.04 ± 0.73 a
Fruit shape index	1.34 ± 0.03 a	1.20 ± 0.02 b	1.23 ± 0.03 b
Internal quality			
Soluble solid content/%	16.33 ± 0.38 a	15.70 ± 0.31 a	15.27 ± 0.37 a
Dry matter content/%	15.28 ± 0.24 a	14.14 ± 0.14 b	14.82 ± 0.37 ab
Soluble sugar content/%	12.10 ± 0.42 a	11.27 ± 0.35 a	12.50 ± 0.29 a
Titratable acidity/%	1.24 ± 0.03 a	1.36 ± 0.03 a	1.26 ± 0.04 a
Vitamin C content/(mg/100 g)	132.10 ± 3.45 a	93.19 ± 1.43 b	127.81 ± 1.39 a
Amino acid content/(mg/g)	7.77 ± 0.43 a	7.01 ± 0.17 a	7.30 ± 0.38 a

Data were collected 2023. Means in the same column, followed by the same letter, are not significantly different ($p < 0.05$), determined by Tukey’s LSD test.

3.4. The Aroma Substances of ‘Wudang 1’ Kiwifruit

By detecting the volatile substances in the fruit, it was found that ‘Wudang 1’ kiwifruit has 41 aroma components during consumption, including 17 esters, 16 aldehydes, 7 ke-

tones, and 1 alcohol. Figure 2 shows that aldehydes have the highest content of volatile components, while ketones have the lowest content, during the consumption of ‘Wudang 1’. The relatively high-content aroma compounds include trans-2-hexenal, hexanal, trans-2-hexen-1-ol, 1-nonanal, methyl benzoate, (E)-2-octenal, trans-2-nonenal, (R)-(+)-2,2-dimethyl-1,3-dioxolane-4-carboxaldehyde, decanal, hexyl 2-methylbutyrate, and geranylacetone (Table 5).

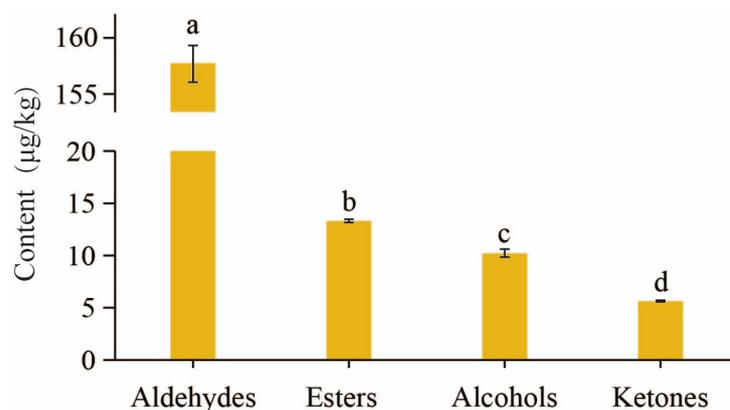


Figure 2. Types of volatile compounds in ‘Wudang 1’ kiwifruit during consumption. Means in the same column, followed by the same letter, are not significantly different ($p < 0.05$), determined by Tukey’s LSD test.

Table 5. Aroma components of ‘Wudang 1’ kiwifruit during consumption.

Number	Aroma Components	Contents (µg/kg)	CAS Registry Number
1	Methyl benzoate	2.45 ± 0.07 e	93-58-3
2	Hexyl 2-methylbutyrate	1.49 ± 0.13 efghi	10032-15-2
3	Hexyl acetate	1.41 ± 0.04 efghi	142-92-7
4	Ethyl acetate	1.39 ± 0.06 efghi	141-78-6
5	Butyl Caprylate	1.22 ± 0.06 efghi	589-75-3
6	(E)-11-Tetradecen-1-ol acetate	0.89 ± 0.07 efghi	33189-72-9
7	Ethyl 4-trans-decenoate	0.76 ± 0.03 fghi	76649-16-6
8	Ethyl butyrate	0.52 ± 0.05 hi	105-54-4
9	2-(2-butoxyethoxy)ethyl benzoate	0.51 ± 0.06 hi	5451-84-3
10	Propyl octanoate	0.46 ± 0.04 i	624-13-5
11	2-Ethylhexyl acetate	0.45 ± 0.02 i	103-09-3
12	Ethyl hexanoate	0.44 ± 0.06 i	123-66-0
13	2-Methylbutyl acetate	0.35 ± 0.02 i	624-41-9
14	Hexyl hexanoate	0.32 ± 0.11 i	6378-65-0
15	Ethyl 2-methylbutyrate	0.28 ± 0.06 i	7452-79-1
16	Butyl acetate	0.24 ± 0.04 i	123-86-4
17	Hexyl butyrate	0.14 ± 0.05 i	2639-63-6
18	trans-2-Hexenal	98.58 ± 2.35 a	6728-26-3
19	Hexanal	37.80 ± 1.77 b	1219803-74-3
20	1-Nonanal	5.75 ± 0.23 d	124-19-6
21	(E)-2-Octenal	2.37 ± 0.04 ef	2548-87-0
22	trans-2-Nonenal	2.25 ± 0.09 efg	18829-56-6
23	(R)-(+)-2,2-Dimethyl-1,3-dioxolane-4-carboxaldehyde	2.18 ± 0.04 efg	15186-48-8

Table 5. Cont.

Number	Aroma Components	Contents (µg/kg)	CAS Registry Number
24	Decanal	2.10 ± 0.09 efgh	112-31-2
25	trans-2-Decenal	1.37 ± 0.07 efghi	3913-81-3
26	Octanal	1.11 ± 0.01 efghi	124-13-0
27	trans,cis-2,6-Nonadienal	0.99 ± 0.04 efghi	557-48-2
28	2-Heptenal, (Z)-	0.95 ± 0.02 efghi	57266-86-1
29	2-Undecenal	0.54 ± 0.05 hi	2463-77-6
30	2-Fluoro-4-(1-methylethyl)benzaldehyde	0.50 ± 0.06 hi	1289014-70-5
31	Benzaldehyde	0.46 ± 0.04 i	100-52-7
32	3-Hexenal	0.39 ± 0.10 i	4440-65-7
33	Citral	0.31 ± 0.01 i	5392-40-5
34	Geranylacetone	1.46 ± 0.02 efghi	3796-70-1
35	6-Methyl-5-hepten-2-one	1.05 ± 0.04 efghi	110-93-0
36	1-Penten-3-one	0.83 ± 0.02 fghi	1629-58-9
37	1-Octen-3-one	0.77 ± 0.03 fghi	4312-99-6
38	alpha-Ionone	0.68 ± 0.03 fghi	127-41-3
39	2-Undecanone	0.52 ± 0.05 hi	112-12-9
40	3-Undecanone	0.34 ± 0.02 i	2216-87-7
41	trans-2-Hexen-1-ol	10.23 ± 0.16 c	928-95-0

Means in the same column, followed by the same letter, are not significantly different ($p < 0.05$), determined by Tukey's LSD test.

3.5. Brief Introduction to Cultivation Techniques of 'Wudang 1' Kiwifruit

3.5.1. Soil Selection

Suitable for cultivation in soil below 1200 m above sea level, with loose soil, convenient irrigation, good drainage, and slightly acidic or neutral soil. It should have a similar climate to the Wudang Mountains, with annual rainfall ranging from 800 to around 1500 mm and an average annual temperature between 14 and around 18 °C.

3.5.2. Vine Trellis and Pruning

The support frames were constructed using galvanized square pipe, with row spacing set at 4 m and plant spacing at 3 m. Male trees need to be planted to pollinate, accounting for one-eighth of the female trees. The trees were trained in a shape featuring one trunk, two main vines, and multiple pinnate lateral branches. During winter pruning, approximately 12 fruiting mother branches were retained on each tree, with a spacing of about 30 cm between branches. Long and sturdy branches were left with 10 to 12 buds, medium branches with 6 to 10 buds, and short branches with 3 to 5 buds. During the summer, sprouting buds were promptly removed or new branch growth was controlled by pinching out the growing tips.

3.5.3. Thinning of Flowers and Fruits

After flowering, overly dense flower buds can be thinned out, retaining one to two full flower buds per inflorescence. Ten to twenty days after the peak blooming period, smaller fruits, misshapen fruits, damaged fruits, and fruits infested by pests and diseases should be thinned out. Typically, one fruit is left on short fruit branches, two to three fruits on medium fruit branches, and three to five fruits on long fruit branches.

3.5.4. Management of Fertilization and Irrigation

Generally, fertilization is applied three times a year. The first application is from late February to early March to promote bud break, with a focus on nitrogen fertilizer sup-

plemented by phosphorus and potassium fertilizers, 0.4 kg of urea, and 0.3 kg of potassium chloride per adult plant. The second application is, after flowering, primarily to enhance fruit robustness, with a balanced application of nitrogen, phosphorus, and potassium, 0.5 kg of urea, 0.25 kg of potassium chloride, and 0.5 kg of phosphate fertilizer per plant. The third application is after fruit harvest, mainly to replenish the soil's basic nutrients, which involves digging trenches or holes to incorporate the fertilizer deep into the soil, with an emphasis on organic fertilizer, 40–50 kg of organic fertilizer, 2.5 kg of cake fertilizer, and 1 kg of phosphate fertilizer per plant. Water supply should be ensured during the budding, flowering, fruit-setting, and fruit expansion stages. Irrigation should be performed timely to combat drought during high temperatures, and drainage should be carried out promptly during rainy seasons to prevent waterlogging.

3.5.5. Harvesting and Yield

Harvest should be conducted promptly when the soluble solids content of the fruits reaches above 6.5%. Yield performance of 'Wudang 1': if grafted on an annual rootstock, a small amount of fruit will begin in the second year. In the third year, it will yield 320.5 kg/667 m²; in the fourth year, it will yield 554.4 kg/667 m²; in the fifth year, it will yield 1089.6 kg/667 m²; and in the seventh year, it will enter the peak fruiting period, with a yield of over 2000 kg/667 m². If grafted high on rootstocks older than 3 years old, the fruit will start to grow in the second year, with a yield of about 500 kg/667 m² in the third year, a high yield in the fifth year, and a yield of over 1500 kg/667 m². In the sixth year, the fruit will enter the peak period, with a stable yield of over 2000 kg/667 m². Under the same cultivation conditions, the yield per 667 m² of 'Wudang 1' was between 'Jinnong' (1850 kg/667 m²) and 'Cuiyu' (2150 kg/667 m²) after the orchard entered the high-yield period. To stabilize 'Wudang 1' tree growth and ensure fruit quality, it is advisable to control the yield of 667 m² to around 2000 kg.

4. Discussion

The Wudang Mountains area, located in the eastern Qinling-Daba Mountains, represents a typical sympatric distribution zone for both *A. chinensis* var. *chinensis* and *A. chinensis* var. *deliciosa* [29]. The naturally occurring mixed populations in this region exhibit inherent hybrid vigor, contributing to exceptionally rich wild kiwifruit resources [30]. Within a 100-km radius centered on the Wudang Mountains, numerous notable kiwifruit cultivars have been successfully selected, including 'Jinkui' [2], 'Jinnong' [8], and 'Hanmei' [31]. Globally renowned varieties such as 'Hayward' (the world's most widely cultivated cultivar) [7] and 'Hongyang' (the first red-fleshed cultivar) [32] also maintain close genetic connections with this region. Currently, the Hubei Wudang Mountains area is emerging as a significant hotspot for kiwifruit germplasm diversity and breeding potential. The Wudang Mountains, together with the Mufu Mountains [33] and Wuling Mountains [4], form a source of high-quality wild *A. chinensis* in Hubei province. We found many *A. chinensis* in the Wudang Mountains, and the seven accessions mentioned in Table 1 are of breeding potential. In addition to 'WD-03-1', which has been successfully commercialized, other selections are also of great interest; the soluble solids content of 'WD-03-6' is higher than that of 'WD-03-1', and the single fruit weight of 'WD-03-3' exceeds that of 'WD-03-1', so they are worth domesticating. In fact, we are evaluating other individuals from the same area of origin as 'WD-03-1'. In the future, the Wudang Mountains will be the same place as Wuning County, Jiangxi province, China, where many excellent cultivars are found in wild resources; it is now known that from the wild resources in Wuning County, excellent cultivars such as 'Jintao' [34], 'Wuzhi 3' [35], 'Moshan Xiong 4' [36], and

‘Moshan Xiong 5’ [37] were born. It has been demonstrated that many regions do not have excellent resources but rather a lack of systematic surveys and assessments [38,39].

While mature fruits of *A. chinensis* var. *chinensis* typically develop yellow flesh [8], the distinctive greenish flesh observed in ‘Wudang 1’ suggests a complex genetic background, possibly indicating hybrid origin. The dioecious nature of kiwifruit fundamentally differs from the self-fertilization or pseudo-hybridization observed in self-pollinating plants [40]; this biological characteristic enables random hybridization events to occur naturally in kiwifruit populations [30], which likely serves as a key factor contributing to the distinctive quality of the ‘Wudang 1’ cultivar of exogenous origin. To comprehensively characterize ‘Wudang 1’, we conducted comparative analyses of phenological stages and fruit quality traits using ‘Jinnong’ and ‘Cuiyu’ as control cultivars. The selection rationale considered both geographical proximity (shared origin with ‘Jinnong’ [8]) and phenotypic relevance (‘Cuiyu’ is a rare green-fleshed *A. chinensis* var. *chinensis* cultivar [2]). The results demonstrated that ‘Wudang 1’ achieves commercial maturity approximately 0.5–1.5 months earlier than both control cultivars, presenting a significant market advantage. Quality assessments revealed superior overall performance in ‘Wudang 1’, particularly higher vitamin C content compared to ‘Jinnong’. The soluble solids content is highly correlated with sugar content and is a typical flavor determinant [41], although no statistically significant differences were detected in SSC among cultivars, but ‘Wudang 1’ had the highest content and certain advantages.

A remarkable feature of ‘Wudang 1’ lies in its aromatic profile. Volatile compound analysis identified 41 distinct aroma components during edible maturity, more than many cultivars of kiwifruit aroma components [42–45]. Comparative studies with the internationally recognized aromatic cultivar ‘Hongyang’ revealed comparable total aroma intensity in ‘Wudang 1’, with particular superiority in aromatic aldehydes [45]. These findings position aromatic quality as a decisive competitive advantage for ‘Wudang 1’. Many studies have shown that the aroma profile varies among kiwifruit cultivars, and ‘Wudang 1’ is rich in aroma components. In a recent study [46], 29 volatile compounds were detected in 6 *A. chinensis* cultivars: ‘Jinyan’, ‘Jintao’, ‘Xuxiang’, ‘Cuiyu’, ‘Hongyang’, and ‘Donghong’, which is much lower than the 41 compounds possessed by ‘Wudang 1’. Although the true reflection of aroma characteristics is influenced by many factors, such as the sampling location [47], the sampling period [48], the detection method [49], and the pollen donor [50], it cannot be denied that ‘Wudang 1’ is a cultivar with outstanding aroma characteristics.

The dioecious nature of kiwifruit transforms natural mixed populations into spontaneous hybridization laboratories, providing ideal conditions for elite cultivar selection [30,51]. Despite advancements from traditional hybridization to fourth-generation molecular breeding technologies, wild selection remains crucial in kiwifruit improvement [52], particularly in China’s Qinling-Daba Mountains and Han River Basin. These regions offer unparalleled genetic diversity through heterogeneous environments and rich germplasm resources [4,53,54]. The successful development of ‘Wudang 1’ exemplifies how strategic utilization of wild resources can revitalize local kiwifruit industries, demonstrating the enduring value of ecological diversity in agricultural innovation.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/horticulturae11070739/s1>, Figure S1: The origin and development of ‘Wudang 1’; Figure S2: Variety approval certificate.

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