‘Goldone’, a Yellow - fleshed Kiwifruit Cultivar with Large Fruit Size

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Abstract

In Korea, kiwifruit is grown within a limited region on the southern coast where the climate is warm. Since the yellow - fleshed kiwifruit variety, ‘Hort16A’, first became commercially available, we have focused on breeding additional yellow - fleshed kiwifruits. Here, we describe the cultivar ‘Goldone’, which originated from ‘Red Princess’ and is characterized by red coloration around the fruit core. Conventional field crosses were performed in 2003, and permission for final release of ‘Goldone’ was obtained in 2011. This cultivar is very productive, with an average fruit weight of 129 g, which is 39% heavier than that of the cultivar ‘Hayward’. ‘Goldone’ is harvested in late October, approximately 165 - 170 days after anthesis. In general, ‘Goldone’ has approximately eight flowers per fruiting shoot; these flowers must be thinned before blooming for commercial production. ‘Goldone’ was registered at the Korean Seed & Variety Service in 2014 for plant variety protection rights (grant no. 4835).

Additional key words: *Actinidia*, cross breeding, cultivar, flesh color, tetraploid

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Introduction

The cultivation of kiwifruit (*Actinidia* Lindl.) in Korea is limited to the southern coastal region due to the potential for freezing injury in other regions during winter (Kwack et al. 2012, 2014). Kiwifruit has a simple cultivar composition in the market compared to other fruit crops. Currently, the predominant kiwifruit cultivar worldwide, including Korea, is green-fleshed ‘Hayward’ (Ferguson 1999). However, following the changes in commercial kiwifruit cultivars that occurred in 2000 with the advent of the yellow-fleshed kiwifruit, ‘Hort16A’, variability has been introduced into kiwifruit breeding programs.

Yellow - fleshed kiwifruit cultivars taste sweeter than the traditional, widely grown green cultivar. Therefore, the demand for yellow kiwifruit is increasing. However, farmers are subject to rules aimed

at cultivar protection by the Plant Variety Protection Act. For example, in Korea, 'Hort16A' is produced on Jeju Island with permission from Zespri International. Farmers who do not have permission from Zespri cannot grow 'Hort16A' commercially.

Our kiwifruit breeding team, in coordination with the Rural Development Administration (RDA), has focused on releasing new yellow - fleshed kiwifruit cultivars for use by domestic farmers unable to grow 'Hort16A'. Based on our efforts, which began in 2000, we have released nine yellow - fleshed cultivars to date. Some of the cultivars developed in the early 2000s have poor fruit quality and many lateral flowers, which must be thinned, requiring more labor compared to cultivars from New Zealand. The cultivar 'Goldone' was developed to compensate for these weaknesses. Here, we describe the characteristics of 'Goldone' kiwifruit.

Origin

In 2003, a conventional field cross was conducted at the RDA kiwifruit - breeding orchard (latitude: 34° 48'N; longitude: 127° 55'E) in Namhae, a region on the southern coast of South Korea. The parents of 'Goldone' originated from germplasm collections of *A. chinensis* var. chinensis that were introduced to Korea from China. The maternal vine, 'Red Princess', has red - colored flesh, and the paternal germplasm is named NHK0013 or IT233175 (Fig. 1). The first selection was made in 2006 and designated '2003 - 1 - 251'. After a 3 - year examination period to evaluate the vine and fruit characteristics of this cross, the resulting 'Goldone' cultivar was released in 2011. All observations and evaluations of fruit and vine features were performed according to the test guidelines of the Korea Seed & Variety Service (KSVS) for kiwifruit (2007) and the International Union for the Protection of New Varieties of Plants (UPOV) guidelines for *Actinidia* (2001).

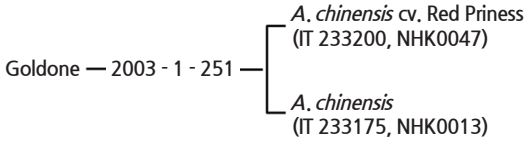

Fig. 1. Pedigree of the new yellow - fleshed kiwifruit cultivar 'Goldone'

Description

'Goldone' is a tetraploid plant that produces oblong - shaped fruit (Figure 2). In general, this cultivar produced a few lateral flowers per cyme during the three season trials conducted in 2009, 2010 and 2011. Like other *A. chinensis* var. chinensis cultivars, this cultivar has no bud cover (Table 1), and it weakly expresses a calyx ring when the fruits are mature. The phenotypes of the fruit include sparse downy hairs on the exterior and a yellowish outer pericarp when ripe.

'Goldone' usually blooms in mid - May (Table 2). In our experimental field, 'Hort16A' bloomed approximately 6 to 10 days earlier than 'Goldone' during the three consecutive seasonal trials. Conversely, 'Goldone' was harvested approximately 6 to 19 days earlier than 'Hort16A' in late October (165 - 170 days after anthesis).

The average fruit weight for 'Goldone' was 129 g, which is heavier than the control cultivars that were grown in parallel: 'Hayward', 'Goldrush' and 'Hort16A' (Table 3). By contrast, the length - to - diameter (LD) ratio and the flat ratio (max - to - min

equatorial diameter) for 'Goldone' were smaller than those of the three other cultivars (Table 3). 'Goldone' also had a slightly lower soluble solids content (SSC) than the other cultivars. The acidity of 'Goldone' is similar to that of the other cultivars, except 'Goldrush' (Table 3).

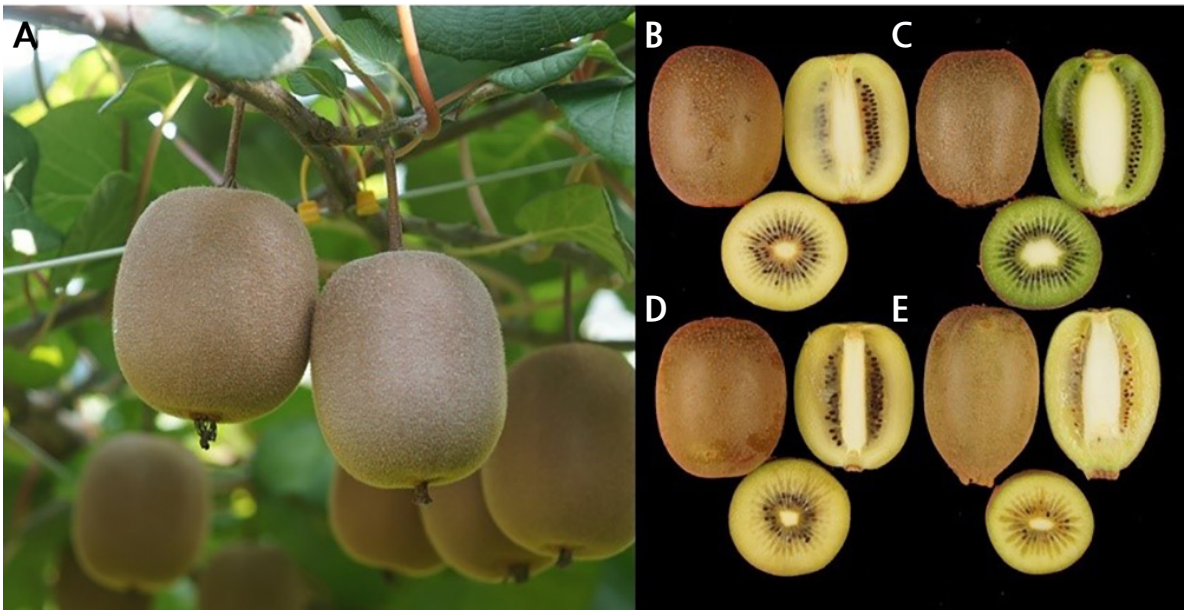

Fig. 2. Fruit set of 'Goldone' (A). Sections of 'Goldone' compared with other cultivars: B, 'Goldone'; C, 'Hayward'; D, 'Goldrush'; E, 'Hort16A'.

Table 1. Qualitative characteristics of 'Goldone' kiwifruit compared to other commercial cultivars grown under open field cultivation from 2009 - 2011 in Namhae, South Korea.

Cultivar	Ploidy[z]	Bud cover	No. of flowers per cyme	Fruit shape	Fruit flesh color	Hair on fruit skin	Fruit calyx ring
Goldone	Tetraploid	Absent	1	Oblong	Yellowish	Downy	Weak
Hayward	Hexaploid	Present	1 - 3	Elliptical	Greenish	Hirsute	Medium
Goldrush	Tetraploid	Absent	1 - 3	Elliptical	Yellowish	Downy	Weak
Hort16A	Diploid	Absent	1	Ovoid	Yellowish	Downy	Weak

[z]Ploidy level was determined via flow cytometry with a Partec ploidy analyzer, Partec CyFlow SL (Partec GmbH, Münster, Germany).

Table 2. Bud break, blooming, and harvest time for 'Goldone' kiwifruit compared to other commercial cultivars grown under open field cultivation from 2009 - 2011 in Namhae, South Korea.

Cultivar	Bud break	Beginning of bloom[z]	Full bloom[y]	Pick time[x]
Goldone	23 - 30 Mar	8 - 20 May	11 - 24 May	9 - 24 Oct
Hayward	24 Mar - 4 Apr	17 May - 3 Jun	19 May - 5 Jun	10 - 15 Nov
Goldrush	23 Mar - 1 Apr	2 - 14 May	9 - 22 May	26 - 28 Oct
Hort16A	21 Mar - 1 Apr	28 Apr - 13 May	1 - 15 May	28 Oct - 2 Nov

[z]Beginning of bloom, when - 10% of flowers on the vines had bloomed
[y]Full bloom, when 70 - 80% of flowers on the vines had bloomed
[x]Pick time, when soluble solids content reached 7.5 - 8.5 °Brix.

Table 3. Quantitative characteristics of 'Goldone' kiwifruit compared to other commercial cultivars grown under open field cultivation from 2009 - 2011 in Namhae, South Korea.

Cultivar	Fruit weight (g)	LD ratio[z]	Flat ratio[y]	Soluble solids content (°Brix)[x]	Titratable acidity (%)[w]	Flesh hardness ($kg \cdot cm^{-2}$)[v]
Goldone	128.7a[u]	1.17d	1.04c	13.2b	1.0a	1.1c
Goldrush	105.9b	1.23c	1.06b	14.1a	0.7b	1.2bc
Hayward	92.6c	1.28b	1.09a	13.9a	1.0a	1.8a
Hort16A	90.0c	1.50a	1.08a	13.9a	0.9a	1.4b

[z]LD ratio, ratio of fruit length to fruit diameter
[y]Flat ratio, ratio of maximum fruit diameter to minimum fruit diameter
[x]Soluble solids content was measured with an refractometer (PR - 32 α, Atago, Bellevue, WA, USA)
[w]Titratable acidity, citric acid content titrated with an automated titrimeter (TitroLine Easy, Schott, Mainz, Germany)
[v]Flesh hardness was measured after cutting into the fruit skin c. 2 mm with a handy hardness meter (12 mm probe diameter, Fujiwara Scientific Co., Japan).
[u]mean separation in columns by the Duncan's multiple range test at $p = 0.05$.

Performance

Like many other kiwifruit cultivars in this genus, 'Goldone' is not self - fertile (Ferguson 1990). Therefore, 'Goldone' requires artificial pollination or bee pollination to obtain commercial fruit set. However, there are currently no commercially available male vines that bloom at the same time or earlier than 'Goldone'. Consequently, growers of 'Goldone' must keep pollen grains in a deep freezer at least one year prior to artificial pollination during the season of interest. 'Goldone' has 7 - 8 flowers per fruiting shoot, while the number of lateral flowers in a fruiting shoot is minimal (data not shown). Thus, 'Goldone' must also undergo flower thinning prior to blooming in order to reduce the amount of pollen grains required for pollination.

Compared with 'Hayward', 'Goldrush', and 'Hort16A', 'Goldone' produces the largest fruits (Table 3). Moreover, with proper fruit thinning to achieve fewer than two fruits per fruiting shoot, the resulting fruit weight can range from 150 to 180 g (data not shown). Thus, plant growth regulators are not required to increase fruit weight in this cultivar. Furthermore, in a practical orchard growing test, the SSC ranged from 13 - 18 °Brix (data not shown).

Availability

'Goldone' was officially registered as a new cultivar in 2014 according to the Plant Variety Protection Act by the Commissioner of the KSVS under plant variety rights grant number 4835. This cultivar was released fo

r commercial growth in the Republic of Korea in 2015. All rights, including the propagation and selling of vines, were granted to Great Korea Kiwifruit Orchardist as specified in a 7 - year contract approved by the RDA.

Disclosure Statement

The authors have no potential conflicts of interest to report.

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