

'Mansu', a Hardy Kiwifruit (*Actinidia arguta* Planch. et Miq.) Cultivar with Improved Storage Life

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Abstract

In general, the storage life of hardy kiwifruit (*Actinidia arguta*) is approximately one month, even in cold storage, which is a limiting factor for its commercialization due to the short marketing period. This short shelf life is in contrast to those of green kiwifruit (*A. deliciosa*, 6 to 8 months) and gold kiwifruit (*A. chinensis*, 4 to 6 months). To increase the storage life of hardy kiwifruit, we performed a cross between *A. arguta* (a local collection, 'Hy2-1', female) and *A. deliciosa* ('Matua', male) at Wando station at the Fruit Research Institute of JARES, Korea in 1999. After the first selection in 2006, we clonally propagated the hybrid plants by grafting them onto *A. arguta* seedlings in Gwangyang and Haenam province, Korea. We performed the final selection of this cultivar in 2012 and applied for plant protection rights from the Korea Forest Research Institute in 2013. Several experimental orchards have been established for commercial production. 'Mansu' begins to flower on May 20 in Gwangyang. The horticultural maturity date in 'Mansu', when the soluble solid content reaches 7°Bx, is October 15, whereas that of the control variety ('Chiak') is October 5. The average fruit size of 'Mansu' is approximately 15 g. The soluble solid content of 'Mansu' is approximately 16 to 17°Bx after ripening. The total yield of mature 'Mansu' vines is estimated to be 2.2 to 2.5 tons per 10a. The fruit firmness of 'Mansu' exceeded 1.5 kg/5 mmØ until 70 days after storage (at 0 and 1°C). Therefore, 'Mansu' fruits have much longer storability than the control. The cultivation and production of 'Mansu' may extend the marketing period for hardy kiwifruit.

Additional key words: bark crack, cultivar, stripe, firmness, maturity, storability

Introduction

Hardy kiwifruit (*Actinidia arguta* Planch. et Miq.) is widely distributed from Southwest China, Korea, and Japan to Siberia (Cui et al., 2002). In the Korean peninsula, *A. arguta* vines are commonly found in the mountains and valleys from Gangwondo to Jeju below an altitude of approximately 1,000 m above sea level (Lee, 1982; Cho et al., 2011). The fruits of *A. arguta* have long been collected and consumed by local people due to their sweetness (Lee, 1982). Trial cultivation to utilize *A. arguta* fruits for commercial production has recently begun (unpublished data from the Korean Arguta Workshop). However, a profitable arguta industry has not yet been established due to various barriers (Williams et al., 2003), such as low consumer awareness, the short marketing period for this fruit, and



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difficulties in vine management, pest management, and deciding when to harvest the fruits (Strik and Cahn, 1998). Among these, the short marketing period is said to be the most important structural problem in the arguta industry. Several approaches can be taken to overcome the short marketing period. The first approach is to develop better storage techniques for arguta kiwifruits. These techniques may include precisely determining the optimum harvest time for each cultivar (Fisk et al., 2006), establishing the best storage conditions, proper packing methods, and fruit handling procedures, as well as developing new cultivars with better storability. Most arguta kiwifruits have short storability (roughly 1 month) (Strik and Cahn, 1998; Fisk et al., 2008). Although 12 arguta cultivars have been released in Korea to date (Cho et al., 2011; Cho et al., 2014), most of these cultivars also have short storability, even in cold storage.

Origin

Brief History of Selection

An interspecific cross was made between *A. arguta* and *A. deliciosa* at Haenam experimental station in May 1999, and the resulting seeds were planted at Wando experimental station in April 2000. The first selection was made in November 2006. The major events in the selection process are presented in Table 1. Experimental orchards were established to further evaluate the selected accession in Gwangyang (latitude 35.01119 and longitude 127.58675) and in Haenam (latitude 34.61381 and longitude 126.52826) by grafting the plants onto another arguta rootstock in March 2007. Final selection was performed between 2011 and 2012, and the cultivar was registered for plant variety protection (Registration number 2013-10) from the National Forest Seed Variety Center in 2013.

Cultural Conditions for Phenotypic Characteristic Evaluations

All vines were planted at a density of 6×6 m and were grown in sandy loam soil for 7 years until 2012. The vines were trained on a pergola system. Experimental blocks of vines were managed organically following general cultural practices such as pruning, thinning, and pest control. No synthetic chemicals or soluble fertilizers were applied, and only organic fertilizer was applied (40 kg per vine during the winter season). In the absence of rain, sprinkler irrigation was performed every 4 days.

Investigations of each phenotypic characteristic were carried out in Gwangyang following the standards for agricultural experiments, research, and investigation issued by the Korean Rural Development Administration (RDA, 1995). Each investigation on flower organs was performed with 30 replicates during the flowering period. At harvest, each group of 60 fruits was investigated for fruit characteristics in three replicates. All flowers and fruits investigated were obtained from the central flower of a flower cluster.

Storability Test and Quality Investigation of Fruits

Fruits were randomly picked from six vines within the experimental blocks and stored at room temperature for one night for precooling and to remove surface moisture. Soft fruits were removed prior to storage, and fruit stalks were also removed. Fruits were stored at $0 \pm 0.5^\circ\text{C}$, $1 \pm 0.5^\circ\text{C}$, or $2 \pm 0.5^\circ\text{C}$ for 2.5 months at 95% relative humidity in plastic bags. For dry matter weight (DM, %) measurements, a 2 mm thick slice was cut from the equatorial part of the fruit and dried at 65°C for 24 h;

Table 1. Brief selection history of 'Mansu'.

Year	2000	2005	2006	2007-2012	2013
<i>A. arguta</i> ('Hy2-1')					
×	→	→	1 st selection, 'Haenamdarae #3'	Evaluation	Registered for PVR ² 'Mansu'
<i>A. deliciosa</i> ('Matua')					
Major events in these years					
Cross in Haenam	Planted in Wando	Flowering and fruit bearing	Grafting onto <i>arguta</i> rootstock	Evaluation in two locations ³ in Jeonnam	Released to six orchards ⁴

²PVR; plant variety right, ³Haenam, Gwangyang, ⁴4 in Bosung, 1 in Gangjin, 1 in Hwasun.

the DM was expressed as dry weight divided by raw weight. All data are the average values from three replicates (20 fruits/replicate).

Description and Performance

Plant Phenotypic Characteristics of 'Mansu'

The characteristics of flowers and floral organs of 'Mansu' are quite similar to those of 'Chiak' (Table 2), a typical *A. arguta* cultivar. The vine vigor and growth characteristics of these varieties are nearly identical (data not presented). However, many severe vertical cracks were observed on the trunk surface of 'Mansu' (Table 3). Therefore, the trunk of 'Mansu' is clearly distinguishable from that of 'Chiak'. On the other hand, the overall leaf shape of 'Mansu' is the same as that of 'Chiak'. However, 'Mansu' leaves do not curl in the summer, but 'Chiak' leaves curl severely (Table 3). Therefore, 'Mansu' is considered to be more tolerant to hot temperatures than 'Chiak'.

Table 2. Flowering period and characteristics of floral organs in 'Mansu' grown in Gwangyang, Korea in the growing seasons of 2011 and 2012.

Cultivar	Beginning of flowering (date)	Full bloom (date)	Flower size (cm)	Peduncle length (cm)	No. of pistils
Mansu	May 20	May 22–25	4.0 a ²	2.5 a	23 a
Chiak (control)	May 20	May 22–25	4.0 a	2.4 a	21 a

²Same letters within columns indicate no significant difference by Duncan's multiple range test at $p \leq 0.05$.

Table 3. Characteristics of leaves and bark of 'Mansu' (2011-12, Gwangyang).

Cultivar	Leaf shape (cm)	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Leaf curling in summer	Bark cracking on trunk
Mansu	Lanceolate	12.9 a ²	7.6 a	8.3 a	None	Severe
Chiak (control)	Lanceolate	11.9 a	6.9 a	6.7 a	Severe	Moderate

²Same letters within columns indicate no significant difference by Duncan's multiple range test at $p \leq 0.05$.

Fruit Characteristics at Harvest

The fruit appearance of 'Mansu' is similar to that of 'Chiak'. The average fruit size of 'Mansu' is approximately 15 to 17 g at harvest. 'Mansu' has typical vertical stripes at the fruit end (Fig. 1). On October 15, the fruit firmness of 'Mansu' was 2.9 kg/5 mmØ, whereas that of 'Chiak' was over 2.6 kg/5 mmØ on October 5 (Table 4). Therefore, 'Mansu' is a late maturing fruit, which should be harvested at least approximately 10 days later than 'Chiak'. The soluble solid content of 'Mansu' appeared to be a bit lower than that of 'Chiak' when compared on the same date in autumn. Dry matter weight (used as a taste index after ripening in kiwifruit) increased in both cultivars at a similar rate when they approached harvest maturity (Table 4).

Quality Changes during Cold Storage and Storability

The fruit firmness of 'Mansu' was higher than that of 'Chiak' at all storage temperatures (0, 1, and 2°C) during storage (Fig. 2). The firmness of 'Mansu' fruits was maintained at over 1.5 kg/5 mmØ until 75 days of storage at 0°C, 60 days at 1°C, and 30 days at 2°C. By contrast, the firmness of 'Chiak' fruits decreased to below 1.5 kg/5 mmØ after 15 to 30 days of storage at all temperatures. The dry matter weight of 'Mansu' was well-maintained throughout the cold storage period (data not presented).

Availability

'Mansu' can be harvested approximately 10 days later than the control ('Chiak'). Although 'Mansu' has very similar



Fig. 1. Fruiting 'Mansu' (left); vertical stripes on the ends of fruits are shown in black circles (right).

Table 4. Fruit characteristics of 'Mansu' at harvest and harvest maturity (2012-2013, Gwangyang).

Cultivar	Fruit shape	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Fruit firmness (kg/5 mm Ø)	Soluble solid content (°Brix)		Dry matter (%)	Harvest maturity
						At harvest	After ripening		
Mansu	Ovate	16.1 a ^z	38.2 a	28.6 a	2.9 a	6.9 a	16.5 a	16.4 a	Oct. 15
Chiak (control)	Ovate	15.9 a	37.5 a	26.8 a	2.6 a	7.1 a	16.9 a	16.6 a	Oct. 5

^zSame letters within columns indicate no significant difference by Duncan's multiple range test at $p \leq 0.05$.

phenotypic characteristics to those of the typical *A. arguta* vine ('Chiak', which was derived from pure *A. arguta* seedlings) (Jo et al., 2007), the vertical cracks in 'Mansu' trunks are clearly distinctive compared to 'Chiak'. Another feature of 'Mansu' vines is that they appear to be tolerant to drought during hot summers, because the leaves of 'Mansu' did not curl under strong sunlight. Such morphological features imply better photosynthetic ability of 'Mansu' vines. In terms of fruit firmness, 'Mansu' exhibited approximately two times longer storability in cold storage than 'Chiak' (Fig. 2). At present, the rapid softening of *A. arguta* fruits after harvest and even in cold storage is one of the limiting factors in the arguta industry. However, the introduction of later maturing cultivars with longer storage lives such as 'Mansu' may represent a breakthrough in the arguta industry in the future. At the same time, further studies are urgently needed to explore marketing technology and postharvest quality management, as well as cultural practices for high quality fruit production, to facilitate the establishment of the arguta industry.

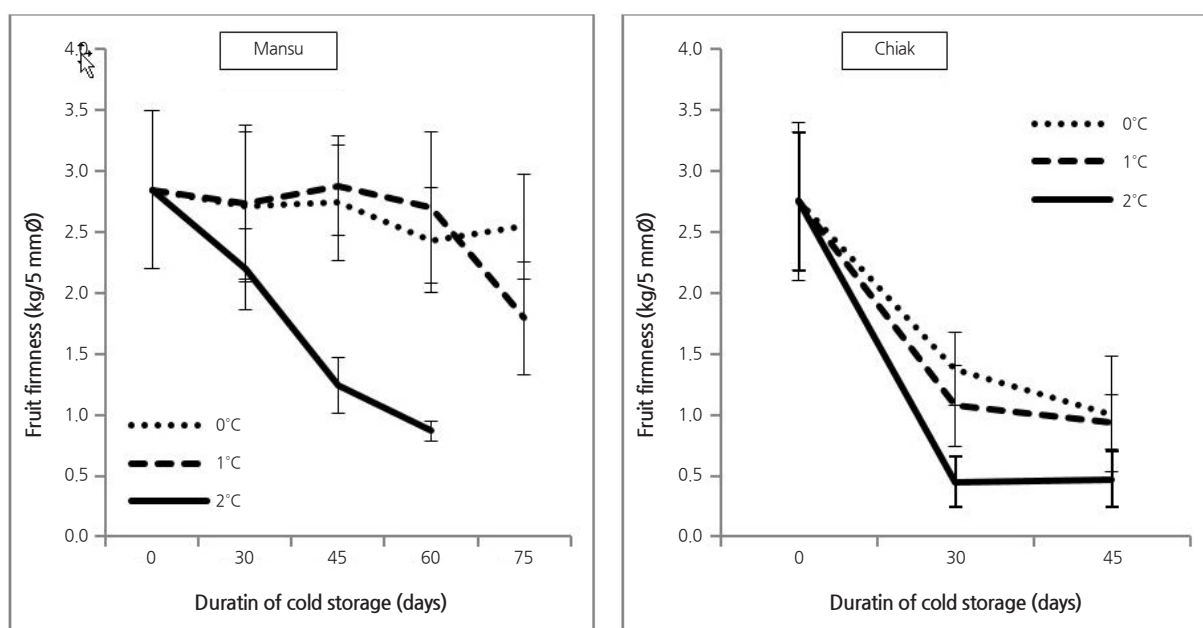


Fig. 2. Comparison of fruit firmness between 'Mansu' and 'Chiak' following cold storage at 0, 1, and 2°C. Error bars represent ± standard error.

Literature Cited

- Cho YS, Cho HS, Park MY (2011) The collection, characteristics and conservation of Korean native genus *Actinidia* plants. Korean Academy of Native Species 17:55-62
- Cho YS, Cho HS, Park MY (2014) The manual of hardy kiwifruit cultivation. Jeonnam Agricultural Research and Extension Services. Bando press, Gwangju, Korea, pp 7-12
- Cui ZX, Huang HW, Xiao XG (2002) *Actinidia* in China. China Agricultural Science and Technology Press, Beijing, China, pp 8
- Fisk CL, Silver AM, Strik BC, Zhao Y (2008) Postharvest quality of hardy kiwifruit (*Actinidia arguta* 'Ananasnaya') associated with packaging and storage conditions. Postharvest Biol Technol 47(3):338-345. doi:10.1016/j.postharvbio.2007.07.015
- Fisk CL, McDaniel MR, Strik BC, Zhao Y (2006) Physicochemical, sensory, and nutritive qualities of hardy kiwifruit (*Actinidia arguta* 'Ananasnaya') as affected by harvest maturity and storage. J Food Sci 71:S204-S210. doi:10.1111/j.1365-2621.2006.tb15642.x
- Jo YS, Ma KC, Cho HS, Park JO (2007) Chiak, a new selection of *Actinidia arguta*. Acta Hort 753(1):259-262. doi:10.17660/ActaHortic.2007.753.31

- Lee TB** (1982) Illustrated flora of Korea. Hyangmoonsa press, Seoul, Korea, pp 2165
- RDA** (1995) The standards of Agricultural experiment, research and investigation. Rural Development Administration (RDA), Suwon, Korea, pp 348-381
- Strik BC, Cahn H** (1998) Growing kiwifruit. Oregon State University, Oregon, US, pp 1-23
- Williams MH, Boyd LM, McNeilage MA, MacRae EA, Ferguson AR, Beatson RA, Martin PJ** (2003) Development and commercialization of 'baby kiwi' (*Actinidia arguta* Planch.). Acta Hort 610:81-86. doi:10.17660/ActaHortic.2003.610.8