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'Sweet Skin' Pear

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Abstract

'Sweet Skin' pear (*Pyrus pyrifolia* [Burm. F.] Nakai) was selected from a cross between 'Shinsui' and Wonkyo Na-11 (Hosui × Okusankichi) made in 1989 at the National Institute of Horticultural and Herbal Science (NIHHS) of the Rural Development Administration in Korea. It was first selected as 89-17-60 in 1997 for its attractive fruit appearance and good eating quality. After regional adaptability tests at 10 sites for 5 years from 2003 to 2007 as Wonkyo Na-40, it was named in 2007. It blooms two days later than 'Wonwhang', an early season leading pear cultivar in Korea. 'Sweet Skin' is strong in tree vigor and upright-spreading in tree habit. It is classified as highly susceptible to pear scab (*Venturia nashicola* Tanaka & Yamamoto) having degree of susceptibility similar to 'Niitaka'. 'Sweet Skin' shows no visual symptoms of black necrotic leaf spot caused by apple stem grooving virus. ''Sweet Skin' is cross-compatible with Korean major pear cultivars such as 'Niitaka', 'Wonhwang' and 'Whasan'. The average optimum harvest time of 'Sweet Skin' was August 18, almost the same as 'Shinsui' and 18 days earlier than 'Wonwhang'. The fruit is oblate in shape and bright yellowish brown in skin color. Average fruit weight was 455 g and soluble solids content was 12.7°Brix. 'Sweet Skin' has 27% non-edible proportion, as estimated by the ratio of core diameter to fruit diameter. The edible proportion is much higher than in 'Niitaka' (35%), 'Wonwhang, (38%)' or 'Shinsui' (35%). The flesh has abundant juice and negligible grit. The fruit taste of 'Sweet Skin' with and without skin was evaluated as superior to 'Shinsui'. It also has higher total phenol and total flavonoid content in both fruit skin and flesh than 'Niitaka', the leading cultivar in Korea.

Asian pear (*Pyrus pyrifolia* [Burm. F.] Nakai) is one of the most important temperate fruit crops in Korea, with planted area increasing by 13% from 18,243 ha in 1996 to 20,656 ha in 2006 (11). Most Asian pears are peeled before eating as the skin is often tough and bitter. Consuming pears with the skin intact is not only convenient but also would increase the consumption of polyphenols and flavonoids, as there are high concentrations of these compounds in the skin.

Phenolic compounds in fruits and vegetables are known to play an important role in protection of cellular membranes against oxygen radical-mediated lipid peroxidation. Peroxidation was reported to be associated with several pathological conditions in human such as carcinogenesis, mutagenesis, atherosclerosis and aging (3). Among phenolic compounds, flavonoids and phenolic acids in pear fruits have recently been receiving attention as potential sources of natural antioxidants with anti-thrombotic activity (2). According to Dongyuibogam, a traditional medical book in Korea (18), Asian pear can alleviate constipation, fever, and coughing, and can especially quench thirst after the drinking of alcoholic beverages (17). It was reported that a polyphenolic compound extracted from pear skin induced activation of immune function of mice and unidentified polyphenol compounds were shown to have a highly significant effect on blood pressure control, skin whitening activity and arthritis inhibition (2). Lignin and pentosan in the stone cells of pear promoted purgative and dieresis effects (4). Pear flesh contains sugars and acids that help to overcome fatigue and hangover (4). Pears have chemoprevention effects on polycyclic aromatic hydrocarbon (PAH)-induced carcinogenic mechanisms due to the rapid excretion of PAH intermediates and reduction of PAH induced oxidative stress (17).

'Sweet Skin' pear was developed to increase pear consumption as a pear edible without peeling.

Materials and Methods

A population of 225 seedlings from a

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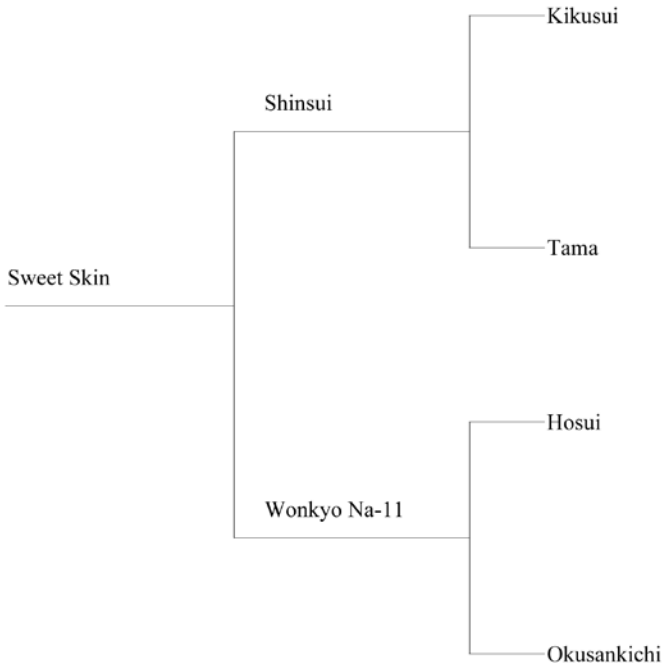

Figure 1. Pedigree of 'Sweet Skin' pear.

cross between 'Shinsui' and Wonkyo Na-11 (Fig. 1) was planted in a breeding field at the NIHHS in Suwon in 1994. It was first selected as 89-17-60 in 1997 for its attractive fruit appearance and good eating quality. After first selection, four trees each of 89-17-60 and the control cultivars 'Shinsui' and 'Wonwhang', all propagated on *P. pyrifolia* seedling rootstock, were planted in 1998. All trees were trained to a central leader growth habit. The trees were evaluated for flower, tree and fruit characteristics according to standard guidelines (12, 16). During the blooming period, 100 flowers at balloon stage at the 2nd or 3rd position of a flower cluster were picked and anthers were collected. After dehiscense of anthers for 24 hours at 20 ^{0}C, pollen was collected by the 100% acetone dipping method, and the total quantity was weighed using analytical balances (Metler Toledo, Excellence KS, USA). Each spring, flower thinning and fruit thinning were carried out to prevent biennial fruiting. Final distance between fruits at harvest was maintained at a minimum of 20-30 cm.

As trees came into bearing, five fruits were taken from each of four trees at three times to ascertain the exact ripening time. After the fruits were weighed, they were cut in half longitudinally. Flesh firmness was measured on each side of the fruit with a fruit firmness tester (Takemura FHM-5, Japan) equipped with a 5 mm diameter plunger. Thereafter, soluble solids concentration was measured on each fruit by expressing juice from each side onto a digital refractometer (Atago PR-101, Japan). Titratable acidity of each fruit was measured from 10 mL samples of squeezed juice plus 40 mL distilled water and reported as percentage in terms of the malic acid equivalents. The solution was titrated to an endpoint of pH 8.1 using 0.1 N NaOH. Titrations were performed using an auto-titrator (Schott TitroLine Alpha, Mainz, Germany).

Sensory evaluation for grit and flesh juiciness

was carried out by three trained people. The sensory evaluations for appearance, taste with or without skin, bitterness of skin, and overall taste of 'Sweet Skin' and 'Shinsui' were conducted by thirty-one untrained personnel. Four types of samples were prepared (intact fruit, sliced with or without skin, and skin only), and randomly offered to the panelists. The degree of scab caused by *V. nashicola* inoculum (Fig. 2) and black necrotic leaf spot caused by apple stem grooving virus were estimated according to the methods of Abe and Kurihara (1), Langford and Keitt (10) and Shin et al. (13, 14).

The methodology for extraction of total phenol and total flavonoid content in fruit flesh and skin was slightly modified from Kim et al. (6). To analyze total phenols and total flavonoids of 'Sweet Skin', 'Niitaka' and 'Wonwhang', 10 fruits per cultivar were used and flesh and skins were sampled (10 g per fruit collected from four parts in the mid-longitude of each fruit). All samples were freeze-dried for three days and ground and then stored at -80°C. Total phenols and total flavonoids were extracted from each sample using 100 mL of 80% aqueous methanol in a 250 mL round-bottomed flask. The mixture of powder and aqueous methanol was sonicated for 20 min. The mixture was filtered through Whatman #2 filter paper (Whatman International Limited, Kent, England) using a chilled Büchner funnel and rinsed with 50 mL of 100% methanol to extract low-molecular-weight phenolics. The solid filter cake was re-extracted by repeating the above steps under the same condition. The two filtrates were combined and transferred into a 1-L round-bottomed flask with an additional 50 mL of 80% aqueous methanol. The solution was concentrated by evaporation under reduced pressure at 40°C. The extract was dissolved in 50 mL of 100% methanol and adjusted to a final volume of 100 mL with distilled deionized water (ddH_2O). The solution then was centrifuged at 12000g for 20 min. at low temperature (about 4°C). The final extract solution was stored at -4°C until analysis.

The experimental procedure used to quantify the total concentration of phenolics in extracts is the one adapted by Singleton et al. (15). The assay data were correlated to the calibration curve of gallic acid in the range of 0-600 μg/ml. The total concentration of flavonoids was quantified according to method of Jia et al. (5) and the assay data were correlated to the calibration curve of (+)-catechin in the range of 0-500 μg/ml.

The experiment was designed was a randomized complete block design with years being designated as blocks. The statistical significance was calculated by Tukey's studentized range (HSD) test of GLM using SAS statistical software (V 9.1, SAS Institute Inc., Cary, NC, USA). The data were graphed using the SigmaPlot 9.0 program (Systat Software, Richmond, Calif., USA).

Description

'Sweet Skin' is strong in tree vigor and

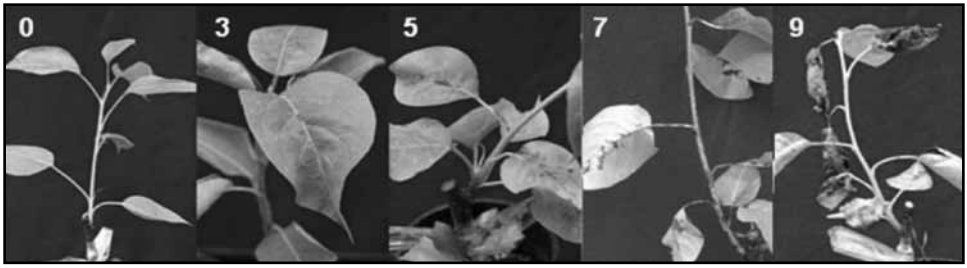

Figure 2. Scab infection score on pear leaves 7 wk after artificial inoculation. 0: no visible symptom on any leaf; 3: sparsely sporulating lesions on a few leaves or petioles; 5: moderately sporulating lesions on a few leaves or petioles; 7: abundant sporulating lesions on several leaves or petioles; 9: abundant sporulating lesions on several leaves or petioles, and detachment of all infected leaves.

Table 1. Tree characteristics and disease resistance of 'Sweet Skin' at Suwon, Korea, 2005-2007.

Cultivar	Date of full bloom	Tree vigor	Tree habit	Number of spurs per branch	Pollen quantity	Black necrotic leaf spot[z]	Scab resistance[y]
Sweet Skin	Apr. 25	Strong	Upright spreading	Many	Medium	Symptomless	9
Shinsui	Apr. 26	Strong	Upright	Many	Much	Symptomless	7
Wonhwang	Apr. 23	Strong	Upright spreading	Many	Much	Symptomless	7

[z] Symptomless: no visible symptoms on any leaf; symptom: abundant black necrotic spots on all leaves
[y] Rated on a 0 to 9 scale where 0 = highly resistant (no visible symptoms on any leaves) and 9 = highly susceptible (abundant sporulating lesions on several leaves or petioles and detachment of all infected leaves).

upright-spreading in tree habit (Table 1). It blooms 2 days later than 'Wonwhang' (9), a leading cultivar for the early season in Korea and one day earlier than 'Shinsui', its maternal parent. Length and thickness of 1-year-old shoots is medium. Lenticels on 1-year-old shoots are fewer than those of 'Wonwhang', but similar in size (data not presented). Spurs are abundant and the number of axillary flower buds on 1-year-old shoots is moderate. Precocity is similar to 'Wonwhang' on *P. pyrifolia* rootstock, with the onset of fruiting in the third year. No yield data were collected. The flowers have 30 stamens per flower (a moderate number), more than the 20 stamens of 'Wonwhang'. In pollination compatibility tests, 'Sweet Skin' was highly compatible with all test cultivars, such as 'Whankeumbae' (8) and 'Chuhwangbae'.' (7) (data not presented). 'Sweet Skin' requires optimal chemical control of scab, since it shows the same high degree of susceptibility to this disease as 'Niitaka', the leading cultivar in Korea, and is more susceptible than 'Wonwhang'. 'Sweet Skin' was, however, classified into the symptomless group against apple stem grooving virus.

Optimum fruit harvest time at Suwon is Aug. 17, more than 2 weeks earlier than 'Wonwhang' but similar to 'Shinsui' during 1999-2007 (Table 2). The fruit is oblate in shape and yellowish brown in skin color (Fig. 3). Average fruit weight was 455 g. Soluble solids concentration averaged 12.7° Brix, slightly lower than that of 'Shinsui' and 'Wonwhang', and titratable acidity was 0.077%, lower than that of the two controls. Fruit flesh was firmer than that of 'Shinsui' and 'Wonwhang', very juicy and had negligible grit. It had a much greater proportion of edible flesh than 'Wonwhang,' or 'Shinsui' in terms of the ratio of core diameter to fruit diameter. The fruit does not store more than 7 days at ambient temperature or more than one

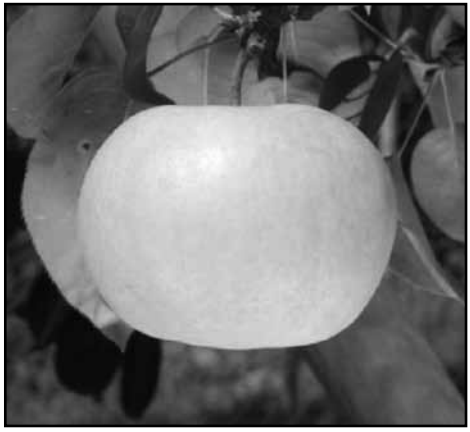

Figure 3. Fruit of pear cultivar 'Sweet Skin'.

Table 2. Fruit charactersitics and optimum ripening time of 'Sweet Skin' at Suwon, Korea, 1999-2007.

Cultivar	Date of maturity	Fruit shape	Fruit skin color	Fruit weight (g)	Soluble solids (°Brix)	Acidity (%)	Grit	Firmness (kg)	Ratio of core diameter /fruit dia. (%)
Sweet Skin	Aug. 18	Oblate	Yellowish brown	455 a[z]	12.7 a	0.077 b	Low	1.30 a	27 b
Shinsui	Aug. 18	Oblate	Yellowish brown	230 b	13.4 a	0.155 a	Low	1.10 b	35 a
Wonhwang	Sept. 5	Roundish oblate	Yellowish brown	451 a	13.1 a	0.169 a	Low	1.10 b	38 a

[z] Means within a column followed by different letters are significantly different at the 5% level according to Tukey's studentized range (HSD) test.

month in cold storage at 1~2°C after harvest.

The appearance score of 'Sweet Skin' was comparable to that of 'Shinsui' (Fig. 4). The sensory evaluation score of fruit taste of 'Sweet Skin' with and without skin was higher than that of 'Shinsui' (Fig. 4). Perception of skin bitterness was significantly lower in 'Sweet Skin'. Overall acceptability score of 'Sweet Skin' was greater than that of 'Shinsui'. 'Sweet Skin' had high total phenol and total flavonoid contents in the fruit skin, and was similar to 'Wonwhang', which cannot be eaten without peeling due to its thick, coarse and bitter skin. 'Niitaka' which also has coarse and

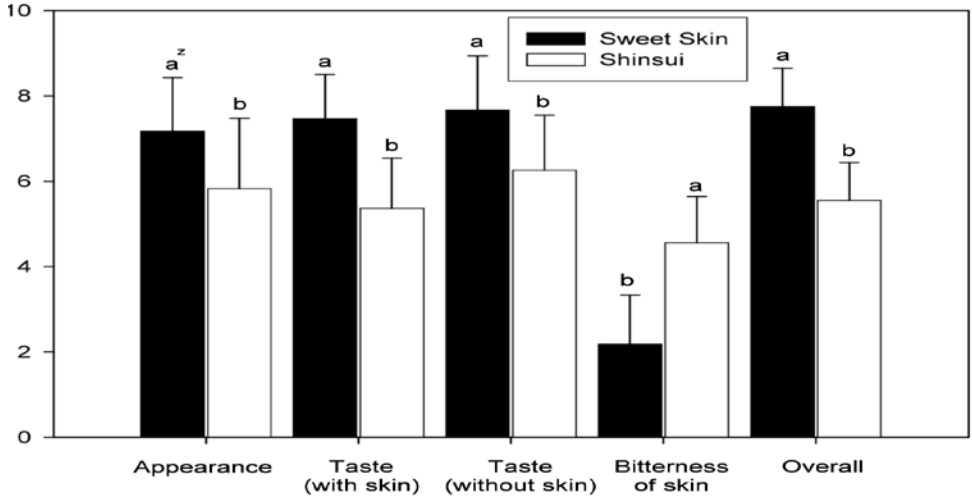

Figure 4. Sensory evaluation score of several characteristics of 'Sweet Skin' and 'Shinsui'. A 10-point scale was used. For appearance, taste with or without skin, and overall score: from 0 (poor) to 9 (excellent); for skin.bitterness, from 0 (weak) to 9 (strong). The vertical bars indicate standard deviation.

[z] Means followed by different letters are significantly different at the 5% level according to Tukey's studentized range (HSD) test.

Table 3. Total phenol and total flavonoid contents in flesh and skin of the Asian pear cultivars 'Sweet Skin', 'Wonwhang' and 'Niitaka'.

	Total phenol content (umol/g dw)		Total flavonoid content (umol/g dw)	
	Flesh	Skin	Flesh	Skin
Sweet Skin	10.574 a[z]	127.300 a	1.682 a	35.764 b
Wonwhang	9.913 a	121.935 a	1.701 a	39.141 a
Niitaka	5.670 b	60.604 b	1.074 b	22.728 c

[z] Means within a column followed by different letters are significantly different at the 5% level according to Tukey's studentized range (HSD) test.

bitter skin, had lower skin and flesh contents of total phenols and total flavonoids than 'Sweet Skin' or 'Wonwhang' (Table 3).

Availability

Protection for 'Sweet Skin' was applied for in Dec. 2007 for registration in 2010 after two years of records on distinctness, uniformity and stability by Korean Seed Industry Law. Propagation material of 'Sweet Skin' will be available after variety registration.

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