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'Elongated Fruit No. 1' Mulberry: An Elite Cultivar for Fresh Consumption

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Abstract

'Elongated fruit No. 1' mulberry (*Morus laevigata* Wall.) is a new cultivar that is suitable for berry production released by the National Pingtung University of Science and Technology (NPUST) and the Miaoli District Agricultural Research and Extension Station (MDARES) in Taiwan. 'Elongated fruit No. 1', specifically named for its unique berry shape, produces attractive bright purple, glossy, large and elongated fruit and is recommended for both pick-your-own and fresh markets. In this study, we found that the fruit ripening season of 'Elongated fruit No. 1' is later, the berry is much sweeter (20.1% soluble solids, SSC), and the eating quality is superior to that of both 'Taisang No. 19' (*Morus atropurpurea* Roxb., a synonym of *Morus alba* L.) and 'Miaoli No. 1' (*Morus atropurpurea* Roxb.), which are currently the most commercially available mulberry cultivars in Taiwan.

Origin

'Elongated fruit No. 1' (*Morus laevigata* Wall.), tested as 70C006, belongs to the Longispica mulberry group (7) and is a local genotype discovered as a chance seedling in 1981 in Gangshan on Kaohsiung, Southern Taiwan (2). It was initially considered for its unique berry shape, large size and remarkable sweetness. In 1982, it was first introduced to the fruiting mulberry breeding program trials at the Miaoli District Agricultural Research and Extension Station (MDARES) in Miaoli (24.3°N; 120.5°E; alt. 136 m), Taiwan, which is researching the mulberry for tree breeding, physiology and cultivation. Since August 2008, 'Elongated fruit No. 1' has been incorporated into the fruit tree breeding projects at the National Pingtung University of Science and Technology (NPUST) in Pingtung (22.4°N; 120.4°E; alt. 71 m), Taiwan.

Materials and Methods

The breeding experiments were conducted on 9 to 12-year-old field-grown 'Elongated fruit No. 1' mulberry trees and two comparable cultivars, 'Taisang No. 19' (*Morus atropurpurea* Roxb., a synonym of *Morus alba* L.) (formerly tested as 46C019) and 'Miaoli No. 1' (*Morus atropurpurea* Roxb) (4, 8), established in 1997 in MDARES. 'Elongated fruit No. 1' was obtained from grafts ['Elongated fruit No. 1'/ 'Taisang No. 3' (*Morus alba* L.)], where 'Taisang No. 19' and 'Miaoli No. 1' were used as self-rooted liners. 'Taisang No. 19' was chosen because it is currently the most widely planted cultivar in Taiwan, with a high yield of medium sized (4.3 g) berries of low sugar content (4.9 % soluble solids, SSC) (2). 'Miaoli No. 1', the first commercial cultivar released by MDARES, is reported to have a high yield of large (5.7g) moderately sweet berries (7.4 % SSC) (4).

Trees were spaced at 4 × 4 m, then fertilized, irrigated, and periodically controlled for pests and diseases. They received a severe post-harvest pruning (around April of each year) according to the management protocols suggested by Chang (1, 2). On Oct. 2, 2006, when the trees reached full size and could produce a regular yield, a total population of 30 shoots from 6 trees for each cultivar was selected and arranged in a completely randomized design. Tree vigor, phenology,

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flower sex, annual yield (one season pick), fruit characteristics, and biological reaction were evaluated for 3 production cycles from Oct. 2006 to May 2009.

Annual yield and fruit characteristics were examined between May and April for each year. One hundred and fifty fruit on 30 bearing shoots from 6 trees for each cultivar were harvested for determination of fruit characteristics. Soluble solids content (SSC) of fruit was measured using a digital refractometer (Atago PR-101, Tokyo). Titratable acidity were determined using a titrator (VIT90 Video Titrator,Toyko) with 0.01 N NaOH equilibrated at pH 8.1; the results were expressed as % citric acid. Tree vigor and biological reactions were rated according to the methods of Chang (2, 4).

Data on yield and fruit characteristics were subjected to analysis of variance (ANOVA) using SAS package software (9). Statistical significance of differences among means was assessed by the least significant difference (LSD) test at 5% error level.

Performance and Description

'Elongated fruit No. 1' is a highly vigorous, deciduous and monoecious mulberry cultivar. The annual growth of new shoot after severe post-harvest pruning (in April) has been reported to reach 2.5─3.0 m in length by winter dormancy; subsequently, the approximate height and canopy spread of a mature tree can reach 3.2─3.6 m and 2.5─3.0 m of diameter, respectively (1). In this study in the Miaoli district of Taiwan, dormancy occurred between mid-November and mid-January, with budbreak occurring in late January (Table 1).

'Elongated fruit No. 1' produces only pistillate flowers, and it often bears seedless fruit, which is the result of parthenocarpy (2) due to triploidy identified by Chang et al (5). In the Miaoli district of Taiwan during the 2006-2009 seasons, 'Elongated fruit No. 1' began flowering in early February and ended in mid-February, and ripe fruit were harvested from early to mid-April, which was approximately 5-7 days later than 'Miaoli No. 1' and 'Taisang No. 19' (Table 1).

Fig. 1. Fruit of 'Elongated fruit No. 1' and two comparable cultivars, 'Miaoli No. 1' and 'Taisang No. 19', with a ruler (cm).

Table 1. Phenology and characteristics of 'Elongated fruit No. 1' and two comparable mulberry cultivars tested at MDARES, Taiwan (2006-2009).

		Dormancy period[y]			Bloom date[y]			Ripening time[y]		
Cultivar	Tree vigor[z]	Start date	End date	Flower sex	First bloom	Full bloom	Last bloom	First harvest	Full harvest	End harvest
'Miaoli No.1'	8[x]	20 Nov.	23 Jan.	Female	30 Jan.	11 Feb.	14 Feb.	31 Mar.	9 Apr.	15 Apr.
'Taisang No. 19'	6	17 Nov.	20 Jan.	Female	28 Jan.	9 Feb.	12 Feb.	29 Mar.	8 Apr.	12 Apr.
'Elongated fruit No. 1'	10	24 Nov.	29 Jan.	Female	4 Feb.	15 Feb.	19 Feb.	4 Apr.	14 Apr.	19 Apr.

[z] Rated on a scale of 1 to 10, where 10 is the most vigorous (more than 2.5 m of annual shoot growth in length), 5 is moderate (around 1.3 m of annual shoot growth in length) and 0 is the least vigorous (less than 0.5 m of annual shoot growth in length)

[y] One-sixth of the given characteristics is regarded as the start or first date, while four-sixths is full. The remaining is the last or end date

[x] Means of 30 shoots from 6 trees for each cultivar.

'Elongated fruit No. 1' was specifically named for its elongated berry shape, which is unique among existing mulberries (Fig. 1). The berry's average weight is around 6.0 g, which is similar to that of 'Miaoli No.1 ', but significantly heavier than 'Taisang No. 19'. Fully mature berries of 'Elongated fruit No. 1' have an attractive, bright purple appearance and a medium titratable acidity. The SSC of fruit at harvest was 20 %, which is magnitudes greater than that of 'Taisang No. 19' or 'Miaoli No. 1', respectively (Table 2). Although the annual yield (11.3 kg/tree) of 'Elongated fruit No. 1' is lower than either of the two the comparable cultivars (Table 2), preliminary reports indicate that due to its much improved fruit sweetness compared to other cultivars and great popularity in Taiwan, 'Elongated fruit No. 1' generates an extremely high premium in the local fresh consumption market. Fruit price premiums up to nine times (~US $10.6 per kg of fresh weight) higher than that of either 'Taisang No. 19' or 'Miaoli No. 1' (~US $1.1 per kg of

Table 2. Fruit yield and characteristics of 'Elongated fruit No. 1' and two comparable mulberry cultivars tested at MDARES, Taiwan (2006-2009).

		Fruit characteristics							Susceptibility[y]
Cultivar	Annual yield (kg/tree)[z]	Shape	Skin color	Length (cm)	Width (cm)	Berry weight (g)	Soluble solids (%)	Titratable acidity (%)	Popcorn disease/ Mulberry beetle/ Bird attack
'Miaoli No.1'	27.8 a	Ovate	Bright purple	3.3 b [x]	1.7 a	5.7 a	7.4 b	0.8 a	Moderate/Moderate/ Mild - susceptibility
'Taisang No. 19'	24.2 a	Ovate	Bright purple	2.7 bc	1.5 ab	4.3 b	4.9 c	0.9 a	Severe/Moderate/ Mild - susceptibility
'Elongated fruit No. 1'	11.8 b	Elongated	Bright purple	9.7 a	0.9 c	5.9 a	20.1 a	0.7 a	Mild/Moderate/ Severe - susceptibility
LSD	6.1	-	-	0.8	0.2	0.6	2.1	0.31	-

[z] Mean followed by different letters within the same column are significantly different as determined by LSD test at $P \leq 0.05$, n=6

[y] Popcorn disease = *Ciboria shirana* (P. Henn.) Whetzel; mulberry beetle = *Apriona germari* Hope.

[x] Mean of 150 fruit from 30 bearing shoots of 6 trees for each cultivar

fresh weight) have been reported (2).

Currently, 'Elongated fruit No. 1' is the only cultivar that is truly suitable for the fresh market, and it represents an exciting candidate for mulberry growers looking for new cultivars to exploit the economic potential of the mulberry industry in Taiwan.

Adaptation

For maximum vegetative growth and fruit quality as observed for 'Miaoli No.1' (4), ''Elongated fruit No. 1'' prefers full sunlight, a temperature between 22-27°C and an annual rainfall of 600-1200 mm (preferably evenly distributed between post-harvest pruning and autumn). It is especially recommended for Central-Southern Taiwan and other subtropical regions with similar climates for production, where the spring fruiting season is sunny and dry. As shown by our previous investigations (2,3), 'Elongated fruit No. 1' suffered a much lower fruit sweetness fruit and higher incidence of pre-harvest drop in Northern Taiwan, where the climate is rainy during the fruit growing season (2).

Disease, Pest and Bird Damage

'Elongated fruit No. 1' is reported to be resistant or tolerant to a variety of diseases, including fruit popcorn disease [*Ciboria shirana* (P. Henn.) Whetzel] and some insect pests (2). It does, however, exhibit moderate susceptibility to the mulberry beetle (*Apriona germari* Hope.), which attacks during the spring and summer seasons (Table 2). The larvae of mulberry beetles attack the xylem of the trunk, and the adults attack the bark on the branches, which results in tree decay. Because it has very sweet fruit (20 % SSC), 'Elongated fruit No. 1' could be prone to bird damage when the fruit are close to full maturity; the use of protective nets prior to harvest is strongly recommended.

Propagation

'Elongated fruit No. 1' can be propagated through grafting onto two foliage cultivars released by MDARES in 1978, 'Taisang No. 1' (*Morus acidosa* Griff) and 'Taisang No. 3' (2), between October and December. Grafts are usually transplanted once in the following spring and are maintained in containers for one more year before field planting.

Uses

Mulberry is reported to be an emerging fruit crop in Taiwan (3). The 'Elongated fruit No. 1' mulberry is a new and promising cultivar suitable for pick-your-own farms as well as fresh markets. Furthermore, 'Elongated fruit No. 1' may have the potential to be used in natural dyes, the cosmetic industry and the medicinal market (6). In addition to berry production, 'Elongated fruit No. 1' could produce leaves for silkworm feeding under conditions of an extreme shortage of leaves from foliage cultivars.

Plant Availability

Taiwan Plant Breeder's Right and a multiplication license for nurseries are pending. A limited quantity of grafts is available for research purposes and can be obtained by sending a request to the corresponding author.

Acknowledgements

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The Wilder Committee of the American Pomological Society (APS) invites nominations for the 2010 Wilder Silver Medal Award. All active members of APS are eligible to submit nominations. The award was established in 1873 in honor of Marshall P. Wilder, the founder and first president of APS. The award consists of a beautifully engraved medal which is presented to the recipient at the annual meeting of APS, held during the American Society for Horticultural Science annual meeting.

The Wilder Medal is presented to individuals or organizations that have rendered outstanding service to horticulture in the area of pomology. Special consideration is given to work relating to the origination and introduction of meritorious fruit cultivars. Individuals associated with either commercial concerns or professional organizations will be considered if their introductions are truly superior and have been widely planted. Significant contributions to the science and practice of pomology other than through fruit breeding will also be considered. Such contributions may relate to any important area of fruit production such as rootstock development and evaluation, anatomical and morphological studies, or noteworthy publications in any of the above subjects. Information about the award, past recipients, etc. can be found on the APS web site at http://americanpomological.org/wilder1.html.

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Nominations must be submitted by May 1, 2010.