A New Pineapple Cultivar *Ananas comosus* (L.) Merr. ('Tainung No. 22')

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'Tainung No. 22' (TNG.22, ♀ 'Smooth Cayenne' × ♂ 'Tainung No. 8'), also known as 'Honey Fragrance', was a new pineapple cultivar released by the Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, on Feb. 2012. The fruit of 'TNG.22' is large in size (1.76 kg on average) with a cylindrical shape and yellow with shades of orange-red-colored peel when ripe. The fruits are of good quality as indicated by the dense and juicy yellow to golden-yellow-colored pulp of medium acidity and high sugar content (17.6 °Brix on average). This new cultivar is free from problems of stem-end splitting, pineapple core rupture, and cracking peel. The fruit can be harvested from May to October.

Origin

Pineapple [*Ananas comosus* (L.) Merrill] is an economically important fruit crop planted extensively in tropical and subtropical regions. According to the Taiwan Agricultural Statistics Yearbook 2014, pineapple is one of the major fruits produced in Taiwan, with nearly 8,950 ha of area under pineapple cultivation, yielding about 456,243 Mg and valued at nearly \$240 million (NT 8 billion). The cultivation areas are located in Pingtung, Tainan, Kaohsiung, Chiayi, and Nantou in Taiwan. Canned pineapple was the major

product for export from 1956 to 1976 (Hsu, 1952). The table pineapple later replaced this (Chang, 1991). In response to this change, many new cultivars of pineapple have been developed by the Taiwan pineapple breeding program. Taiwan experiences hot and humid summers because of which many cultivars are of low quality, showing stem-end splitting, cracking peel, and other problems during fruit development. These problems were observed in 'TNG.17' (Tang and Kuan, 2012), the main cultivar in Taiwan, leading to the breeding of the cultivar Tainung No. 21 by the Chiayi Agricultural Experiment to improve fruit quality (Tang et al., 2014), which is the fruit having relatively thicker peel; therefore, improved fruit quality is still a major breeding objective.

A new cultivar of pineapple, Tainung No. 22 (TNG.22), also known as 'Honey Fragrance' (♀ 'Smooth Cayenne' × ♂ 'Tainung No. 8') has been hybridized since 1976 and obtained variety rights till 2012. Cultivation and primary selection were undertaken from 1976 to 1980. The criterion for selection was the better quality of fruits for consumption. Between 1980 and 2000, to strengthen propagation, 33 cultivars of pineapple were selected, all producing good-quality fruits for consumption. Among these 33 cultivars, TNG.22 is free of stem-end splitting and cracking peel and can be expected to overcome the poor quality of 'Tainung No. 17' ('TNG.17') as it shows improved qualities of high total soluble solids (TSS), medium titratable acidity (TA), and high pulp content with well-developed fruits even in summer.

Description

In this study, we compare the fruit quality, weight per fruit, yield, and the effect of temperature to test for storability of the cultivar TNG.22 with other cultivars such as TNG.17.

Comparisons of quality among C65-7-187 ('TNG.22') and four other selected lines (C69-8-105, C71-8-142, C71-6-153, and 'TNG.17') were undertaken at the Chiayi

Agricultural Experiment Branch in 1999. The experiment was conducted in a randomized complete block design with four replications and 60 plants per replication. The plants were grown at a spacing of 30 cm of planting, 50 cm in each row, and 100 cm in each furrow.

Comparison of weight per fruit, yield, and quality between C65-7-187 ('TNG.22'), 'TNG.17', and 'Smooth Cayenne' cultivars was carried out in the years 2005–06, 2006–07, and 2007–08, respectively. Comparative tests across regions included these three cultivars with five replications each. Pineapples were grown at a spacing of 30 cm of planting, 50 cm in each row, and 100 cm in each furrow. The experiment was conducted in a randomized complete block design.

To study fruit storability of 'TNG.22', effects of temperature on the quality of fruits were studied. Fruits from 'TNG.22' and 'TNG.17' were stored for 2 weeks at 25 and 15 °C.

The least significant difference test is used to statistically compare the differences.

Performance

The growth characteristics of 'TNG.22' (C65-7-187) were investigated in 2001 and the results were as follows: The mean plant height was 101.4 cm, leaf length was 90.7 cm, leaf width was 5.2 cm, number of leaves was 40 (Table 1), and leaf color was green with purple-red. The weight per fruit without crown was 1.2 kg and the fruit were cylindrical and yellow with shades of orange-red peel color when ripe. In regard of the texture, it is worth nothing that the pulp attributes intensities by the sense panel members, preferred solid, and strong. The pulp was juicy and yellow in color, with high content of TSS (16.4 °Brix) and medium acidity (Table 2).

Agronomic characters of the selected cultivars were measured in 2001 and compared. The weight per fruit (1.273 kg) and yield per hectare (50.9 t·ha⁻¹) were the least for 'TNG.22'. However, this cultivar showed higher content of TSS (16.4 °Brix) than TNG.17 (14.5 °Brix), C69-8-105 (15.9 °Brix), and C71-8-142 (15.8 °Brix). Although the TA content (0.39%) in TNG.22 was the least when compared with that of the other cultivars, the TSS/TA ratio (42.5) was the highest. Significant difference in yield and quality (as determined by the TSS and TA contents) was observed among the three cultivars.

At the regional level, comparison of weight per fruit, yield, and TSS and TA contents between 'TNG.22' (C65-7-187), 'TNG.17', and 'Smooth Cayenne' was conducted in the years 2005–06 (Table 3), 2006–07 (Table 4), and 2007–08 (Table 5), respectively. There was a significant difference, overall, in weight per fruit between 'TNG.22' and 'TNG.17' across all years. The yield was higher in 'TNG.17', which was similar to that in 'Smooth Cayenne'. The average TSS content of 'TNG.22' among the three locations ranged from 14.6 to 18.9

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Table 1. The characteristics of selected pineapple hybrids in primary trial for the period 1999–2001.^z

Selection	PH (cm)	LL (cm)	LW (cm)	NL	FW (g)	FL (cm)	FrW (cm)	NS
C65-7-187	101.4 a ^y	90.7 a	5.2 a	40.3 b	1,273.3 c	17.0 b	12.2 a	176.0 b
C69-8-105	72.4 c	65.9 d	4.5 c	50.8 a	1,587.3 a	17.5 b	12.3 a	188.5 ab
C71-6-153	80.2 b	65.7 d	4.8 b	49.8 a	1,508.0 b	19.4 a	12.3 a	201.5 a
C71-8-142	97.0 a	77.0 c	4.7 bc	53.3 a	1,324.5 c	19.1 a	12.1 a	199.0 a
TNG17	74.7 c	67.2 d	4.5 c	48.8 a	1,396.0 c	18.8 a	11.3 a	198 a

^zValues indicate mean of 20 fruits.^yMeans followed by the same letters at the same column within the same year were not significantly different at 5% level by least significant difference test. PH = plant height; LL = leaf length; LW = leaf width; NL = number of leaves; FW = fruit weight; FL = fruit length; FrW = fruit width; NS = number of scales.

Table 2. Comparison of the horticultural traits among ‘TNG.17’ and four selected lines of ‘TNG.22’ pineapples for the period 1999–2001.

Cultivar/selection	Wt per fruit (g)	40,000 plant/hectare		TSS (°Brix)	TA (%)	TSS/TA ratio	Pulp fiber	Pulp texture
		Yield (t/ha)	Index (%)					
C65-7-187	1,273.3 c ^z	50.9	91	16.4 b	0.39 c	42.5 a	Rough	+++ ^y
C69-8-105	1,587.3 a	63.6	114	15.9 c	0.42 b	37.5 b	Smooth	++
C71-6-153	1,508.0 b	60.3	108	16.6 b	0.64 a	27.9 c	Smooth	++
C71-8-142	1,324.5 c	53.0	95	15.8 c	0.45 b	36.9 b	Smooth	++
TNG.17 (CK)	1,396.0 c	55.8	100	14.5 d	0.45 b	32.2 b	Medium	+++

^zMeans followed by the same letters at the same column within the same year were not significantly different at 5% level by least significant difference test.^y+ = loose; ++ = medium; +++ = dense; ++++ = bally dense.

TSS = total soluble solids; TA = titratable acidity.

Table 3. Regional differences in horticultural traits of pineapple [‘TNG.22’ (C65-7-187), ‘TNG.17’, and ‘Smooth Cayenne’] for the period 2005–06.^z

City/township	Cultivar	Wt per fruit (g)	Yield (t/ha)	Index of yield (%)	TSS (°Brix)	TA (%)	TSS/TA ratio
Nantou/Nantou	TNG.22	1,701.8 a ^y	54.5	107	14.6 b	0.41 c	40.2 a
	TNG.17	1,587.3 a	50.8	100	16.1 a	0.53 b	30.6 b
	Smooth Cayenne	1,658.7 a	53.1	104	15.2 a	0.65 a	24.1 c
Tainan/Shanshang	TNG.22	1,826.4 a	58.4	109	16.0 a	0.38 c	44.6 a
	TNG.17	1,668.9 b	53.4	100	15.8 a	0.44 b	36.9 b
	Smooth Cayenne	1,824.8 a	58.4	109	14.4 b	0.57 a	26.2 c
Kaohsiung/Dashu	TNG.22	1,690.5 b	54.1	106	15.5 a	0.43 b	37.6 a
	TNG.17	1,588.5 b	50.8	100	15.9 a	0.43 b	37.5 a
	Smooth Cayenne	1,882.7 a	60.2	119	14.1 b	0.58 a	25.0 b
Mean	TNG.22	1,806.2 a	57.8	122	15.3 a	0.41 b	40.8 a
	TNG.17	1,481.6 b	47.4	100	15.9 a	0.47 b	35.0 b
	Smooth Cayenne	1,855.4 a	59.4	125	14.6 b	0.60 a	25.1 c

^zThe seedlings for autumn planting are transplanted in Dec. 2004, with field observations conducted in Sept. 2005 to Oct. 2006, and fruits harvested in June to July 2006.^yMeans followed by the same alphabet in a column, within the same year, were not significantly different at 5% level by least significant difference test.

TSS = total soluble solids; TA = titratable acidity.

Table 4. Regional differences in horticultural traits of pineapple [‘TNG.22’ (C65-7-187), ‘TNG.17’, ‘Smooth Cayenne’] for the period 2006–07.^z

City/township	Cultivar	Wt per fruit (g)	Yield (t/ha)	Index of yield (%)	TSS (°Brix)	TA (%)	TSS/TA ratio
Chiayi/Minsyong	TNG.22	1,714.2 b ^y	54.9	111	15.8 a	0.35 b	45.8 a
	TNG.17	1,543.7 c	49.4	100	15.0 b	0.38 b	40.1 b
	Smooth Cayenne	1,834.0 a	58.7	119	13.2 c	0.44 a	31.7 c
Tainan/Sinhua	TNG.22	1,860.2 a	59.5	112	16.2 a	0.33 ab	51.2 a
	TNG.17	1,662.9 b	53.2	100	13.5 c	0.37 a	37.2 b
	Smooth Cayenne	1,876.9 a	60.1	113	14.3 b	0.31 b	48.6 a
Pingtung/Majia	TNG.22	1,740.8 a	55.7	110	18.9 a	0.42 b	47.1 a
	TNG.17	1,576.1 c	50.4	100	18.0 b	0.49 a	39.1 b
	Smooth Cayenne	1,928.1 b	61.7	122	16.8 c	0.45 ab	40.4 b
Mean	TNG.22	1,771.7 a	56.7	111	16.9 a	0.37 a	48.0 a
	TNG.17	1,594.2 b	51.0	100	15.5 ab	0.41 a	38.8 b
	Smooth Cayenne	1,879.7 a	60.1	118	14.8 b	0.40 a	40.2 b

^zThe seedlings for autumn planting were transplanted in Dec. 2005, with field observation conducted between Sept. 2006 and Oct. 2007. Fruits were harvested in June and July 2007.^yMeans followed by the same alphabet in a column, within the same year, were not significantly different at 5% level by least significant difference test.

TSS = total soluble solids; TA = titratable acidity.

°Brix. This was significantly higher than that in both ‘TNG.17’ and ‘Smooth Cayenne’. Whereas most comparisons of the TA content between the three cultivars at the regional level were not significantly different, the TSS/TA ratio for ‘TNG.22’ was significantly higher than that for the other two cultivars.

During the storage trial, occurrence of abnormal peeling in ‘TNG.22’ was less than

that in ‘TNG.17’. In addition, the crowns and peel were relatively better. There were no significant differences observed in fruit translucency and internal browning between ‘TNG.22’ and ‘TNG.17’ (Table 6).

‘TNG.17’ attains high yield with good fruit shape and appearance and shows more consistent fruit quality when cultivated successfully. The high flavor and

higher TSS/TA ratio of pineapple were normally related to its tapping sound, which showed accurate performance in quality (Sornsrivichai et al., 2000), but ‘TNG.17’ does not conform to this generalization. The leaf margin in ‘TNG.17’ was without thorns (Chang et al., 1999), whereas the apical leaf of ‘TNG.22’ showed a few thorns (Table 7; Fig. 1A).

Table 5. Regional differences in horticultural traits of pineapple ['TNG.22' (C65-7-187), 'TNG.17', and 'Smooth Cayenne'] for the period 2007–08.^z

City/township	Cultivar	Wt per fruit (g)	Yield (t/ha)	Index of yield (%)	TSS (°Brix)	TA (%)	TSS/TA ratio
Chiayi/Minsyong	TNG.22	1,628.9 a ^b	52.1	98	17.4 a	0.58 a	30.9 a
	TNG.17	1,658.2 a	53.1	100	15.7 b	0.55 a	29.0 a
	Smooth Cayenne	1,748.9 a	56.0	105	14.6 c	0.59 a	27.4 a
Pingtung/Chaujou	TNG.22	1,781.3 a	57.0	112	17.4 a	0.44 b	40.2 a
	TNG.17	1,590.2 b	50.9	100	16.0 ab	0.45 ab	35.5 b
	Smooth Cayenne	1,715.7 a	54.9	108	14.9 b	0.49 a	30.6 c
Mean	TNG.22	1,705.1 a	54.6	105	17.5 a	0.51 a	34.3 a
	TNG.17	1,624.2 b	52.0	100	15.9 b	0.50 a	32.3 b
	Smooth Cayenne	1,732.3 a	55.4	107	14.8 b	0.54 a	29.0 b

^zThe seedlings for autumn planting are transplanted in Dec. 2006, with field observation survey conducted in Sept. 2007 to Oct. 2008, and fruits harvested in June to July 2008.

^bMeans followed by the same alphabet in a column, within the same year, were not significantly different at 5% level by least significant difference test. TSS = total soluble solids; TA = titratable acidity.

Table 6. Effect of storage temperature on the fruit quality of 'TNG.22' and 'TNG.17' pineapple.

Storage temp (°C)	Cultivar	Fruit wt loss (%)	Abnormal symptom of peel	Fruit translucency	IB	TSS (°Brix)	TA (%)
15	TNG.22	9.6 a ^z	1.2 b	2.0 a	0.0 a	13.5 a	0.77 a
	TNG.17	4.1 b	2.1 a	2.0 a	0.0 a	10.3 b	0.71 a
25	TNG.22	11.2 a	2.8 a	0.0 b	0.0 a	12.9 a	0.60 a
	TNG.17	8.5 a	3.0 a	0.0 b	0.0 a	10.8 b	0.62 a

The fruits were stored at 15 °C for two weeks and then returned to ambient air at 25 °C for 4 d.

^zMeans followed by the same alphabet in a column, within the same year, were not significantly different at 5% level by least significant difference test. IB = internal browning (the symptom of chilling injury); TSS = total soluble solids; TA = titratable acidity.

Table 7. Phenology and growth characteristics of 'TNG.22' (C65-7-187) and two other comparable cultivars at Chiayi Agricultural Experiment Station.

Plant part	Growth characteristics	TNG.22	TNG.17	Smooth Cayenne
Plant	Plant height	Short	Short	high
	Growth vigor	Strong	Strong	Strong
Leaf	Leaf length	Long	Medium	Long
	Leaf width	Medium	short	Medium
	Leaf thickness	Thick	Thick	Medium
	Length/width ratio	Medium	Small	Slender
	Leaf luster	Light	Light	Light
	Leaf texture	Medium	Hard	Medium
	Leaf thorn	Apical	Basal and apical	Basal and apical
	Leaf color	Green with purple-red	Green with purple-red	Green with light purple-red
	Blade pubescence	Symmetrical	Nonsymmetrical	Symmetrical
	Petal color	Dark purple	Dark purple	Purple
Flower	Self-incompatibility	Yes	Yes	Yes
Bud	Crown weight	Heavy	Light	Heavy
	Crown length	Medium	Short	Long
	Number of slips	Few	Few	Medium
	Number of aerial suckers	Few	Few	Few
Fruit	Number of ground suckers	Few	Few	Few
	Weight per fruit	Heavy	Heavy	Bally heavy
	Fruit length	Medium	Long	Long
	Fruit diameter	Medium	Medium	Large
	Fruit shape	Cylindrical	Conical	Cylindrical
	Number of scales	Medium	Few	Medium
	Size of scales	Large	Large	Large
	Thickness of scales	Prominent	Flat	Flat
	Fruit core diameter	Medium	Medium	Medium
	Ovary interspace	Medium	Medium	Medium
	Locule	Shallow	Medium	Medium
	Peel color	Yellow with orange-red	Yellow with orange-red	Yellow
	Pulp texture	Medium	Rough	Medium
	Pulp firmness	Medium	Hard	Medium
	Pulp color	Yellow	Light yellow	Light yellow
Other	Pulp content	High	High	High
	Total soluble solids	High	Low	Medium
	Titratable acidity	Medium	Medium	Medium
	Stem-end splitting	Non	Low	Low
	Cracking peel	Non	Low	High

The growth vigor of 'TNG.22' was strong (Fig. 1B) and the fruit shape was cylindrical. The peel color of mature fruit was yellow with orange-red (Fig. 1C) and the pulp color was yellow to golden. The pulp texture was

dense and had high TSS, which allows better storage. These characteristics of 'TNG.22' were comparable to 'TNG.17'. However, fruit of 'TNG.17' pineapple were prone to stem-end splitting and cracking of peel during

summer months because of higher temperatures and humidity. The 'TNG.22' fruit were unaffected, thus making them a better choice for improved fruit quality during summer months.

Fig. 1. The individual plant appearance and fruit features of ‘TNG.22’ (C65-7-187). (A) Apical leaf with few thorns, leaf color was green with purple-red. (B) The growth vigor was strong. (C) The fruit shape was cylindrical and the peel color of mature fruit was yellow with shades of orange-red. (D) The peel was thin, the locule was shallow, the pulp color was yellow to golden, and the pulp texture was dense.

Availability

‘Tainung No. 22’ was released by the Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, on Feb. 2012.

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