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

| Selection | PH (cm) | LL (cm) | LW (cm) | NL | FW (g) | FL (cm) | FrW (cm) | NS |
|-----------|---------|---------|---------|----|--------|---------|---------|----|
| C65-7-187 | 101.4   | 90.7 a  | 5.2 a   | 40.3 | 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  | 185.8 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    |

*Values indicate mean of 20 fruits.
*Means 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.

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 trans-lucency and internal browning between ‘TNG.22’ and ‘TNG.17’ (Table 6).

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

| City/township Cultivar | Wt per fruit (g) | Yield (t/ha) | Index (%) | TSS (°Brix) | TA (%) | TSS/TA ratio | Pulp fiber | Pulp texture |
|------------------------|------------------|--------------|-----------|-------------|--------|--------------|------------|-------------|
| TNG.22                 | 1,701.8 a y      | 90.7 a       | 5.2 a     | 40.3 b      | 12.2 a | 176.0 b      | Rough      | ++          |
| TNG.17                 | 1,587.3 a        | 63.6         | 8.1 c     | 50.8 a      | 12.3 a | 185.8 ab     | Rough      | ++          |
| Smooth Cayenne         | 1,508.0 b        | 60.3         | 10.8 b    | 51.0 a      | 12.4 a | 199.0 a      | Smooth     | ++          |
| TNG.17 (CK)            | 1,396.0 c        | 55.8         | 10.0 a    | 48.8 a      | 12.2 a | 198 a        | Medium     | +++         |

*Means 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.

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

| City/township Cultivar | Wt per fruit (g) | Yield (t/ha) | Index (%) | TSS (°Brix) | TA (%) | TSS/TA ratio | Pulp fiber | Pulp texture |
|------------------------|------------------|--------------|-----------|-------------|--------|--------------|------------|-------------|
| TNG.22                 | 1,701.8 a y      | 90.7 a       | 5.2 a     | 40.3 b      | 12.2 a | 176.0 b      | Rough      | ++          |
| TNG.17                 | 1,587.3 a        | 63.6         | 8.1 c     | 50.8 a      | 12.3 a | 185.8 ab     | Rough      | ++          |
| Smooth Cayenne         | 1,508.0 b        | 60.3         | 10.8 b    | 51.0 a      | 12.4 a | 199.0 a      | Smooth     | ++          |
| TNG.17 (CK)            | 1,396.0 c        | 55.8         | 10.0 a    | 48.8 a      | 12.2 a | 198 a        | Medium     | +++         |

*Means followed by the same alphabet in a column, within the same year, were not significantly different at 5% level by least significant difference test.

Table 4. Regional differences in horticultural traits of pineapple ['TNG.22' (C65-7-187), 'TNG.17', and 'Smooth Cayenne'] for the period 2005–06.

| City/township Cultivar | Wt per fruit (g) | Yield (t/ha) | Index (%) | TSS (°Brix) | TA (%) | TSS/TA ratio | Pulp fiber | Pulp texture |
|------------------------|------------------|--------------|-----------|-------------|--------|--------------|------------|-------------|
| TNG.22                 | 1,701.8 a y      | 90.7 a       | 5.2 a     | 40.3 b      | 12.2 a | 176.0 b      | Rough      | ++          |
| TNG.17                 | 1,587.3 a        | 63.6         | 8.1 c     | 50.8 a      | 12.3 a | 185.8 ab     | Rough      | ++          |
| Smooth Cayenne         | 1,508.0 b        | 60.3         | 10.8 b    | 51.0 a      | 12.4 a | 199.0 a      | Smooth     | ++          |
| TNG.17 (CK)            | 1,396.0 c        | 55.8         | 10.0 a    | 48.8 a      | 12.2 a | 198 a        | Medium     | +++         |

*Means followed by the same alphabet in a column, within the same year, were not significantly different at 5% level by least significant difference test.

Table 5. The characteristics of selected pineapple hybrids in primary trial for the period 1999–2001.

| PH (cm) | LL (cm) | LW (cm) | NL | FW (g) | FL (cm) | FrW (cm) | NS |
|---------|---------|---------|----|--------|---------|---------|----|
| C65-7-187 | 101.4   | 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  | 185.8 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    |

*Values indicate mean of 20 fruits.
*Means 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.

'3Brix. 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 trans-lucency 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 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).
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.

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

| 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        | 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    | 1,600.2 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       |

The 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.

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 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             | 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.

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.

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

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

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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.