Studies on the Usage of Tropical Fruits in Okinawa (Part 1)
Characteristics and Chemical Composition of Guava

Masako KATSURA
Department of Home Economics, College of Education, University of the Ryukyus,
Nishihara-cho, Okinawa 903-01, Japan

A comparison was carried out of the physical characteristics of chemical components among four varieties of ripened guava fruit, and of the effects of heat processing on the ascorbic acid content of one variety of fruit.

The hardness of the fruit varied from 0.67 (Taiwan round white) to 1.60 kg/cm² (Taiwan pear-shaped white). Both Taiwan varieties yielded more purée per unit weight than the other varieties, namely 83.33 (round) and 84.34% (pear-shaped). Hawaiian pink showed the highest acidity, 1.01% as citric acid, and the lowest Brix/acidity ratio, 10.89. Taiwan round white contained the largest amount of ascorbic acid, 270.32 mg%.

The total ascorbic acid contents in the peel, flesh and core were determined for Okinawan pink, the peel showing a high of 125.54 mg%, followed by the flesh (61.25 mg%) and core (59.03 mg%). The highest acidity was found in the peel, and the Brix/acidity ratio was the highest in the core.

The effect of heat treating the purées on the ascorbic acid content was determined at 104°C. Ascorbic acid in the heat treated purée was retained as 42.24% of the original total ascorbic acid content. This high heat resistance indicates that guava jam offers more advantage as a source of ascorbic acid than strawberry jam (1.7 times higher value).

(Received October 28, 1988)

Keywords: tropical fruit, guava, purée, ascorbic acid, Brix, acidity.

Introduction

Guava is native to tropical America, from Mexico to Peru. It was later distributed throughout the world, especially in tropical and sub-tropical areas, by the Spanish. It is said that guava was introduced to Okinawa during the era of the Kingdom of Ryukyus, but the exact time is not clear. Guava (Psidium guajava L.), which is a widely known fruit plant of the Myrtaceae family, is known as “banjyuro” in Japan. The fruit, which is round, ovate or pear-shaped, varies from 5 to 12 cm in length and from 5 to 6 cm in diameter. The skin color of the ripe fruit ranges from yellowish green to pale yellow, and the flesh color may be white, pale yellow or light pink, with a large number of small seeds of 2–3 mm in diameter. The fruit is aromatic with sour, juicy flesh. The raw fresh of ripe fruit is suitable as a food and is often processed into jelly and purée.

The characteristic constituent of guava is its high content of ascorbic acid, differing in amount according to the ripeness and area where grown. Ripe fruits of guava contain from 250 to 500 mg% of ascorbic acid which is heat stable even in purée form.

In this report, the shape of fruit and its composition were compared for four varieties of guava. Heat processing at different temperatures was examined to identify the change of ascorbic acid content. Although a difference in acid content between the cultivated variety and the wild type has been already been determined by Chan et al., the acidity, Brix, ratio of Brix to acidity and ascorbic acid content in the flesh and other parts of the ripened fruit were determined for native Okinawan pink guava and other varieties.

Experimental materials

1. Specimens. The fruit of four varieties of guava (Hawaiian pink, Taiwan round white, native Okinawan pink, and Taiwan pear-shaped white) were collected on September 4, 5, 6 and 9,
1986, respectively, and used as experimental materials.

2. Physical properties of the fruit. Five specimens of each of the selected four varieties of guava were collected, weighed and measured by caliper for their length and diameter. The average values for the five specimens are listed in Table 1. The hardness was measured as the maximum pressure resisted by a universal hardness meter (Kiya Manufacturing, Japan) fitted with a conical shaped needle-head.

3. Preparation of the samples. After the guava specimens had been weighed and measured, they were cut into 2 cm cubes. These cubes were then ground in an ordinary grinder (National MX-945G) for about 10 sec, and the resulting puree after straining was used for the determination of vitamin C and Brix. The puree was divided into 30-50 g samples, doubly wrapped in vinyl sheets, and then stored at −30°C until required for the determination of reducing sugar and other measurements.

4. Determination of the chemical composition of the samples. 1) Reducing sugar: As shown in Fig. 1, 5 g of each sample was employed. To remove the protein and polysaccharides, aqueous extracts of the sample were successively treated with 10% trichloroacetic acid and 99% methanol. After evaporating the MeOH in vacuo, the residual solution was diluted with water to an appropriate volume for use as a sample solution. The amount of reducing sugar in each solution was determined by the Somogyi-Nelson method, and the sugar was expressed as glucose.

2) Ascorbic acid: The guava puree was dissolved in 10% of m-phosphoric acid solution and centrifuged. Ascorbic acid (AsA) was measured in the supernatant by the 2,4-dinitrophenylhydrazine method.

3) Acidity: The acidity was measured by the titration method, and cited as citric acid.

4) Brix and Brix/acidity ratio: A refractometer was used for the Brix measurement, and the Brix/acidity ratio is expressed by the ratio of Brix to the total acid.

Results and discussion

1. Nature and characteristics of the fruit

Desirable fruits for processing are those with thick outer flesh and a small seed cavity, since they yield more puree per weight than the thin-fleshed type. Therefore, the data significant for processing are shown in Table 1.

1) Weight, length and diameter. The average weight of the fruits varied from 78.2 to 149.4 g according to variety, and although the average weight of native Okinawan pink was the smallest, it is readily available and was mostly used in this study. The only clear difference between the length and diameter of the different varieties was in the case of Okinawan pink, for which the diameter was characteristically greater than the length.

2) Hardness. The hardness of the fruit tends to decrease with increasing ripeness, Ikeda et al. classifying the ripeness of fruit with their hardness in the range of 2.36–2.45 kg/cm² as unripe, and 1.19–1.92 kg/cm² as ripe fruit. The hardness was measured at 3 points on each fruit specimen, and
the average values for the hardness are listed in Table 1. The greatest values were for Taiwan pear-shaped white (1.60 kg), and Taiwan round white (0.67 kg) gave the smallest. According to Ikeda’s classification, the four samples used were obviously ripe fruits. It has been reported that the hardness of a fruit reflects its pectin content.9)

3) Seed and puree. The percentage of seed, by weight, of ripe fruit varied from 12.72% for native Okinawan pink to 3.57% for Taiwan pear-shaped white. The yield of puree varied from 84.34% for Taiwan pear-shaped white to 69.05% for native Okinawan pink. Obviously, Taiwan pear-shaped white had the merit of yielding more puree per unit weight.

Table 1 shows that the Taiwan round white and Taiwan pear-shaped white yielded more puree, and from Table 2, it is clear that they also had the highest Brix/acidity ratio. Table 3 indicates that these two varieties of guava provide a food rich in vitamin C, containing 4–5 times more total ascorbic acid than orange. However, these two varieties with white flesh have the demerit of browning when processed, containing a higher content of dehydroascorbic acid (DHA) than the other two varieties tested. The Hawaiian pink and native Okinawan pink varieties are more suitable for processing with less browning because of the original pink color.

2. Chemical components

1) Content of reducing sugar. It has been reported that fructose is the predominant sugar, constituting 58.9% of total sugar, followed by glucose at 35.7% and sucrose at 5.3%.10) From a practical point of view, it is convenient to show how much reducing sugar is in guava, this being indicated in Table 2. The percentage of reducing sugar in Taiwan pear-shaped white and native Okinawan pink had similar values of 27.00 and 26.49%, respectively.
2) Total acid, Brix, Brix/acidity ratio and pH.
The total acid, Brix, Brix/acidity ratio and pH of
the guava are shown in Table 2. The total acid
content of Hawaiian pink maintained a high
average of 1.01%, while the content for Taiwan
pear-shaped white and native Okinawan pink were
similar, but lower than the value of the former.
The most suitable kind of fruit for processing is
one containing high acidity. Hawaiian pink had
the lowest pH of 3.64, while the other three varie-
ties were in a higher range of pH from 4.10 to
4.76. Therefore, Hawaiian pink is judged the
most suitable one for processing.

Table 2 also shows that Taiwan pear-shaped
white and native Okinawan pink were sweeter than
the other two varieties. Judging from the higher
Brix/acidity ratio than that of the others, the flesh
of Taiwan round white is edible in its raw form.
The Brix value for a fruit is one of the most im-
portant quality indexes, and has been selected as
an important component of the JAS system for
processing fruit.

Table 3 shows that Hawaiian pink is suitable
for processing, not only for its color, but also by
its relatively high AsA content, high acidity and
high yield of purée compared to the other three
varieties. Native Okinawan pink showed a very
low AsA/TAA ratio compared to the three varie-
ties, which means that most of the ascorbic acid
in the fruit was contained in DHA form. The
relative value of DHA in TAA depends on the
ripeness and the variety.

4) Components in peel, flesh and core. Even
though native Okinawan pink guava is easily
available in Japan, such characteristics as ascorbic
acid, Brix, acidity and Brix/acidity ratio in differ-
ent parts of the fruit have not before been analyzed
in detail. These analyses were undertaken, and
the results are shown in Table 4. The largest
amount of TAA was found in the peel, and the
ratio of DHA to TAA in the peel was characteris-
tically high. The entire use of the peel, flesh and
core for processing is reasonable, because there
remains a higher value of ascorbic acid. The
total acid content in Okinawan pink was found
to be 0.51, 0.44 and 0.35% in the peel, flesh and
core, respectively. The Brix/acidity ratio was in
the reverse order of core, flesh and peel.

5) Ascorbic acid content as affected by heat proces-
sing for purée. It has been reported that vitamin
C in guava is heat resistant and extremely stable
at high temperatures.

Table 4. Chemical analyses of different parts of Okinawan pink guava

<table>
<thead>
<tr>
<th>Part</th>
<th>TAA (AsA + DHA) (mg %)</th>
<th>DHA (mg %)</th>
<th>AsA (mg %)</th>
<th>AsA/TAA ratio (%)</th>
<th>Sugar Brix</th>
<th>Acidity (% as citric acid)</th>
<th>Brix/acidity ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel</td>
<td>125.54</td>
<td>115.64</td>
<td>9.90</td>
<td>7.89</td>
<td>11.0</td>
<td>0.51</td>
<td>21.57</td>
</tr>
<tr>
<td>Flesh</td>
<td>61.25</td>
<td>50.07</td>
<td>11.18</td>
<td>18.25</td>
<td>12.2</td>
<td>0.44</td>
<td>27.73</td>
</tr>
<tr>
<td>Core</td>
<td>59.03</td>
<td>46.45</td>
<td>12.58</td>
<td>21.30</td>
<td>12.5</td>
<td>0.35</td>
<td>35.71</td>
</tr>
</tbody>
</table>
Studies on the Usage of Tropical Fruits in Okinawa (Part 1)

Table 5. Change of ascorbic acid content in guava* processed at different temperatures

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>TAA (AsA + DHA) (mg %)</th>
<th>DHA (mg %)</th>
<th>AsA (mg %)</th>
<th>AsA/TAA ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw**</td>
<td>188.07</td>
<td>76.31</td>
<td>111.76</td>
<td>59.42</td>
</tr>
<tr>
<td>50</td>
<td>167.29</td>
<td>154.44</td>
<td>12.85</td>
<td>7.68</td>
</tr>
<tr>
<td>100</td>
<td>124.39</td>
<td>41.76</td>
<td>82.63</td>
<td>66.43</td>
</tr>
<tr>
<td>104</td>
<td>118.18</td>
<td>35.58</td>
<td>82.62</td>
<td>69.89</td>
</tr>
<tr>
<td>104 (with 45% sugar)</td>
<td>79.44</td>
<td>15.55</td>
<td>63.89</td>
<td>80.82</td>
</tr>
<tr>
<td>115</td>
<td>87.38</td>
<td>5.52</td>
<td>81.86</td>
<td>93.69</td>
</tr>
</tbody>
</table>

* Hawaiian pink guava was used as the sample. ** Raw: room temperature (at 27-30°C).

maintained in the purée at this processing temperature. A temperature of 115°C was selected for determining the heat resistance of the vitamin C to sterilization in an autoclave.

Table 5 shows the percentage of ascorbic acid remaining after treatment. The heat treatment used for making strawberry jam is reported to decrease, the ascorbic acid content to 25% of original value.15) It therefore becomes evident that, with a heat-treatment of 104°C for making jam, guava is distinctly preferable to strawberry for retained vitamin C because the remaining ascorbic acid is 1.7 times greater.

References
3) Norinsho Shokuryo Kenkyusho: Shokuryo, Norinsho Shokuryo Kenkyusho, No. 15, 78 (1972)
15) K. Morimoto, J. Hayashi and S. Ashikaga: Chori to Vitamin, Kenpakusha, Tokyo, 163 (1971)
クも生で食するのに適している。
（2）部位別では、総ビタミン C 含量は果皮＞果肉＞果芯の順となっており、種子および石細胞を除くすべてを加工処理に用いるほうがよい。
（3）ピューレの加熱温度別では、ジャム加工の加熱温度の 104°C で総ビタミン C 含量は 79.44 mg %で 42.24 %残存し、加工処理してもなおビタミン C 供給源として有効と思われる。

キーワード：熱帯果実，グァバ，ピューレ，ビタミン C，グリックス，酸度。