EAST AFRICAN STANDARD

Passion fruit — Specification and grading

EAST AFRICAN COMMUNITY

HS 0810.90.00 [HS 0810.90.5000]
Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that “Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose”.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

© East African Community 2010 — All rights reserved

East African Community
PO Box 1096
Arusha
Tanzania
Tel: 255 27 2504253/8
Fax: 255-27-2504481/2504255
E-Mail: eac@eachq.org
Web: www.each.int
Introduction

This second edition of this standard supersedes and cancels EAS 91:2000, Passion fruit — Specification.

In the preparation of this East African Standard, the following sources were consulted extensively:

CODEX STAN 193:1995 (Rev.5:2009), General Standard for Contaminants and Toxins in Foods
CODEX STAN 228:2001 (Rev.1:2004), General methods of analysis for contaminants
CODEX STAN 230:2001 (Rev.1:2003), Maximum levels for lead

Codex Alimentarius website: http://www.codexalimentarius.net/mrls/pestdes/jsp/pest_q-e.jsp
USDA Foreign Agricultural Service website: http://www.mrldatabase.com
USDA Agricultural Marketing Service website: http://www.ams.usda.gov/AMSv1.0/Standards
European Union: http://ec.europa.eu/sanco_pesticides/public

Assistance derived from these sources and others inadvertently not mentioned is hereby acknowledged.

This standard has been developed to take into account:

— the needs of the market for the product;
— the need to facilitate fair domestic, regional and international trade and prevent technical barriers to trade by establishing a common trading language for buyers and sellers.
— the structure of the CODEX, UNECE, USA, ISO and other internationally significant standards;
— the needs of the producers in gaining knowledge of market standards, conformity assessment, commercial cultivars and crop production process;
— the need to transport the product in a manner that ensures keeping of quality until it reaches the consumer;
— the need for the plant protection authority to certify, through a simplified form, that the product is fit for crossborder and international trade without carrying plant disease vectors;
— the need to promote good agricultural practices that will enhance wider market access, involvement of small-scale traders and hence making fruit and vegetable production a viable means of wealth creation; and
— the need to keep unsatisfactory produce from the market by allowing the removal of unsatisfactory produce from the markets and to discourage unfair trade practices e.g. trying to sell immature produce at the beginning of the season when high profits can be made. Immature produce leads to dissatisfaction of customers and influences their choices negatively, which disadvantages those traders who have waited until the produce is mature.
Contents

1 Scope ........................................................................................................... 1
2 Normative references .................................................................................. 1
3 Definitions .................................................................................................... 1
4 Provisions concerning quality ................................................................. 2
  4.1 General ................................................................................................... 2
  4.2 Minimum requirements .......................................................................... 2
  4.3 Classification .......................................................................................... 3
  4.4 Classification by colour .......................................................................... 4
5 Sizing ........................................................................................................... 4
6 Tolerances ................................................................................................... 4
  6.1 Quality tolerances .................................................................................. 4
7 Provisions concerning presentation ......................................................... 5
  7.1 Uniformity .............................................................................................. 5
  7.2 Packaging ............................................................................................... 5
8 Marking or labelling .................................................................................... 5
  8.1 Consumer packages .............................................................................. 5
  8.2 Non-retail containers ............................................................................ 5
9 Contaminants .............................................................................................. 6
  9.1 Heavy metals ........................................................................................ 6
  9.2 Pesticide residues ................................................................................ 6
10 Hygiene ....................................................................................................... 6
Annex C (informative) Model certificate of conformity with standards for fresh fruits and vegetables 11
Annex D (informative) Passion fruit — Fact sheet ........................................... 12
Annex E (informative) Passion fruit — Codex, EU and USA pesticide residue limits ................. 27
Passion fruit — Specification and grading

1 Scope

This East African Standard specifies requirements for the commercial varieties of passion fruits grown from the species *Passiflora* of the *Passifloraceae* family to be supplied fresh in the export and local markets, after preparation and packaging. Passion fruits for industrial processing are excluded.

This standard is based on the characteristics of *Passiflora edulis* and *Passiflora ligularis* Juss, but the requirements apply to the rest of the species in the *Passifloraceae* family listed in Annex D.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CAC/GL 21, *Principles for the Establishment and Application of Microbiological Criteria for Foods*

CAC/RCP 1, *Recommended International Code of Practice — General Principles of Food Hygiene*

CAC/RCP 44, *Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables*

CAC/RCP 53, *Code of Hygienic Practice for Fresh Fruits and Vegetables*

EAS 38, *Labelling of prepackaged foods — Specification*

ISO 6561-1, *Fruits, vegetables and derived products — Determination of cadmium content — Part 1: Method using graphite furnace atomic absorption spectrometry*

ISO 6561-1, *Fruits, vegetables and derived products — Determination of cadmium content — Part 2: Method using flame atomic absorption spectrometry*

ISO 6633, *Fruits, vegetables and derived products — Determination of lead content — Flameless atomic absorption spectrometric method*


3 Definitions

For the purpose of this East African Standard, the following definitions shall apply.

3.1 fresh
firm fruit with a smooth surface skin

3.2 woody
small, very hard fruits with very little juice

3.3 clean
practically free from dirt, earth, insect stains or other foreign substances and material
3.4 disease
any unhealthy condition caused by fungus, bacterium, virus and pest and may include either or all of the following:

3.4.1 Brown lesions on fruit;
3.4.2 “Dusty” appearance on skin surface;
3.4.3 Whitish to pinkish masses of insects on fruit;
3.4.4 Sooty mould;
3.4.5 Holes on surface due to insect bites;

3.5 damage
any defect or injury which materially affects the appearance or storage quality of the fruit

3.6 mishapen
the fruit is so out of normal round-oval shape that its appearance is obviously affected

4 Provisions concerning quality

4.1 General
The purpose of the standard is to define the quality requirements of passion fruits at the export-control stage, after preparation and packaging.

However, if applied at stages following export, products may show in relation to the requirements of the standard:

— a slight lack of freshness and turgidity
— for products graded in classes other than the “Extra” Class, a slight deterioration due to their development and their tendency to perish.

The holder/seller of products may not display such products or offer them for sale, or deliver or market them in any manner other than in conformity with this standard. The holder shall be responsible for observing such conformity.

4.2 Minimum requirements

4.2.1 In all classes, subject to the special provisions for each class and the tolerances allowed, the passion fruits shall be:

(a) whole;
(b) free of cracks in rind;
(c) firm in consistency;
(d) fresh in appearance;
(e) free from woodiness;
(f) sound, produce affected by rotting or deterioration such as to make it unfit for consumption is excluded;
(g) clean, practically free of any visible foreign matter;

(h) free of abnormal external moisture, excluding condensation following removal from cold storage;

(i) free of any foreign smell and/or taste \(^1\);

(j) a pedicel detached at first knot;

(k) free of pests affecting the general appearance of the produce;

(l) practically free of damage caused by pests;

(m) keep the natural wax layer which covers the fruit at harvest.

(n) free of broken skin/cracks.

(o) Have a stalk not exceeding 10 mm in length. However, its absence is not considered a defect on condition that the place of the stalk attachment is dry and intact.

(p) Have a minimum diameter of 45 mm.

4.2.2 The passion fruits must have been carefully picked and have reached an appropriate degree of development and ripeness \(^2\) in accordance with criteria proper to the variety and/or commercial variety, and to the area in which they are grown.

4.2.3 The development and condition of the passion fruits must be such as to enable them:

— to withstand transportation and handling; and

— to arrive in satisfactory condition at the place of destination.

4.2.4 Maturity requirements

The passion fruits must be sufficiently developed and display satisfactory ripeness.

The development and state of maturity of the passion fruits must be such as to enable them to continue their ripening process and to reach the appropriate degree of ripeness.

4.3 Classification

Passion fruits are classified in the classes defined below:

4.3.1 “Extra” Class

Passion Fruits in this class must be of superior quality. They must be characteristic of the variety and/or commercial variety. They must be free defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package.

4.3.2 Class I

Passion Fruits in this class must be of good quality. They must be characteristic of the variety and/or commercial variety. The following slight defects, however, may be allowed, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package:

---

\(^1\) This provision accepts the smell produced by preservatives used according to corresponding provisions.

\(^2\) Maturity of passion fruits shall be defined for its external colouring and confirmed when the total soluble solid contents, acidity and maturity rate be inspected.
4.3.3 Class II

This class includes passion fruits which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified in 4.2. The following defects, however, may be allowed provided that the passion fruits retain their essential characteristics as regards the quality, the keeping quality and presentation:

— Defects in shape such as protraction on stalk adjacent zone;
— Defects in shape, skin appearance, lack of wax and superficial scarring. This defects shall not exceed 20% of the total surface area;

The defects must not, in any case, affect the flash of the produce.

4.4 Classification by colour

Passion fruits shall be classified into two groups according to colour:

a) yellow passion fruit;
b) purple passion fruit.

5 Sizing

Size is determined by maximum diameter of the equatorial section or by weight of each fruit according to the following table:

<table>
<thead>
<tr>
<th>Size Code</th>
<th>Diameter (mm)</th>
<th>Weight per fruit per grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>≥ 78</td>
<td>140</td>
</tr>
<tr>
<td>B</td>
<td>77 – 71</td>
<td>128</td>
</tr>
<tr>
<td>C</td>
<td>70 – 66</td>
<td>122</td>
</tr>
<tr>
<td>D</td>
<td>65 – 61</td>
<td>106</td>
</tr>
<tr>
<td>E</td>
<td>60 – 56</td>
<td>83</td>
</tr>
<tr>
<td>F</td>
<td>≤ 55</td>
<td>74</td>
</tr>
</tbody>
</table>

The difference between the largest and the smallest passion fruit diameter in any one package shall be not more than 5 mm in all classes.

6 Tolerances

Tolerances in respect of quality and size shall be allowed in each package for produce not satisfying the requirements of the class indicate

6.1 Quality tolerances

6.1.1 Extra Class

Five percent by number or weight of passion fruits not satisfying the requirements of the class, but meeting those of Class I or, exceptionally, coming within the tolerances of that class.

6.1.2 Class I

Ten percent by number or weight of passion fruits not satisfying the requirements of the class, but meeting those of Class II or, exceptionally, coming within the tolerances of that class.
6.1.3 Class II
Ten percent by number or weight of passion fruits satisfying neither the requirements of the class nor the minimum requirements, with the exception of produce affected by rotting or any other deterioration rendering it unfit for consumption.

6.2 Size tolerance
For all classes: 10% by number or weight of passion fruits corresponding to the size immediately above and/or below that indicated on the package.

7 Provisions concerning presentation

7.1 Uniformity
The contents of each package must be uniform and contain only passion fruits of the same origin, variety or commercial type, quality and size (if sized).

The ripeness and colouring of passion fruits in “Extra” Class and Class I must be practically uniform.

The visible part of the contents of the package must be representative of the entire contents.

7.2 Packaging
Passion fruits must be packed in such a way as to protect the produce properly. The materials used inside the package must be new\(^3\), clean, and of a quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly of paper or stamps bearing trade specifications is allowed, provided the printing or labelling has been done with non-toxic ink or glue.

The containers shall meet the quality, hygiene, ventilation and resistance characteristics to ensure suitable handling, shipping and preserving of the passion fruits. Packages must be free of all foreign matter and smell.

Passion fruits shall be packed in each container in compliance with CAC/RCP 44.

8 Marking or labelling

8.1 Consumer packages
In addition to the requirements of EAS 38, the following specific provisions apply:

8.1.1 Nature of produce
If the produce is not visible from the outside, each package shall be labelled as to the name of the produce and, with the name of the variety and/or commercial variety.

8.2 Non-retail containers
Each package\(^4\) must bear the particulars outlined hereafter, in letters grouped on the same side, legibly and indelibly marked, and visible from the outside.

8.2.1 Identification
The exporter, packer and/or dispatcher shall be identified by name and physical address (e.g. street/city/region/postal code and, if different from the country of origin, the country) or a code mark

---

\(^3\) For the purposes of this Standard, this includes recycled material of food-grade quality.

\(^4\) According to the Geneva Protocol, footnote 2, “Package units of produce prepacked for direct sale to the consumer shall not be subject to these marking provisions but shall conform to the national requirements. However, the markings referred to shall in any event be shown on the transport packaging containing such package units”. 

© EAC 2010 — All rights reserved
EAS 91:2010

officially recognized by the national authority.\(^5\)

8.2.2 Origin of produce

Country of origin (or countries, where appropriate) and, optionally, district where grown, or national, regional or local place name.

In the case of sales units containing a mixture of distinctly different colours, varieties and/or commercial types of passion fruits of different origins, the indication of each country of origin shall appear next to the name of the colour, variety and/or commercial type concerned.

8.2.3 Nature of produce

— “Passion Fruits” and the commercial type if the contents are not visible from the outside.

— “Passion — Yellow”;

— “Passion — Purple”;

8.2.4 Commercial specifications

— Class;

— Size; (size code);

— Number of pieces (optional);

— Net weight (optionally).

8.2.5 Official control mark (optional)

9 Contaminants

9.1 Heavy metals

Passion fruits shall comply with those maximum levels for heavy metals established by the Codex Alimentarius Commission for this commodity. The current limits are as indicated below:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Unit of measurement</th>
<th>Maximum limit</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead (Pb)</td>
<td>mg/kg wet weight</td>
<td>0.10</td>
<td>ISO 6633 (AAS)</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>mg/kg wet weight</td>
<td>0.050</td>
<td>ISO 6561-1 or 6561-2</td>
</tr>
</tbody>
</table>

9.2 Pesticide residues

Passion fruits shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity. Annex E provides current MRLs for the USA, EU and Codex markets.

10 Hygiene

10.1 It is recommended that the produce covered by the provisions of this Standard be prepared and handled in accordance with the appropriate sections of CAC/RCP 1, CAC/RCP 53, and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

10.2 The produce should comply with any microbiological criteria established in accordance with CAC/GL 21.

The national legislation of a number of countries requires the explicit declaration of the name and address. However, in the case where a code mark is used, the reference “packer and/or dispatcher (or equivalent abbreviations)” has to be indicated in close connection with the code mark, and the code mark should be preceded by the ISO 3166 (alpha) country/area code of the recognizing country, if not the country of origin.
Passion Fruit, Granadilla, Purple

Fresh purple passion fruits

Yellow granadilla passion fruit (*Passiflora ligularis*)
Yellow passion fruit (*Passiflora ligularis*)

Banana passion fruit
Giant granadilla, *Passiflora quadrangularis* L.

*Passiflora alata* — Fragrant Granadilla — Maracuja grande

*Passiflora vitifolia* — Grape-leaf passion fruit
Passiflora maliformis — Sweet Calabash, Chulupa
## Annex C
(informative)

### Model certificate of conformity with standards for fresh fruits and vegetables

| 1. Trader: | Certificate of conformity with the Community marketing standards applicable to fresh fruits and vegetables |
| No. ......................... |
| (This certificate is exclusively for the use of inspection bodies) |
| 2. Packer identified on packaging (if other than trader) |
| 3. Inspection body |
| 4. Place of inspection/country of origin (1) |
| 5. Region or country of destination |
| 6. Identifier of means of transport |
| 7. |
| Internal |
| Import |
| Export |
| 8. Packages (number and type) |
| 9. Type of product (variety if the standards specifies) |
| 10. Quality Class |
| 11. Total net weight in kg |
| 12. The consignment referred to above conforms, at the time of issue, with the Community standards in force, vide: |
| **EAS 91:2010, Fresh passion fruit — Specification and grading** |
| Customs office foreseen ........................................ Place and date of issue ........................................ |
| Valid until (date): .................................................. |
| Signatory (name in block letters): .................................. |
| Signature Seal of competent authority |
| 13. Observations: |

(1) Where the goods are being re-exported, indicate the origin in box 9.
Annex D
(informative)

Passion fruit — Fact sheet

D.1  *Passiflora* species — Passifloraceae

There are over 60 true species with edible fruits — promising interspecific hybrids also exist.

D.1.1  Cultivated varieties

— *Passiflora alata* Fragrant Granadilla, Maracuja grande
— *Passiflora cumbalensis* Red Banana Passionfruit
— *P. edulis* Sims Purple passionfruit, Purple granadilla
— *Passiflora edulis* f. *flavicarpa* Deg. Yellow passionfruit, Yellow granadilla
— *Passiflora mollissima* Banana passion fruit, Tacso
— *Passiflora vitifolia* Grape-leaf passion fruit

D.1.2  Potentially cultivable varieties

— *Passiflora adenopoda* Granadilla de monte
— *Passiflora ambiguia* Granadilla de monte
— *Passiflora ampullacea* White-flowered Tacso
— *Passiflora antioquiensis* Banana passion fruit
— *Passiflora caerulea* Blue-crown passionflower
— *Passiflora coccinea* Red Granadilla
— *Passiflora incarnata* Maypop
— *Passiflora incarnata* Yellow Granadilla, Jamaica honeysuckle
— *Passiflora ligularis* Sweet Granadilla, Sweet Passionfruit
— *Passiflora maliformis* Sweet Calabash, Chulupa
— *Passiflora manicata*
— *Passiflora mixta* Curuba de Indio
— *Passiflora platyloba* Acid granadilla
— *Passiflora quadrangularis* L. Giantgranadilla
— Passiflora rubra Pomme de liane zombie
— Passiflora seemannii Guate-guate
— Passiflora serrato-digitata Tagua-tagua
— Passiflora suberosa Cork-stem Passionfruit
— Passiflora trifoliata
— Passiflora tripartita Tacso
— Passiflora trisecta
— Passiflora warmingii Maracuja mirim

D.2 Passiflora edulis Sims

*P. edulis* Sims, has almost the exclusive designation of passion fruit, without qualification. Within this species, there are two distinct forms, the standard purple, and the yellow, distinguished as *P. edulis* f. *flavicarpa* Deg., and differing not only in color but in certain other features as will be noted further on.

General names for both in Spanish are *granadilla, parcha, parchita, parchita maracuyá, or ceibey* (Cuba); in Portuguese, *maracuja peroba*; in French, *grenadille, or couzou*. The purple form may be called purple, red, or black granadilla, or, in Hawaii, *ilikoi*; in Jamaica, mountain sweet cup; in Thailand, *linmangkon*. The yellow form is widely known as yellow passionfruit; is called yellow *ilikoi* in Hawaii; golden passionfruit in Australia; *parcha amarilla* in Venezuela.

D.2.1 Description

The passionfruit vine is a shallow-rooted, woody, perennial, climbing by means of tendrils. The alternate, evergreen leaves, deeply 3-lobed when mature, are finely toothed, 7.5-20 cm long, deep-green and glossy above, paler and dull beneath, and, like the young stems and tendrils, tinged with red or purple, especially in the yellow form. A single, fragrant flower, 5-7.5 cm wide, is borne at each node on the new growth. The bloom, clasped by 3 large, green, leaflike bracts, consists of 5 greenish-white sepals, 5 white petals, a fringelike corona of straight, white-tipped rays, rich purple at the base, also 5 stamens with large anthers, the ovary, and triple-branched style forming a prominent central structure. The flower of the yellow is the more showy, with more intense colour. The nearly round or ovoid fruit, 4-7.5 cm wide, has a tough rind, smooth, waxy, ranging in hue from dark-purple with faint, fine white specks, to light-yellow or pumpkin-colour. It is 3 mm thick, adhering to a 6 mm layer of white pith. Within is a cavity more or less filled with an aromatic mass of double-walled, membranous sacs filled with orange-coloured, pulpy juice and as many as 250 small, hard, dark-brown or black, pitted seeds. The flavour is appealing, musky, guava-like, subacid to acid.

D.2.2 Origin and distribution

The purple passionfruit is native from southern Brazil through Paraguay to northern Argentina. It has been stated that the yellow form is of unknown origin, or perhaps native to the Amazon region of Brazil, or is a hybrid between *P. edulis* and *P. ligularis* (q.v.). Cytological studies have not borne out the hybrid theory. Some now think the yellow is a chance mutant that occurred in Australia and is both wilt-and nematode-resistant and does not sucker from the roots. However, E.P. Killip, in 1938, described *P. edulis* in its natural range as having purple or yellow fruits.

Brazil has long had a well-established passionfruit industry with large-scale juice extraction plants. The purple passionfruit is there preferred for consuming fresh; the yellow for juice processing and the making of preserves.

Brazil has long had a well-established passionfruit industry with large-scale juice extraction plants. The purple passionfruit is there preferred for consuming fresh; the yellow for juice processing and the making of preserves.
the purple and yellow which have shown some ability to withstand the serious virus disease called "woodiness".

Commercial culture of purple passionfruit was begun in Kenya in 1933 and was expanded in 1960, when the crop was also introduced into Uganda for commercial production. In both countries, the large plantations were devastated several times by easily-spread diseases and pests. It became necessary to abandon them in favor of small and isolated plantings which could be better protected.

Various species of *Passiflora* have reached the United States Plant Introduction Station (now the Subtropical Horticulture Research Unit) in Miami, Florida, in the routine course of plant accession. Some vines were known to exist and bear fruit year after year here and there in the southern and central areas of the state since 1887 or earlier.

In 1965, the Laboratoire de Recherche des Produits Nestlé, Vevey, Switzerland, placed the passionfruit among the three insufficiently-known tropical fruits having the greatest potential for nectar processing for the European market. It is obvious, then, that in spite of the handicaps of passionfruit culture, the crop offers revenue-earning opportunities for developing countries with low labour costs.

**D.2.3 Varieties**

The yellow form has a more vigorous vine and generally larger fruit than the purple, but the pulp of the purple is less acid, richer in aroma and flavour, and has a higher proportion of juice-35-38%. The purple form has black seeds, the yellow, brown seeds.

The following are some of the older cultivars as well as some of the more recent:

- **'Australian Purple', or 'Nelly Kelly';** a purple selection of mild, sweet flavour.
- **'Common Purple';** thick-skinned, with small seed cavity, but of fine flavor and low acidity.
- **'Kapoho Selection';** a cross of 'Sevcik' and other yellow. A heavy bearer of large fruits but subject to brown rot; many fruits contain little or no pulp and the juice has the off-flavor of 'Sevcik' though not as pronounced.
- **'Pratt Hybrid';** apparently a natural cross between the 'Common Purple' and a yellow strain; subject to rot, but juice is of fine colour and flavour, low in acid.
- **'Sevcik Selection';** a golden form of the yellow; a heavy bearer, but subject to brown rot and the juice has a peculiar woody flavour.
- **'University Round Selection';** Crosses of 'Waimanalo' and 'Yee'—fruit smaller than 'Yee'; not as attractive but yields 10% more juice of very good flavour.
- **'University Selection No. B-74';** hybrid between 'Pratt' and 'C-77', usually yellow, occasionally with red tinges; resembles 'Waimanalo'; has good juice yield and very good flavour.
- **'Waimanalo Selection';** consists of 4 strains: 'C-54', 'C-77', 'C-80', of similar size, shape, color and very good flavour, and 'C-39' as pollinator.
- **'Yee Selection';** yellow, round, very attractive, highly disease-resistant, but fruit has thick rind and low yield of juice which is of very good flavour.

What may be a great improvement over any of the above is the cultivar known as **'Noel's Special'.** It is a yellow passionfruit selected in 1968 from open-pollinated seedlings of a vine discovered at an abandoned farm on Hilo, Hawaii, by Noel Fujimoto in the early 1950's. The fruit is round, averages 90 g; the cavity is filled with dark-orange pulp yielding 43 to 56% bright-orange, richly flavoured juice. The vine is vigorous, begins to bear in one year, and is tolerant to brown spot. It produces 88% marketable fruit in a season—a higher proportion than any other cultivar.

In the Cauca Valley of Colombia, the best-performing yellow passionfruit is the ‘Hawaiiana’. Venezuelan growers favor the ‘Hawaiiana’, ‘Brasilera amarilla’, and the purple-fruited ‘Brasilera rosada’.

A highly promising hybrid, ‘M-21471A’ has been developed by Dr. R.J. Knight at the United States Department of Agriculture’s Subtropical Horticulture Research Station, Miami. The fruit is maroon, weighs about 85 g; is close to the purple parent in quality; is self-compatible and resists soil-borne diseases like its yellow parent. F1 hybrids may be reddish-purple with more conspicuous white dots than on the purple parent, and sometimes there is a tinge of yellow in the background. F2 hybrids show three variations of purple and are difficult to distinguish from the purple parent.

D.2.4 Pollination

Yellow passionfruit flowers are perfect but self-sterile. The yellow passionfruit has three types of flowers according to the curvature of the style: TC (totally curved), PC (partially curved), and SC (upright-styled). TC flowers are most prevalent. Carpenter bees (Xylocopa megaxylocopa frontalis and X. neoxylocopa) efficiently pollinated TC and PC flowers. Honey bees (Apis mellifera adansonii) were much less efficient. Wind is ineffective because of the heaviness and stickiness of the pollen. SC flowers have fertile pollen but do not set fruit. To assure the presence of carpenter bees, it is wise to have decaying logs among the vines to provide nesting places. Carpenter bees will not work the flowers if the nectary is wet. If rain occurs in 1 1/2 hrs after pollination, there will be no fruit set, but if 2 hrs pass before rain falls, it will have no detrimental effect.

In crossing the yellow and purple forms, it is necessary to use the purple as the seed parent because the flowers of the yellow are not receptive to the pollen of the purple, and an early-blooming yellow must be utilized in order to have a sufficient overlapping period for pollen transfer.

In some areas, trellis-grown vines of the yellow passionfruit require hand-pollination to assist fruit set. In the home garden, at least two vines of different parentage should be planted and allowed to intertwine for cross-pollination.

D.2.5 Climate

The purple passionfruit is subtropical. It grows and produces well between altitudes of 650-1,300 m.

The yellow passionfruit is tropical or near-tropical.

Both forms need protection from wind. Generally, annual rainfall should be at least 90 cm. It is reported that annual rainfall in passionfruit-growing areas of India ranges between 100 cm to 250 cm.

D.2.6 Soil

Passionfruit vines are grown on many soil types but light to heavy sandy loams, of medium texture are most suitable, and pH should be from 6.5 to 7.5. If the soil is too acid, lime must be applied. Good drainage is essential to minimize the incidence of collar rot.

D.2.7 Propagation

Passionfruit vines are usually grown from seeds. With the yellow form, seedling variation provides cross-pollination and helps overcome the problem of self-sterility. Some say that the fruits should be stored for a week or two to allow them to shrivel and become perfectly ripe before seeds are extracted. If planted soon after removal from the fruit, seeds will germinate in 2 to 3 weeks. Cleaned and stored seeds have a lower and slower rate of germination. Sprouting may be hastened by allowing the pulp to ferment for a few days before separating the seeds, or by chipping the seeds or rubbing them with fine sandpaper. Soaking, often recommended, has not proved helpful. Seeds are planted 1.25 cm deep in beds, and seedlings may be transplanted when 25 cm high. If taller—up to 1 m—the tops should be cut back and the plants heavily watered.
Some growers prefer layers or cuttings of matured wood with 3 to 4 nodes. Cuttings should be well-rooted and ready for setting out in 90 days. Rooting may be hastened by hormone treatment. Grafting is an important means of perpetuating hybrids and reducing nematode damage and diseases by utilizing the resistant yellow passionfruit rootstock. Scions from healthy young vines are preferred to those from mature plants. The diameter of the selected scion should match that of the rootstock. Either a cleft graft, whip graft, or side-wedge graft may be made.

If approach-grafting is to be done, a row of potted scions must be placed close alongside the row of rootstocks so that the union can be made at about 3/4 of the height of the plant.

D.2.8 Culture

Root-pruning should precede transplanting of seedlings by 2 weeks. Transplanting is best done on a cool, overcast day. The soil should be prepared and enriched organically a month in advance if possible. Grafted vines must be planted with the union well above ground, not covered by soil or mulch, otherwise the disease resistance will be lost. Mounding of the rows greatly facilitates fruit collection.

In plantations, the vines are set at various distances, but studies indicate that highest yields in yellow passionfruit are obtained when the vines are set 3 m apart each way. Spacing of purple passionfruit in Kenya has been 3 m between vines and 1.8 m between rows. Recent 3-year trials of 1.2 m between rows, with light pruning the 2nd and 3rd years, resulted in the highest yield (50% of the crop being home the first year). But it is recognized that such close planting can lead to disease problems and replanting after the 3rd year.

Commercially, vines are trained to strongly-supported wire trellises at least 2.13 m high. However, for the benefit of the homeowner, it should be pointed out that the yellow passion fruit is more productive and less subject to pests and diseases if allowed to climb a tall tree.

After a vine of either the yellow or purple passion fruit attains 2 years of age, pruning once a year will stimulate new growth and consequently more flower and fruit production. Plantations can be kept in full production for as long as 8 years.

Regular watering will keep a vine flowering and fruiting almost continuously. Water requirement is high when fruits are approaching maturity. If soil is dry, fruits may shrivel and fall prematurely. Fertilizer (10-5-20 NPK) should be applied at the rate of 1.36 kg per plant 4 times a year, under normal conditions. In India, trials of purple passion fruit on red sandy loam with a pH of 6.5 and high organic content, the optimum fertilizer treatment was found to be 132 kg N and 31.6 kg P per ha per year. French horticulturists have reported that, in plantations on the Ivory Coast, annual supplements of 220 g urea and 210 g potassium sulfate per plant per year of age will have a highly favourable effect on production. It is said that 900-1,000 g of nitrogen are required to produce 30 kg of fruits, but excessive nitrogen will cause premature fruit drop. Passion fruit vines should always be watched for deficiencies, particularly in potassium and calcium, and of less importance, magnesium.

The passion fruit vine, especially the yellow, is fast-growing and will begin to bear in 1 to 3 years. Ripening occurs 70 to 80 days after pollination. Injuries to the base of the vine, which allow entrance of disease organisms, can be avoided by hand-weeding or the application of herbicides around the main stems. These practices will also protect the shallow root system. In Surinam, good weed control under trellises has been achieved by covering the soil with black plastic.

D.2.9 Seasons and harvesting

Ripe fruits fall to the ground and will roll in between mounded rows. They do not attract flies or ants but should be collected daily to avoid spoilage from soil organisms. In cases where they are subject to sunburn damage on the ground, the fruits are picked from the vines 2 or 3 times a week before they are fully ripe, that is, when they are light-purple. At this stage, they will reach the fresh fruit market before they wrinkle. For juice processing, the fruit is allowed to attain a deep-purple colour. In India and Israel the fruits are always picked from the vine rather than being allowed to fall. It has been found that fallen fruits are lower in soluble solids, sugar content, acidity and ascorbic acid content.
The fruits should be collected in lugs or boxes, not in bags which will cause "sweating". If not sent immediately to processing plants, the fruits should be spread out on wire racks where there will be good air circulation.

D.2.10 Yield

Many factors influence the yield of passion fruit vines. In general, yields of commercial plantations range from 9000 to 15750 kg acre.

D.2.11 Storage

Underripe yellow passion fruits can be ripened and stored at 20 ºC with relative humidity of 85 to 90%. Ripening is too rapid at 30 ºC. Ripe fruits keep for one week at 2.22 ºC – 7.22 ºC. Fruits stored in unperforated, sealed, polyethylene bags at 23.1 ºC, have remained in good condition for 2 weeks. Coating with paraffin and storing at 5º to 7 ºC and relative humidity of 85 to 90%, has prevented wrinkling and preserved quality for 30 days.

D.2.12 Pests and diseases

Thrips (Thysanoptera sp.) injure and cause stunting of young seedlings in nurseries. In dry weather, they also feed on leaves and fruits, leaving them defaced and prone to shrivel and fall prematurely. In East Africa, injury from the tobacco white fly (Bemisia tabaci) may lead to galls on the leaves. Leaf beetles (Haltica sp.) and weevils (Systates spp.) chew the foliage, and cutworms behead seedlings in nurseries.

The aphids, Aphis gossypii and Myzus Persicae, transmit the virus which causes "woodiness".

In South Africa, purple passionfruit vines are damaged by several species of nematodes. The most important, which causes extreme thickening of the roots, is the root-knot nematode, Meloidogyne javanica. Others include the spiral nematode (Scutellonema truncatum and Helicotylenchus sp.), and the lesion nematode (Pratylenchus sp.). The yellow passionfruit is nematode-resistant.

Nectria haematococca, or Hypomyces solani, the ascogenous state of Fusarium solani, has been determined to be the organism girdling the collar zone and bringing on sudden wilt of the purple passionfruit vine in Uganda.

The virus disease, "woodiness", or "bullet", appearing as small misshapen fruits with thick rind and small pulp cavity, has been the most serious plague of the purple passionfruit in Australia and East Africa, but it has little effect on the yellow form. The "woodiness" virus (PWV) is also the source of tip blight in the coastal districts of central Queensland. This virus has a wide host range, not only in the genus Passillora, but also weedy species in the families Amaranthaceae, Chenopodiaceae, Cucurbitaceae and Solanaceae.

Damping-off is caused by Rhizoctonia solani and Pythium spp. Thread blight of yellow passionfruit vine seen as patches of black, papery, shredded leaves with grey to tan layer of merged "threads" beneath, has been attributed to Rhizoctonia solani (also called Thanatephorus cucumeris). It may invade the entire vine.

D.2.13 Food uses

The fruit is used as food in a variety of ways as well as being eaten raw when ripe. Passion fruit juice can be boiled down to a syrup which is used in making sauce, gelatine desserts, candy, ice cream, sherbert, cake icing, cake filling, meringue or chiffon pie, cold fruit soup, or in cocktails. The seeded pulp is made into jelly or is combined with pineapple or tomato in making jam. The flavour of passion fruit juice is impaired by heat preservation unless it is done by agitated or "spin" pasteurization in the can. The frozen juice can be kept without deterioration for 1 year at -17.78 ºC and is a very appealing product. The juice can also be "vacuum-puff" dried or freeze-dried.
Food value per 100 g of edible portion (purple passion fruit, pulp and seeds)*

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>90</td>
</tr>
<tr>
<td>Moisture</td>
<td>75.1 g</td>
</tr>
<tr>
<td>Protein</td>
<td>2.2 g</td>
</tr>
<tr>
<td>Fat</td>
<td>0.7 g</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>21.2 g</td>
</tr>
<tr>
<td>Fibre</td>
<td>?</td>
</tr>
<tr>
<td>Ash</td>
<td>0.8 g</td>
</tr>
<tr>
<td>Calcium</td>
<td>13 mg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>64 mg</td>
</tr>
<tr>
<td>Iron*</td>
<td>1.6 mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>28 mg</td>
</tr>
<tr>
<td>Potassium</td>
<td>348 mg</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>700 I.U.</td>
</tr>
<tr>
<td>Thiamine</td>
<td>Trace</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.13 mg</td>
</tr>
<tr>
<td>Niacin</td>
<td>1.5 mg</td>
</tr>
<tr>
<td>Ascorbic Acid</td>
<td>30 mg</td>
</tr>
</tbody>
</table>

*According to U.S. Dept. Agr., ARS.

The yellow passion fruit has somewhat less ascorbic acid than the purple but is richer in total acid (mainly citric) and in carotene content. It is an excellent source of niacin and a good source of riboflavin. Free amino acids in purple passion fruit juice are: arginine, aspartic acid, glycine, leucine, lysine, proline, threonine, tyrosine and valine. Carotenoids in the purple form constitute 1.160%; in the yellow, 0.058%; flavonoids in the purple, 1.060%; in the yellow, 1.000%; alkaloids in the purple, 0.012%; in the yellow, 0.700% (mainly harman), and the juice is slightly sedative. Starch content of purple passion fruit juice is 0.74%; of the yellow, 0.06%.

D.2.14 Toxicity

A cyanogenic glycoside is found in the pulp of passion fruits at all stages of development, but is highest in very young, unripe fruits and lowest in fallen, wrinkled fruits, the level in the latter being so low that it is of no toxicological significance.

D.2.15 Other uses

Commercial processing of the yellow passion fruit yields 36% juice, 51% rinds, and 11% seeds.

Rind: The rinds have a very low pectin content—only 2.4% (14% on a dry weight basis). Nevertheless, it has been determined in Fiji that extraction of pectin from the rinds—up to 5 tons (4.5 MT) annually—reduces the otherwise burdensome problem of waste disposal. The rind residue contains about 5 to 6% protein and could be used as filler in poultry and stock feed. In Brazil, pectin is extracted from the purple form which has better quality pectin than that in the yellow. In Hawaii, the pectin is not extracted; instead, the rinds are chopped, dried, and combined with molasses as cattle or pig feed. They can also be converted into silage.

Seeds: The seeds yield 23% oil which is similar to sunflower and soybean oil and accordingly has edible as well as industrial uses. The seed meal contains about 12% protein and 50 to 55% fibre. It has been judged unsuitable for cattle feed.

Analyses of the fresh rind show: moisture, 78.43-85.24%; crude protein, 2.04-2.84%; fat, 0.05-0.16%; crude starch, 0.75-1.36%; sugars (sucrose, glucose, fructose), 1.64%; crude fibre, 4.57-7.13%; phosphorus, 0.03-0.06%; silica, 0.01-0.04%; potassium, 0.60-0.78 %; organic acids (citric and maleic), 0.15%; ascorbic acid, 78.3-166.2%. The outer skin of the purple form contains 1.4 mg per 100 g of the anthocyanin pigment, pelargonidin 3-diglucoside. There is also some tannin.

The composition of the air-dried seeds is reported as: moisture, 5.4%; fat, 23.8%; crude fibre, 53.7%; protein, 11.1%; N-free extract, 5.1%; total ash, 1.84%; ash insoluble in HC1, 0.35%; calcium, 80 mg; iron, 18 mg; phosphorus, 640 mg per 100 g.
The seed oil contains 8.90% saturated fatty acids; 84.09% unsaturated fatty acids. The fatty acids consist of: palmitic, 6.78%; stearic, 1.76%; arachidic, 0.34%; oleic, 19.0%; linoleic, 59.9%; linolenic, 5.4%.

**Medicinal uses:** There is currently a revival of interest in the pharmaceutical industry, especially in Europe, in the use of the glycoside, *passiflorine*, especially from *P. incarnata* L., as a sedative or tranquilizer. Italian chemists have extracted *passiflorine* from the air-dried leaves of *P. edulis*.

In Madeira, the juice of passionfruits is given as a digestive stimulant and treatment for gastric cancer.

**D.3 Water Lemon (*Passiflora laurifolia* L.)**

The water lemon, *Passiflora laurifolia* L., is also known as bell-apple, sweet cup, yellow granadilla, Jamaica honeysuckle, vinegar pear, golden apple, where English is spoken; as *pomme d’or*, *pomme liane*, or *pomme de liane*, *Marie-Tambour*, or *maritambou*, in the French West Indies; as *parcha*, *parca de culebra*, or *pasionaria con hojas de laurel* in Spanish. In the Portuguese language, in Brazil, it is called maracuja comum or maracuja laranja. It is *paramarkoesa* in Surinam. In Malaya, it is *markusa leuth*, *buah susu*, *buah belebar*, or *buah selaseh*; in Thailand, *sa-wa-rot*; in Vietnam, *guoi tay*.

**D.3.1 Description**

The water lemon vine is a moderately vigorous climber, 10 m or more, its twining, more or less woody or wiry stems longitudinally grooved and bearing slender, tough tendrils in the leaf axils flanked by 2 slim, green stipules. The alternate leaves are oblong-ovate or elliptical, rounded at the base, abruptly pointed at the apex; 15-20 cm long, 3.4-8 cm wide; thick and leathery. The fragrant, solitary, 5-petalled flowers, 7.4-10 cm across, have a bell-shaped calyx, oblong, red or purple-red sepals and petals, and corona filaments 6-ranked, banded with red, blue, purple and white. The fruit is ellipsoidal or ovoid, 5-8 cm long, 4-6 cm wide; orange-yellow; clasped at the base by 3 large, green, leaflike bracts, toothed and edged with conspicuous glands. The rind is leathery, to 3 mm thick, white and spongy within; becomes hard when dry. Pleasantly rose-scented, the translucent, nearly white pulp is juicy, mucilaginous and of agreeable, subacid flavor, and encloses numerous seeds, flat and minutely ribbed.

**D.3.2 Origin and distribution**

The water lemon is native to tropical America and common, wild and cultivated from southern Venezuela, Surinam, Guyana and French Guiana down through the Amazon region of Brazil to Peru. In the dry season, the fruits are regularly sold in local markets. The vine is cultivated and naturalized from Trinidad and Barbados to Jamaica, Puerto Rico, Hispaniola and Cuba. In Bermuda, it is only occasionally grown. It was introduced into Malaya in the 18th Century; is commonly cultivated in the lowlands and naturalized in Singapore and Penang. The water lemon is grown in Thailand and throughout the southern half of Vietnam.

**D.3.3 Pollination**

The water lemon flowers open only in the afternoon, and apparently are not self-pollinated, or only slightly so. Cross-pollination is required for good crops. If carpenter bees are not present at the right time, the pollen must be transferred by hand.

**D.3.4 Climate**

A warm, dry atmosphere is essential for early ripening of the stigmas. The vine grows vigorously up to 457 m altitude.

**D.3.5 Soil**

The vine has grown and flowered well on sand and on limestone.
D.3.6 Propagation

The water lemon grows readily from seeds or cuttings.

D.3.7 Pests

Trials have shown that the vine is fairly resistant to rootknot nematodes.

D.3.8 Food Uses

The pulp and seeds are used for refreshment. The juice of the strained pulp makes an excellent beverage.

D.3.9 Food value

The pulp contains 1.55 mg of pantothenic acid per 100 g; the rind, 1.87 mg. This element belongs to the vitamin B complex group and is sometimes called vitamin B5.

D.3.10 Toxicity

The rind, leaves and seeds contain a cyanogenic glycoside. On the other hand, the leaves possess 387 mg, per 100 g, ascorbic acid. The leaf decoction is taken as a vermifuge. The seeds have a sedative action on the nervous system and heart and, in strong doses, are hypnotic. The root acts as a very potent vermifuge.

D.4 Sweet Granadilla (Passiflora ligularis Juss.)

Ranking close to Passiflora edulis in popular appeal and potential, the sweet granadilla, P. ligularis Juss., is also known as granadilla (Bolivia, Costa Rica, Ecuador, Mexico, Peru); granadilla común (Guatemala); granadilla de China or parchita amarilla (Venezuela); and granaditta (Jamaica).

D.4.1 Description

The vine is a vigorous, strong grower, woody at the base, climbing by tendrils, topping the highest trees, shading out and killing the undergrowth. Its leaves are broadly heart-shaped, pointed at the apex, 8 to 20 cm long, 6 to 15 cm wide, conspicuously veined, medium-green on the upper surface, pale-green with a bloom on the underside. Spaced along the petiole, are 3 pairs of hairlike glands about 1 cm long. At the leaf axils, there are paired, leaflike stipules, ovate-oblong and about 2.5 cm long and a little over 1.25 cm wide; more or less finely toothed.

The flowers, sweet and musky in odour, usually 2 to a node, may be 10 cm across, on a 4 cm peduncle bearing 3 leaflike, ovate-oblong, pointed bracts, 4 cm long and 2.5 cm wide, faintly toothed. The sepals are greenish-white, lanceolate; the petals pinkish white; the filaments, in 2 rows, white, horizontally striped with purple-blue.

The fruit is broad-elliptic, 6 cm to 7.5 cm long, green with purple blush on sunny side and minutely dotted when unripe, orange-yellow with white specks when ripe. The rind is smooth, thin, hard and brittle externally, white and soft on the inside. The pulp (arils) is whitish-yellow or more or less orange, mucilaginous, very juicy, of sprightly, aromatic flavour, and encloses numerous black, flat, pitted, crisp but fairly tender seeds.

D.4.2 Origin and distribution

The sweet granadilla is the common species of Passiflora ranging from central Mexico through Central America and western South America, through western Bolivia to south-central Peru. Throughout this region, it is popular and abundant in the markets.

It is cultivated and naturalized in Jamaica and, in recent years, has been blooming and fruiting prolifically in mountainous Haiti.
D.4.3 Climate

The sweet granadilla is subtropical. In its natural range, it is wild and cultivated at elevations of 900-2,700 m. At 1,500-2,500 m in Colombia, the vine fruits well. At higher altitudes, it flourishes and blooms but will not fruit. The vine is intolerant of heat.

D.4.4 Soil

Thin, volcanic soils do not discourage the sweet granadilla, providing they are moist. It is naturally adapted to high rainforests.

D.4.5 Propagation

The sweet granadilla can be grown from seeds or cuttings.

D.4.6 Season and keeping quality

There is but one crop per year. The fruit, despite its hard shell, has poor keeping quality, deteriorating soon after the harvest.

D.4.7 Pests

Rodents are a major problem for the planted seeds, though the seeds of *P. edulis* in the same situation have never been disturbed. Squirrels seem to have a preference for this crop.

D.4.8 Food uses

Usually, the fruit is cracked open and the pulp and seeds consumed out-of-hand. For the table, the fruit is cut in half and the contents are eaten with a spoon. The strained juice is much used for making cold drinks and sherbet (ice).

### Food value per 100 g of edible portion*

<table>
<thead>
<tr>
<th></th>
<th>Pulp and Seeds Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>69.9-79.1 g</td>
</tr>
<tr>
<td>Protein</td>
<td>0.340-0.474 g</td>
</tr>
<tr>
<td>Fat</td>
<td>1.50-3.18 g</td>
</tr>
<tr>
<td>Crude Fibre</td>
<td>3.2-5.6 g</td>
</tr>
<tr>
<td>Ash</td>
<td>0.87-1.36 g</td>
</tr>
<tr>
<td>Calcium</td>
<td>5.6-13.7 mg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>44.0-78.0 mg</td>
</tr>
<tr>
<td>Iron</td>
<td>0.58-1.56 mg</td>
</tr>
<tr>
<td>Carotene</td>
<td>0.00-0.035 mg</td>
</tr>
<tr>
<td>Thiamine</td>
<td>0.00-0.002 mg</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.063-0.125 mg</td>
</tr>
<tr>
<td>Niacin</td>
<td>1.42-1.813 mg</td>
</tr>
<tr>
<td>Ascorbic Acid</td>
<td>10.8-28.1 mg</td>
</tr>
</tbody>
</table>

*Analyses made in Ecuador, El Salvador, Costa Rica and Guatemala.

D.5 Sweet Calabash (*Passiflora maliformis* L.)

The sweet calabash, *P. maliformis* L., has been called water lemon (Bermuda); *ceibey cimarron* (Cuba), *calabassie* (Haiti), *calabacito de Indio* (Dominican Republic); sweet cup, conch apple, conch nut (Jamaica); *paracha cimarrona* (Puerto Rico); *Pomme calabas, liane a agouti* (Guadeloupe); *pomme-liane de la Guadeloupe* (Martinique); *culupa, granadilla, curuba or kuruba* (Colombia); *granadilla de hueso or granadilla de mono* (Ecuador); *guerito* (Cuba).

D.5.1 Description

The vine is woody but slender, climbing to 10 m or more by means of tendrils in the leaf axils, and draping trees, walls and small buildings. The evergreen leaves are ovate-cordate, or ovate-oblong,
with a short, recurved point at the apex; fairly thin, light-green; 6-15 cm long, with 2 round, flat glands at about the middle of the petiole. The peduncle bears 3 thin, ovate, pointed bracts, to 5 cm long, which enclose the unopened bud and form an ivory-hued background for the opened flower, which is fragrant, 5-6 cm wide, with keeled, green, maroon-dotted sepals and 5 small petals, greenish-white, dotted with red or purple. The corona is 3-ranked and variegated white, purple and blue.

The fruit is oblate to nearly round-oval, the specific name implying “apple-shaped”, being derived from *Malus*, the apple genus. It is 4.5-5 cm long, 3.5-4 cm wide. The rind is yellow to brownish when fully ripe, thin; varies from rather flexible and leathery to hard and brittle. The pulp is greyish or pale orange-yellow, juicy, sweet or subacid and pleasingly aromatic, containing many black, flat, ovate, pitted seeds.

D.5.2 Origin and distribution

This species is native and common in the wild in Cuba, Puerto Rico, the Dominican Republic, Jamaica, and from Saba to Barbados and Trinidad; also Venezuela, Colombia and northern Ecuador. It is cultivated in Jamaica, Brazil and Ecuador for its fruits, and in Hawaii as an ornamental in private gardens and in experimental stations for use in breeding work.

D.5.3 Climate

The vine grows and fruits at cool altitudes–up to 1,700 m–in South America; in Jamaica, between 152-366 m.

D.5.4 Season

The fruits ripen from September to December in Jamaica.

D.5.5 Pests and diseases

This species is noted for its resistance to pests and diseases that affect its relatives.

D.5.6 Food uses

The fruit, whether leathery or hard-shelled, is difficult to open but the seedy pulp is much enjoyed locally. In Jamaica, it is scooped from the shell and served with wine and sugar. The strained juice is excellent for making cold drinks.

D.5.7 Other uses

Snuff boxes have been made of the shell of the hard type.

D.6 Giant Granadilla (*Passiflora quadrangularis* L.) (*Passiflora macrocarpa* M.T. Mast.)

The largest fruit in its genus, the giant granadilla, *Passiflora quadrangularis* L. (syn. *P. macrocarpa* M.T. Mast.), is often called merely *granadilla*, or *parcha*, Spanish names loosely applied to various related species; or it may be distinguished as *granadilla real*, *grandadilla grande*, *parcha granadina* or *parcha de Guinea*. In El Salvador, it is known as *granadilla de fresco* or *granadilla para refrescos*; in parts of Colombia, it is *badea* or *corvejo*; in the State of Táchira, Venezuela, *badea*; in Bolivia, *granadilla real* or *sandía de Pasión*. In Brazil, it is *maracuyá-acu*, *maracujá-assu*, *maracujá silvestre*, *maracuja grande*, *maracuja suspiro*, *maracuja mamo*, or *maracuja de caíena*. In Surinam, it is *grote* or *grote markeesa*; in Peru and Ecuador, *tumbo* or *tambo*. In the Philippines, its local names are *parola*, *kasaflora*, and *square-stemmed passion flower*. To Indonesians, it is familiar as *markiza*, *markoesa*, *markeesa*, or *manesa*, and to the Malays, *timun belanda*, *marquesa* or *mentimun*. In Thailand, it is *su-khontha-rot*; in Vietnam, *dua gan tay*, or *barbadine*, the French name.

D.6.1 Description

The vine is fast-growing, large, coarse, herbaceous but woody at the base, arising from a fleshy root that becomes enlarged with age, and climbing trees to a height of 10-15 m or even 45 m in Java. It
has thick 4-angled stems prominently winged on the angles, and axillary tendrils to 30 cm long, flanked by leaflike, ovate or ovate-lanceolate stipules 2-3.5 cm long, sometimes faintly toothed. The alternate leaves are broad-ovate or oblong-ovate, 8.25-15 cm wide, 10-20 cm long; rounded or cordate at the base, abruptly pointed at the apex, sometimes toothed near the base; thin, with conspicuous veins sunken on the upper surface, prominent beneath. The solitary, fragrant flowers, up to 12-12.5 cm wide, have a bell-shaped calyx, the 5 sepals greenish or reddish-green on the outside, white, pink or purple inside; the 5 petals, to 4.5 cm long, white-and-pink; the corona filaments 2-ranked, to 6 cm)long, purple-and-white below, blue in the middle, and pinkish-blue above, around the typical complex of pistil, style and stigmas.

The pleasantly aromatic, melon-like fruit is oblong-ovoid, 12-15 cm wide, and 10-30 cm long; may be faintly ribbed or longitudinally 3-lobed; has a thin, delicate skin, greenish-white to pale- or deep-yellow, often blushed with pink. Beneath it is a layer of firm, mealy, white or pink flesh, 2.5-4 cm thick, of very mild flavour, and coated with a parchment-like material on the inner surface. The central cavity contains some juice and masses of whitish, yellowish, partly yellow or purple-pink, sweet-acid arils (commonly referred to as the pulp), enclosing flattened-oval, purplish-brown seeds to 1.25 cm long.

D.6.2 Origin and distribution

The giant granadilla is generally agreed to be a native of tropical America, though the actual place of origin is unknown. It was growing in Barbados in 1750 and is present in several other Caribbean Islands and in Bermuda. It is commonly cultivated, and sometimes an escape from cultivation or truly wild, from Mexico to Brazil and Peru. At some point in the 18th Century, it was introduced into Malaya, where it thrives in both the north and the south. In Vietnam, it is limited to the southern half of the country. Perhaps it reached Indonesia earlier, for it is more common and even naturalized there. It is also cultivated in the lowlands of India, Ceylon and the Philippines; in tropical Africa, and throughout Queensland, Australia. In tropical North Queensland it has run wild, growing lushly in jungle areas. It flourishes and fruits heavily especially in the Cairns district. It was being grown in Hawaii in 1888 and by 1931 had become naturalized in moist places.

D.6.3 Varieties

There are various strains producing fruits of different sizes and quality. One strain with especially large fruits and good flavour was formerly considered a separate species (P. macrocarpa), but it hybridizes readily with smaller strains and there are intermediate types.

D.6.4 Pollination

The vine may produce few or no fruits in a dry atmosphere, or in the absence of insect pollinators. Also the pollen may ripen before the stigma is ready to receive it, and, at times, bees may steal the pollen too early in the morning. Hand-pollination is regularly practiced in Queensland and has been successful in limited experiments in Florida. It should be done in the late morning, no later than 4 to 6 hours after the flowers open.

D.6.5 Climate

The ideal climate for the giant granadilla is one that is truly tropical, warm both day and night, with little fluctuation, and with high humidity. It is grown between 200 m to 2,200 m.

D.6.6 Soil

For maximum growth and productivity, the vine requires deep, fertile, moist but well-drained soil. Good growth has been observed on volcanic, alluvial, and sandy soil, and even decomposed granite.

D.6.7 Propagation

The giant granadilla grows readily from seeds, which germinate in 2 to 3 weeks and the seedlings can be set out when 15-30 cm high. Cuttings of mature wood 25-30 cm or even 0.6-0.9 m long, are partially defoliated and deeply planted in well-watered sand. There will be sufficient vegetative growth and root development to permit transplanting in 30 days. Air- or ground-layers are also satisfactory.
D.6.8 Culture

In commercial plantings in Indonesia, the vines are set 2-3 m apart each way. When the plants reach about 2 m in height, they must be trained to a strong, horizontal trellis. Pruning may be necessary if the growth becomes too dense. Regular applications of fertilizer high in organic matter, and copious watering are necessary.

D.6.9 Harvesting and yield

In Indonesia and Queensland, a productive vine will fruit more or less continually all year and the annual yield may range from 25 to 35 fruits in the larger types to 70 to 120 fruits in medium to small types. Venezuelan horticulturists report that their main blooming period is May to October and the fruits ripen in 62 to 85 days from flower-opening, the crop being harvested mainly from July through October. The yield of 2- to 3-year-old vines varies from 16 to 50 fruits. The fruits are ready for harvesting when the skin becomes translucent and glossy and is beginning to turn yellowish at the apex. It is clipped from the vine. Very careful handling and packing are essential.

D.6.10 Pests and diseases

Stem-end rot in East Africa has been attributed to the fungus, *Botryodiplodia theobromae*.

D.6.11 Food uses

The fruit can be eaten raw or prepared in many styles to offer edible products. Jelly can be made from the unpeeled flesh boiled for 2 hours and the pulp simmered separately. The juice strained from both is combined and, with added sugar and lemon juice, is boiled until it jells.

The pulp (arils) yields a most agreeable juice for cold drinks. It is bottled in Indonesia and served in restaurants. Wine is made in Australia by mashing several of the whole ripe fruits, adding sugar and warm water and allowing the mix to ferment for 3 weeks, adding 2 pints of brandy, and letting stand for 9 to 12 months.

The young, unripe fruit may be steamed or boiled and served as a vegetable, or may be cut up, breaded and cooked in butter with milk, pepper and nutmeg. The root of old vines is baked and eaten in Jamaica as a substitute for yam.

Food value per 100 g of edible portion*

<table>
<thead>
<tr>
<th></th>
<th>Thick Flesh</th>
<th>Arils and Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>94.4 g</td>
<td>78.4 g</td>
</tr>
<tr>
<td>Protein</td>
<td>0.112 g</td>
<td>0.299 g</td>
</tr>
<tr>
<td>Fat</td>
<td>0.15 g</td>
<td>1.29 g</td>
</tr>
<tr>
<td>Crude Fiber</td>
<td>0.7 g</td>
<td>3.6 g</td>
</tr>
<tr>
<td>Ash</td>
<td>0.41 g</td>
<td>0.80 g</td>
</tr>
<tr>
<td>Calcium</td>
<td>13.8 mg</td>
<td>9.2 g</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>17.1 mg</td>
<td>39.3 mg</td>
</tr>
<tr>
<td>Iron</td>
<td>0.80 mg</td>
<td>2.93 mg</td>
</tr>
<tr>
<td>Carotene</td>
<td>0.004 mg</td>
<td>0.019 mg</td>
</tr>
<tr>
<td>Thiamine</td>
<td>0.003 mg</td>
<td></td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.033 mg</td>
<td>0.120 mg</td>
</tr>
<tr>
<td>Niacin</td>
<td>0.378 mg</td>
<td>15.3 mg</td>
</tr>
<tr>
<td>Ascorbic Acid</td>
<td>14.3 mg</td>
<td></td>
</tr>
</tbody>
</table>

*According to analyses made in El Salvador.

D.6.12 Toxicity

The leaves, skin and immature seeds contain a cyanogenic glycoside. The pulp contains passiflorine and, if indulged in excessively, causes lethargy and somnolence. The raw root is said to be emetic, narcotic and poisonous.
D.6.13 Medicinal uses

The fruit is valued in the tropics as antiscorbutic and stomachic. In Brazil, the flesh is prescribed as a sedative to relieve nervous headache, asthma, diarrhoea, dysentery, neurasthenia and insomnia. The seeds contain a cardiotonic principle, are sedative, and, in large doses, narcotic. The leaf decoction is a vermifuge and is used for bathing skin afflictions. Leaf poultices are applied in liver complaints. The root is employed as an emetic, diuretic and vermifuge. Powdered and mixed with oil, it is applied as a soothing poultice.

D.7 Banana passion fruit [Passiflora mollissima Bailey; Passiflora tomentosa var. mollissima Tr.& Planch; Tacsonia mollissima HBK.]

A distinctive and much admired passionfruit relative, Passiflora mollissima Bailey (syns. P. tomentosa var. mollissima Tr. & Planch.; Tacsonia mollissima HBK.), was given this appealing and appropriate English name in New Zealand. In Hawaii, it is called banana poka. In its Latin American homeland, it is known as curuba, curuba de Castilla, or curuba sabanera blanco (Colombia); tacso, tagso, tauso (Ecuador); parcha (Venezuela), tumbo or curuba (Bolivia); tacso, tumbo, tumbo del norte, trompos, or tintín (Peru).

D.7.1 Description

The vine is a vigorous climber to 6-7 m, its nearly cylindrical stems densely coated with yellow hairs. Its deeply 3-lobed leaves, 7.5-10 cm long and 6-12 cm wide, are finely toothed and downy above, grayish-or yellowish-velvety beneath. The stipules are short, slender and curved. The attractive blossom has a tube 7.5-10 cm long, gray-green, frequently blushed with red, rarely downy; corolla with 5 oblong sepals and deep-pink petals flaring to a width of 5-7.5 cm; and a rippled, tuberculated, purple corona. The fruit is oblong or oblong-ovoid, 5-12 cm long, 3.2-4 cm wide. The rind is thick, leathery, whitish-yellow or, in one form, dark-green, and minutely downy. Very aromatic pulp (arils), salmon-colored, subacid to acid and rich in flavor, surrounds the small, black, flat, elliptic, reticulated seeds.

D.7.2 Origin and Distribution

The banana passionfruit is native and commonly found in the wild in Andean valleys from Venezuela and eastern Colombia to Bolivia and Peru. It is believed to have been domesticated only shortly before the Spanish Conquest.

D.7.3 Varieties

In general, the fruit is smaller in Peru than in Colombia and Ecuador. There are said to be several varieties. A form called curuba quiteña in Colombia is dark-green externally even when fully ripe, the apex is abruptly pointed and furrowed; the pulp is dark-orange or orange-brown.

D.7.4 Climate

This species is at home at elevations of 1800-3200 m in the Andes, and has adapted well to altitudes of 1200-1800 m in Hawaii and New Zealand. It can tolerate brief drops in temperature to -2 ºC.

D.7.5 Propagation

The vine can be propagated from cuttings but is usually grown from seeds which normally germinate in 10 weeks. The time can be shortened to 5 weeks by preliminary soaking in lukewarm water.

D.7.6 Culture

The seedlings can be transplanted when 3 months old and need to be trained onto a horizontal trellis 2 m high with crosswires 40 cm apart. At a vine spacing of 2 m each way, there will be 607 plants per acre. Less dense planting, allowing 3 m each way between vines, and 50 cm between crosswires, will result in 445 vines per acre. The first crop will be produced in 2 years. At dense spacing, and with good weed control and adequate fertilization, the annual harvest in Colombia will be 200 to 300 fruits.
per vine, amounting to 200,000 to 303,000 fruits per acre, or about 14000 kg to 21000 kg per acre. The individual fruits range from 50-150 g. Some growers have practiced pruning, which improves air-flow, reducing disease, and facilitates weeding, irrigation, spraying and harvesting. It produces larger fruits but fewer and therefore is generally viewed as not practical as size is not important to the consumer. In India, the average yield is said to be 40 to 50 fruits per vine beginning with the 6th year from planting.

D.7.7 Season

There is more or less continuous fruiting the year round.

D.7.8 Keeping quality

The fruit stands shipment well and will keep in good condition in a dry and not too cold atmosphere for a reasonable length of time.

D.7.9 Pests and diseases

In humid and poorly drained situations, some plantations suffer from nematodes (*Meloidogyne* sp.). Leaves and shoots may be attacked by leafhoppers (*Empoasca* sp.) and by *Dione* or *Agraulis, vanillae*; leaves and fruits may be plagued by mites (*Tetranychus* sp.); larvae of *Hepialus* sp. invade the flowerbud; stems may be bored and tunneled by *Heteractes* sp. and *Nyssodrys* sp. Occasionally the fruits are attacked by fruit flies. Young shoots are prone to powdery mildew (*Asterinia* sp.) and anthracnose (*Colletotrichum* sp.) may affect the vine and fruits. Boron deficiency causes cracking of fruits. Sometimes, for physiological reasons not yet fully understood, 50 to 60% of the fruits may drop prematurely.

D.7.10 Food uses

The pulp is eaten out-of-hand or is strained for its juice which is not consumed alone but employed in refreshing mixed cold beverages.

Canning the juice with benzoate of soda as a preservative loses much of the quality and, therefore, there is as yet no commercial processing.

**Food value per 100 g of edible portion**

| Nutrient            | Value  
|---------------------|--------
| Calories            | 25     
| Moisture            | 92.0 g 
| Protein             | 0.6 g  
| Fat                 | 0.1 g  
| Carbohydrates       | 6.3 g  
| Fiber               | 0.3 g  
| Ash                 | 0.7 g  
| Calcium             | 4 mg   
| Phosphorus          | 20 mg  
| Iron                | 0.4 mg 
| Riboflavin          | 0.03 mg
| Niacin              | 2.5 mg 
| Ascorbic Acid       | 70 mg  

*Analyses made in Colombia.*

Draft for comments only — Not to be cited as East African Standard
Annex E
(informative)

Passion fruit — Codex, EU and USA pesticide residue limits

Users are advised that international regulations and permissible Maximum Residue Levels (MRL) frequently change. Although this International MRL Database is updated frequently, the information in it may not be completely up-to-date or error free. Additionally, commodity nomenclature and residue definitions vary between countries, and country policies regarding deferral to international standards are not always transparent. This database is intended to be an initial reference source only, and users must verify any information obtained from it with knowledgeable parties in the market of interest prior to the sale or shipment of any products. The developers of this database are not liable for any damages, in whole or in part, caused by or arising in any way from user's use of the database.

Results Key
MRL values in (italics) are more restrictive than US --- indicates no MRL value is established.
Cod, EU, etc. indicates the source of the MRL and EXP means the market defers to the exporting market.
All numeric values listed are in parts per million (ppm), unless otherwise noted

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>Cod</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azoxystrobin</td>
<td>2</td>
<td>---</td>
<td>EU 7</td>
</tr>
<tr>
<td>1. European Union does not maintain a specific MRL for the Azoxystrobin/Fruit, Passion combination, but does maintain an MRL of 0.05 PPM for its &quot;Inedible peel, small&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bifenazate</td>
<td>0.9</td>
<td>---</td>
<td>EU 2</td>
</tr>
<tr>
<td>2. European Union does not maintain a specific MRL for the Bifenazate/Fruit, Passion combination, but does maintain an MRL of 0.01 PPM for its &quot;Miscellaneous fruit&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buprofezin</td>
<td>0.3</td>
<td>---</td>
<td>EU 3</td>
</tr>
<tr>
<td>3. European Union does not maintain a specific MRL for the Buprofezin/Fruit, Passion combination, but does maintain an MRL of 0.01 PPM for its &quot;Inedible peel, small&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carfentrazone-ethyl</td>
<td>0.1</td>
<td>---</td>
<td>EU 4</td>
</tr>
<tr>
<td>3. European Union does not maintain a specific MRL for the Carfentrazone-ethyl/Fruit, Passion combination, but does maintain an MRL of 0.01 PPM for its &quot;Inedible peel, small&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorothalonil</td>
<td>0.2</td>
<td>---</td>
<td>EU 5</td>
</tr>
<tr>
<td>4. European Union does not maintain a specific MRL for the Chlorothalonil/Fruit, Passion combination, but does maintain an MRL of 0.01 PPM for its &quot;Inedible peel, small&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glyphosate</td>
<td>0.2</td>
<td>---</td>
<td>EU 6</td>
</tr>
<tr>
<td>5. European Union does not maintain a specific MRL for the Glyphosate/Fruit, Passion combination, but does maintain an MRL of 0.1 PPM for its &quot;Inedible peel, small&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>0.1</td>
<td>---</td>
<td>EU 7</td>
</tr>
<tr>
<td>6. European Union does not maintain a specific MRL for the Imidacloprid/Fruit, Passion combination, but does maintain an MRL of 0.05 PPM for its &quot;Inedible peel, small&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malathion</td>
<td>0.2</td>
<td>---</td>
<td>EU 8</td>
</tr>
<tr>
<td>7. European Union does not maintain a specific MRL for the Malathion/Fruit, Passion combination, but does maintain an MRL of 0.02 PPM for its &quot;Miscellaneous fruit&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methoxyfenozide</td>
<td>0.2</td>
<td>---</td>
<td>EU 9</td>
</tr>
<tr>
<td>Paraquat dichloride</td>
<td>0.2</td>
<td>(0.01)</td>
<td>EU 10</td>
</tr>
<tr>
<td>8. Codex does not maintain a specific MRL for the Paraquat dichloride/Fruit, Passion combination, but does maintain an MRL of 0.01 PPM for its &quot;Assorted tropical and sub-tropical fruits - inedible peel&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyriproxyfen</td>
<td>0.1</td>
<td>---</td>
<td>EU 11</td>
</tr>
<tr>
<td>10. European Union does not maintain a specific MRL for the Pyriproxyfen/Fruit, Passion combination, but does maintain an MRL of 0.05 PPM for its &quot;Miscellaneous fruit&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinetoram</td>
<td>0.3</td>
<td>---</td>
<td>EU 12</td>
</tr>
<tr>
<td>11. European Union does not maintain a specific MRL for the Spinetoram/Fruit, Passion combination, but does maintain an MRL of 0.05 PPM for its &quot;Miscellaneous fruit&quot; group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinosad</td>
<td>0.3</td>
<td>---</td>
<td>EU 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
</tr>
</tbody>
</table>

© EAC 2010 — All rights reserved