Papaya Evaluation Handbook

Productivity and fruit quality traits

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Introduction

Productivity traits and visual appearance are the first quality determinants made by growers, wholesalers, retailers or consumers. After consulting with a reference group of papaya growers, breeders and marketers from Queensland, important traits which should be considered in applied papaya breeding were identified. They include those relating to a tree's productivity: total saleable yield, consistent fruit set over time (i.e. no yield gap), consistent fruit size, ease of harvest and disease resistance, and to fruit quality traits: appearance, fruit shape, flesh colour, sweetness and flavour. These traits are varied and quantitatively expressed in papaya germplasm.

Papaya fruit evaluation was developed by IBPGR in 1988. The keybook could be outdated and some traits may need to be included for evaluation in breeding and selection, especially for Australian market. We also would like to develop an evaluation procedure for providing reference for routine selection. Information in this handbook is referred in IBPGR (1988) and Kanchana-udomkan (2015) and is provided by experienced growers, researchers, breeders and marketers.

Objectives

The main objective of this handbook is to develop a standard protocol to evaluate papaya tree productivity and fruit quality for robust, reliable and practical evaluation.

Overview

Evaluations of papaya trees are to be performed three times over the tree development. The list of traits to be assessed in each evaluation is presented in Table 1.

Table 1: List of traits for evaluation for papaya fruit quality and tree productivity.

No.	Tree age	Productivity traits	Fruit quality traits
1	5 months	Sex type Height to first marketable fruit Number of side shoots Trunk circumference Peduncle length	
2	10 months	Trunk circumference Peduncle length Saleable yield (number of saleable fruits) Yield gap Number of carpelloid fruit Fruit size (fruit length and fruit width) Cavity size (cavity length and cavity width)	Skin gloss Skin freckle Skin colour Fruit firmness Fruit shape Teat shape Stalk insertion Cavity shape Flesh colour Consistency in flesh colour Flesh thickness Flesh texture Flesh sweetness (°Brix)
3	15 months	Same as the 2nd evaluation	Same as the 2nd evaluation

Productivity traits

Sex type

Papaya trees were classed as either dioecious (male and female flowers on separate trees) or gynodioecious (hermaphrodite flower on the same tree)

Figure 1: Female flower

Figure 2: Hermaphrodite flower

Figure 3: Male flower

Height to first marketable fruit

Height to the first marketable fruit is measured in centimetre (cm) from the ground to the first marketable fruit

Figure 4: Measurement of height to the first marketable fruit

Trunk size

Trunk circumference is measured from 15 cm-height above the ground.

Figure 5: Measurement of trunk size

Number of side shoots

Side shoots are counted after the tree reaches its maturity (at 5 to 6 months after field planting). It is categorised in three groups by length of the side shoots.

Small = length of the side shoots is less than 5 centimetres

Medium = length of the side shoots is between 5 and 20 centimetres

Large = length of the side shoots is more than 20 centimetres

Figure 6: Side shoot of papaya

Figure 7: Three categories of side shoot, left: a small side shoot, middle: a medium side shoot, right: a large side shoot

Peduncle length

Peduncle or stem length is scored using the 1, 3 and 5 rating scale; where

1 = short peduncle (less than 3 cm),

3 = medium peduncle (between 3 and 5 cm) and

5 = long peduncle (greater than 5 cm).

Figure 8: Measurement of peduncle length

Figure 9: Three categories of peduncle length, left: short peduncle; middle: medium peduncle; right: long peduncle

Saleable yield

Saleable yield is estimated in kilograms (kg) by counting the total number of marketable fruits per tree within 45 cm column starting from the peduncle of the lowest fruit. Fruit weight of each tree is obtained from average fruit weight of three to five mature marketable fruits. Saleable yield for each tree is calculated using formula.

Saleable yield (kg) = number of fruits per tree x Average fruit weight (kg)

Figure 10: Yield on papaya trees. The white bars indicate the length of fruit column at 45 centimetre for counting number of saleable fruit.

Number of carpelliod fruits

Number of carpelliod fruits are counted within 45 cm column at the same time when evaluating saleable yield.

Figure 11: Carpelloid fruits

Yield gap

Yield gap is estimated by the pattern of fruit set of each tree and scored between 1 and 5; where there is

1 = no space observed between two harvesting times

3 = less than 50% of a fruit space between two harvesting times

5 = greater than 50% of a fruit space between two harvesting times

Figure 12: Gap of yield on papaya trees. Left: rating at 1 as there is no space on the fruit column; middle: rating at 3 for the gap on the fruit column less than 50%; right: rating at 5 for the gap on the fruit column less than 50%.

Fruit quality traits

Maturity and ripening stages

Maturity and ripening is rated the numeric system detailed below;

1 = mature green

2= 25% colour

3 =50% colour

4 =75% colour

5 = full ripe

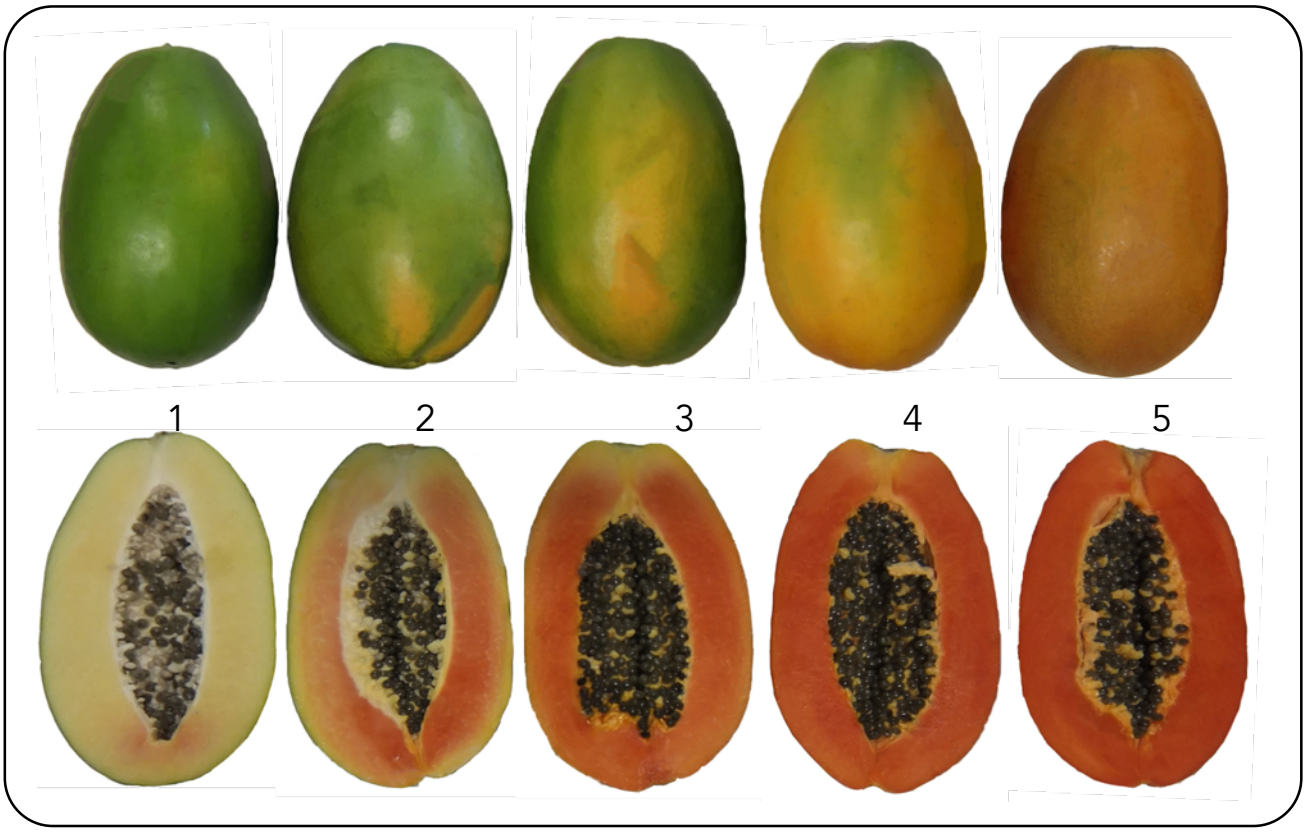

Figure 13: Five fruit maturity and ripening stages

Fruit size

Fruit size is assessed by weight (kg) and by measuring the length (cm) and diameter (cm) of the middle part of the papaya fruit.

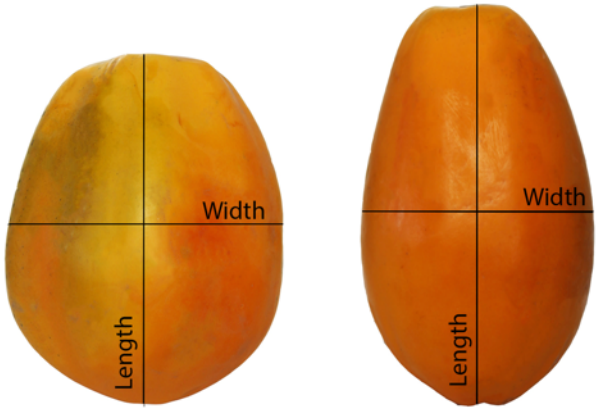

Figure 14: Determination of fruit length and width

Fruit shape

Papaya fruit is grouped into irregular shape, round shape and elongate shape. Each fruit is scored in numeric system as detail below:

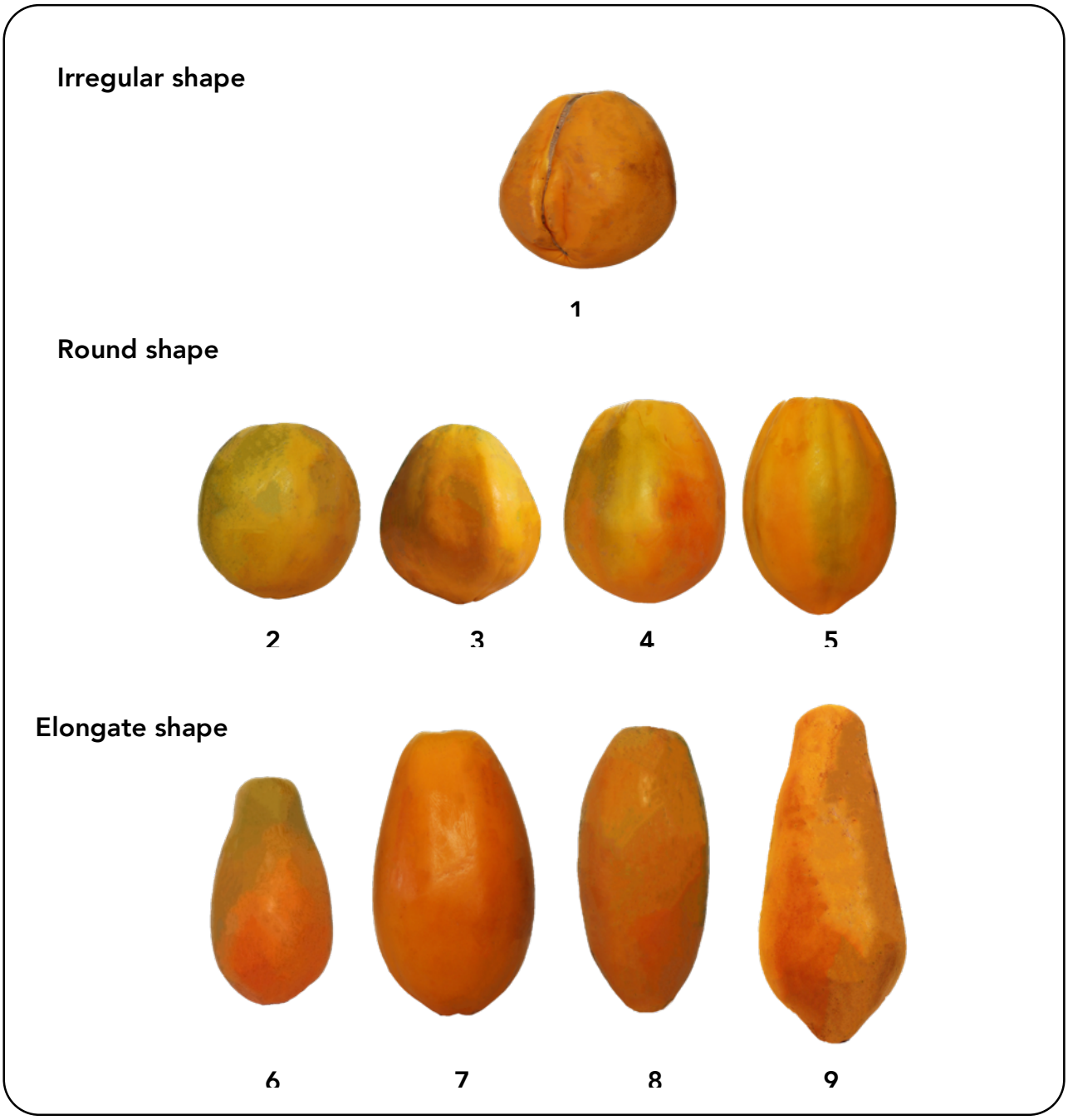

Figure 15: Rating for papaya fruit shape

Teat shape

Teat of each fruit is scored in numeric system as below

1 = blossom end defect

2 = sunken

3 = flat

4 = pronounced

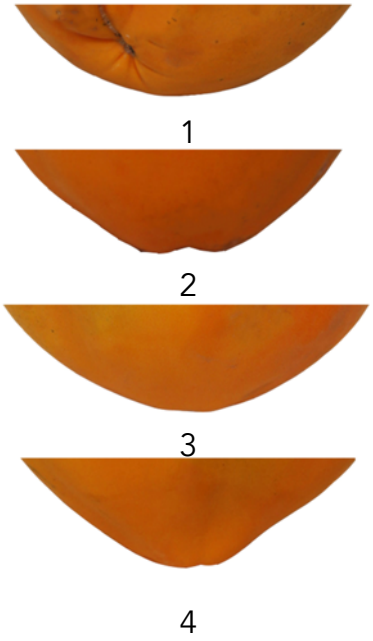

Figure 16: Rating for teat shape

Stalk insertion point

The insertion point of the stalk of each fruit is scored using the numeric system detailed below;

1 = depressed

2 = flattened

3 = inflated

4= pointed

Figure 17: Rating for stalk insertion point

Skin gloss

Skin gross is visually observed and scored using a rating system; where

1 = dull

2 = average

3 = glossy

4 = very glossy/ excellent skin quality

Figure 18: Rating for skin gloss

Skin freckle

Skin freckle or winter spots are observed on mature fruits at the ripe full colour stage. The severity of freckle is recorded using a rating system of 0 to 4 where

1 = winter spots cover less than 1% of the surface

2 = winter spots cover 1% to 25%

3 = winter spots cover 26% to 50%

4 = winter spots cover 51% to 75%

5 = winter spots cover more than 75%.

Figure 19: Rating for skin freckle

Skin colour

Skin colour was visually observed and recorded using a numeric rating system as detailed:

1 = light green

2 = green

3 = dark green

4 = green/slight yellow

5 = yellow/slight green

6 = yellow-orange

7 = orange

8 = orange-red

9 = red

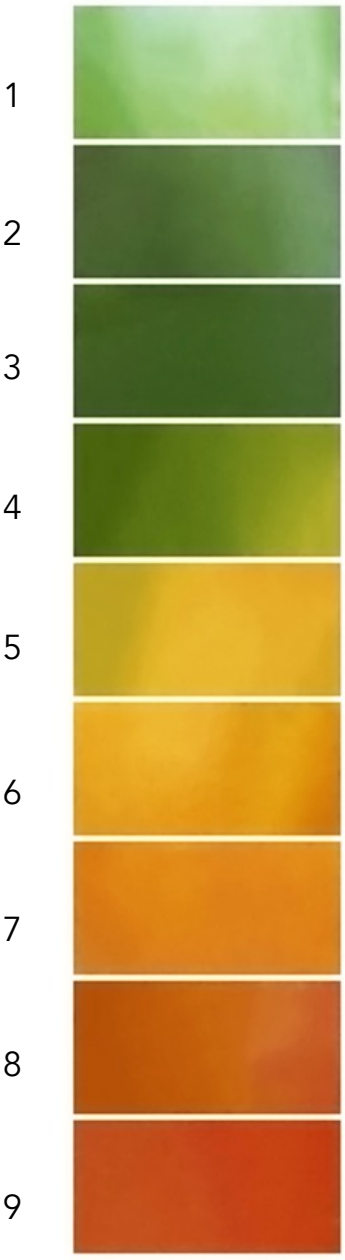

Figure 20: Rating for skin colour

Fruit firmness

Fruit firmness is assessed at ready to eat stage by using a firmness tester and by hand pressure at the centre of the fruit.

Firmness tester

Measure fruit firmness at 2-4 points at the centre of the fruit. Using an 8-millimetre pin and record pressure force against fruit surface.

Hand pressure

Fruit is assessed by holding a fruit with both hands and pressing centre fruit with the thumps and rating the firmness as

1 = soft

2 = intermediate/ rubbery

3 = firm/hard

Figure 21: Evaluation of fruit firmness, rating by using thumb pressure.

Flesh texture

Flesh texture is assessed at ready to eat stage by using a firmness tester and mouth feel.

Firmness tester

Each fruit is cross-sectioned and 2-4 points at the centre of the fruit. Using an 8-millimetre pin and record pressure force against flesh.

Mouth feel

Fruit sample is cut into a small cube and the flesh texture is assessed by mouth sensory to score as

1 = soft texture

2 = intermediate/ rubbery

3 =firm

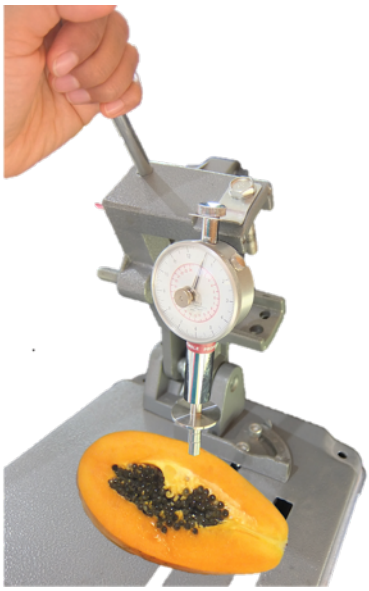

Figure 22: Evaluation of flesh texture using a penetrometer (firmness tester).

Cavity shape

Each fruit is cross-sectioned laterally. The central cavity of each fruit is scored as detailed below;

1 = round

2 = angular or pentagon

3 = slightly star or star

4 = flower

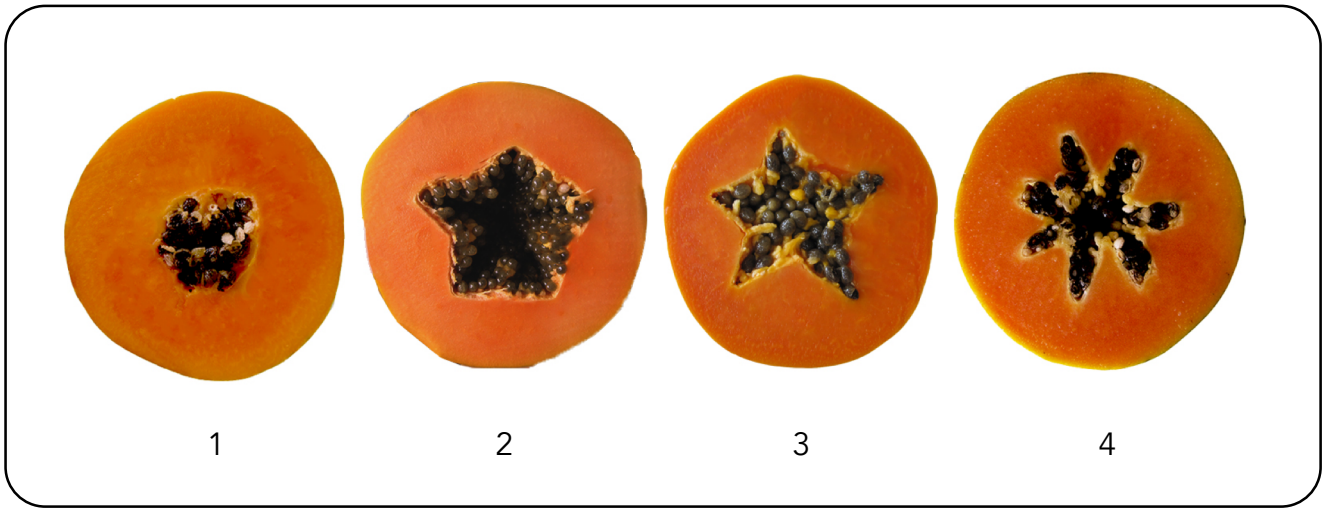

Figure 23: Rating for cavity shape

Cavity size

Cavity size is measured at the central cavity of each fruit. Cavity length (cm) and width (cm) are measured between one flesh wall to another.

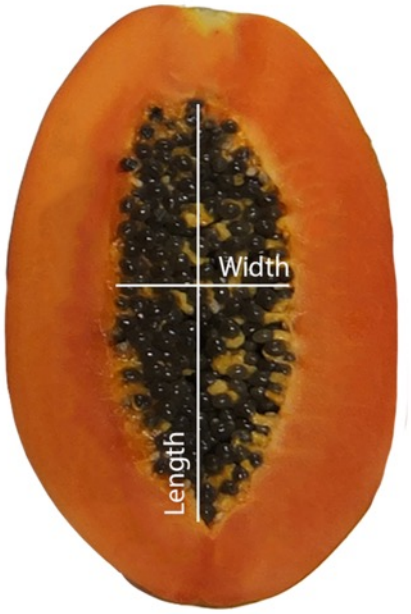

Figure 24: Measurement of cavity size

Flesh colour

Each fruit is cross-sectioned in half laterally, and scored for flesh colour as

1 = white

2 = creamy white

3 = slight pink

4 = pale yellow

5 = yellow

6 = yellow-orange

7 = orange

8 = orange-red

9 = red

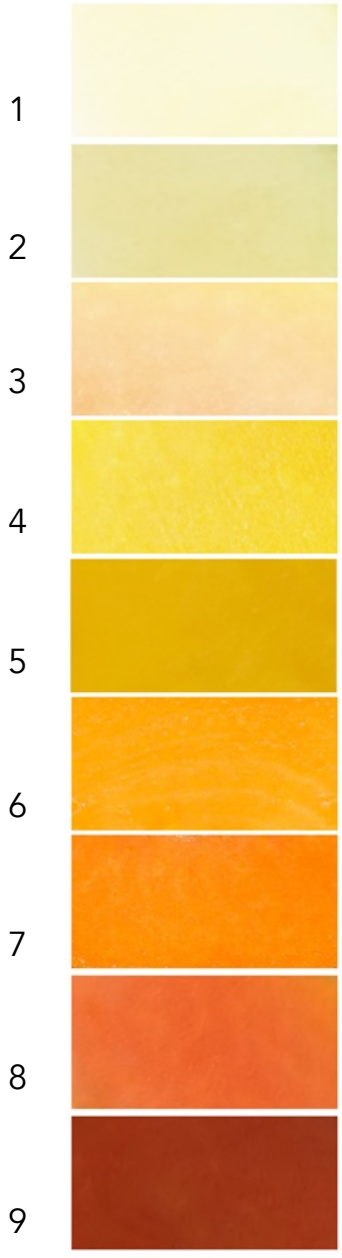

Figure 25: Rating for flesh colour

Consistency in flesh colour

Each fruit is cross-sectioned in half laterally and scored for consistency of flesh colour as detailed in the numeric rating scale for consistency of flesh colour; where

1 = less than 50% colour consistency

2 = colour inconsistency is between 50-75%

3 = flesh colour is more than 75% consistency

Figure 26: Rating for consistency in flesh colour

Flesh thickness

Flesh thickness is measured in millimetres from the skin to the seed cavity

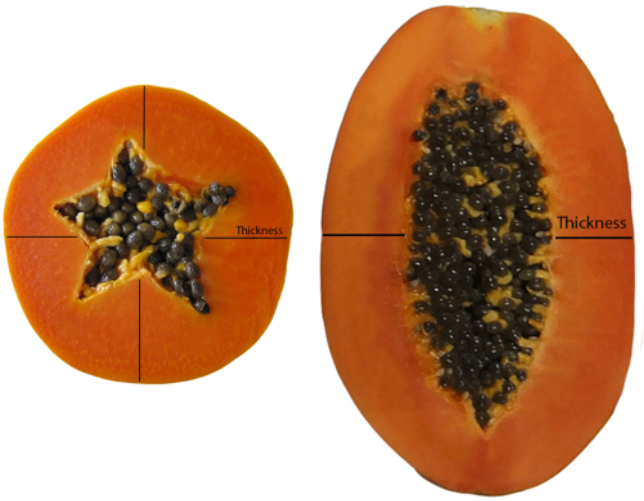

Figure 27: Measurement for flesh thickness

Flesh sweetness (Sugars)

Total soluble solids (SS) were measured on ripe fruits using a hand held refractometer. The measurement was recorded in a °Brix scale.

Figure 28: Measurement for flesh sweetness using a hand held refractometer

Flesh dry weight/moisture content

Flesh sample is sliced thinly for the dry weight/moisture content assessment. The container is weighted and about one gram of fresh flesh is placed in the container.

Record weight of container and weight of fresh flesh. Sample is dried in oven at 70 °C for 16 hour. Final weight of dried flesh and container is recorded. Dry weight and moisture content are calculated using the formula below.

Dry weight = Final weight - weight of container

% Dry weight = Dry weight/ weight of fresh flesh x 100

% Moisture content = (Fresh weight - dry weight) / weight of fresh flesh x 100

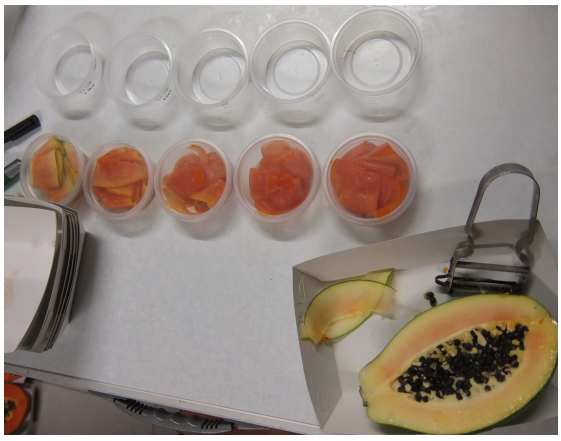

Figure 29: Fruit sample preparation for measuring flesh dry weight and moisture content

Fruit flavour

Each fruit was tasted at the ripe fruit stage. The details are described below;

Flavour

1 = No Flavour

2 = Nasturtium: bitter and off smell

3 = Musk: perfume-like

4 = Khaegdum: refreshing

5 = Solo: melon-like

Strength of flavour

1 = weak

2 = intermediate

3 = strong

Figure 30: Fruit sample preparation for tasting