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OECD GUIDANCE ON OBJECTIVE TEST TO DETERMINE QUALITY OF FRUITS AND VEGETABLES AND DRY AND DRIED PRODUCE

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GUIDANCE ON OBJEKTIVE TESTS FOR DETERMINING THE RIPENESS OF FRUIT

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GUIDANCE ON OBJEKTIVE TESTS TO DETERMINE QUALITY OF FRUITS AND VEGETABLES AND DRY AND DRIED PRODUCE

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GUIDANCE ON OBJEKTIVE TESTS TO DETERMINE QUALITY OF FRUITS AND VEGETABLES AND DRY AND DRIED PRODUCE

objective measurable ripeness parameter to

- determine the correct point for harvesting
- determine the optimal point for selling
- assist the inspection body

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Marketing Standards:

Minimum requirements

The produce must be **sufficiently developed**, and **display satisfactory ripeness**, depending on the nature of produce.

The development and condition of the *produce* must be such as to enable them:

- to withstand transport and handling, and
- to arrive in satisfactory condition at the place of destination.

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Maturity requirements

Objective measurable ripeness parameter which are specified in some marketing standards:

- sugar content (refractometric index)
- juice content
- firmness (penetrometric index)
- dry matter content
- colouring of skin
- sugar/acid ratio
- moisture content

Specified minimum parameters:

Produce	Parameter	UN/ECE	EU
Apples	°Brix	*9° / 10°* *(trial period till end of 2007)*	*(in discussion)*
Avocados	Dry matter content	21 / 20 / 19 %	21 / 20 / 19 %
Kiwi fruit	°Brix Dry matter content	6.2° / 9.5° 15 %	6.2° / 9.5° 15 %
Melons	°Brix	8° / 10°	8° / 10°
Peaches & nectarines	°Brix Firmness	*8°* *below 6.5 kg* *(trial period until Nov. 2006)*	8° below 6.5 kg

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Specified minimum parameters:

Produce	Parameter	UN/ECE	EU
Table grapes	°Brix Sugar/acid ratio	12° / 13° / 14° *trial period starting 2006:* *12° / 14°* *18 : 1*	12° / 13° / 14°
Water melons	° Brix	8°	8°
Hazelnuts	Moisture content	max. 12% whole nuts max. 7% kernels	max. 12% whole nuts max. 7% kernels
Walnuts	Moisture content	max. 12% whole nuts max. 7% kernels max. 20% fresh nuts	max. 12% whole nuts max. 7% kernels max. 20% fresh nuts

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Specified minimum parameters:

Citrus fruits

Parameter	species	UN/ECE	EU
Juice content	Lemons	20 / 25 %	20 / 25 %
	Mandarins	33 / 40 %	33 / 40 %
	Oranges	30 / 33 / 35 / 45 %	30 / 33 / 35 / 45 %
	Limes	42 %	(no standard)
	Grapefruits	33 %	(no standard)
° Brix	Grapefruits	9°	(no standard)
	Pummelos (Shaddock)	8°	(no standard)

Guidance will comprise the following testing methods:

Determination of

1. **TOTAL SOLUBLE SOLIDS or SUGAR (TSS)** by refractometer;
2. **FIRMNESS** of a fruit by penetrometer;
3. **FRUIT ACIDS** by titration and calculation of the **SUGAR/ACID RATIO**;
4. the **JUICE CONTENT**;
5. **DRY MATTER CONTENT** by laboratory reference method or microwave-oven quick method;

Guidance will comprise the following testing methods:

Determination of

5. **TOTAL SOLUBLE SOLIDS** by **VIS-NIR**;
6. the **STARCH CONTENT** of apples and pears using an iodine solution;
7. **SKIN COLOUR** by OECD colour gauges;
8. **the MOISTURE CONTENT** for dried fruits;
9. **the MOISTURE CONTENT** for dry fruit.

Guidance specifies the method for testing:

- Material (Instruments to be used)
- Checking, use and calibration of the instruments
- Sampling
- Sample preparation
- Measurement
- Results

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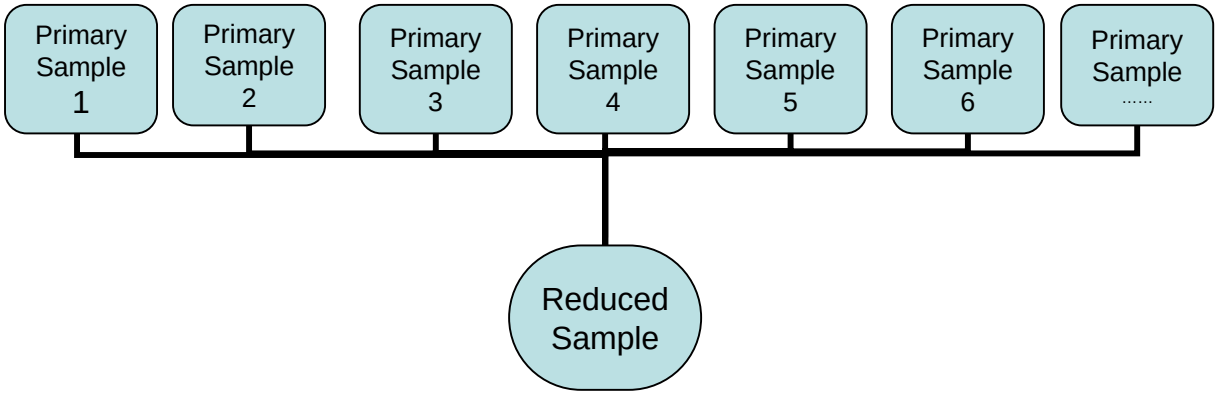
Sampling –

The sample has to be taken in accordance with the „**Operational Guidelines for the Control of the Quality of Produce exported under the SCHEME**“, Doc. AGR/CA/FVS(98)REV1.

No of packages:	No. of samples
Up to 100	5
101 – 300	7
301 – 500	9
501 – 1.000	10
over 1.000	15 (min.)

Bulk sample: Sum of individual samples



Reduced sample: max. 10% of the bulk sample

Sampling:

To evaluate the lot selected for inspection, take a sample of at least 10 fruits of each size at random from the reduced sample.

In case of small fruits (e.g. strawberries, cherries) take at least 4 fruits from 10 sales packages (at least 4 fruits from 10 primary samples if fruits are in bulk in the package).

However, fruits should be free from defects such as sun scorch and pest or disease damage, which may have affected the normal ripening process.

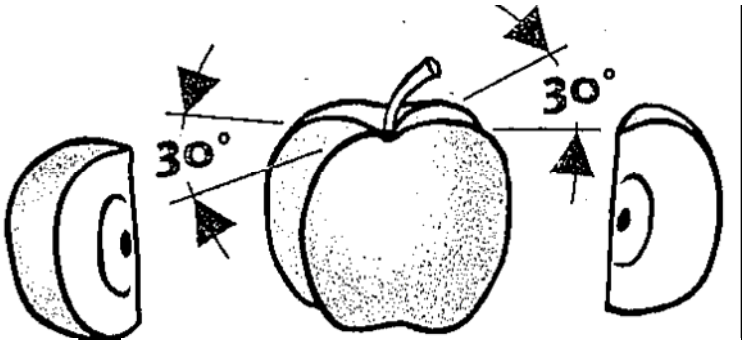
Sample preparation (e.g. refractometric index)

Where specific methods for sample preparation or juice extraction are given in marketing standards or OECD brochures, it should be followed.

In absence of such guidelines, sample preparation and the juice extraction should be done in following way:

e.g. Apples, pears, peaches/nectarines:

From each fruit two longitudinal slices (from stem end to calyx-end) are taken, one from the most coloured side and one from the opposite. The core is removed. The slice is squeezed longitudinally to get a mixture of juice from all regions.



Test by REFRACTOMETER – Sample preparation

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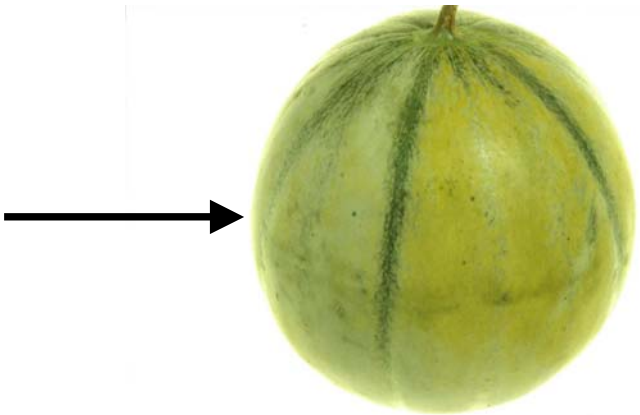
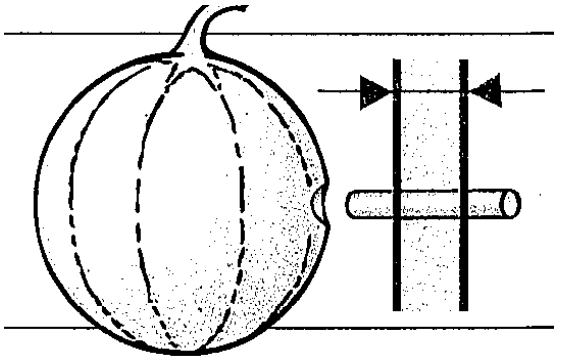
Kiwi fruit

Cut the stem and blossom ends at a distance of 15 mm from each end of the fruit and squeeze the two slices separately.

Test by REFRACTOMETER – Sample preparation

Melons:





Using a small diameter metal borer (1 – 4 mm) a core of melon should be extracted from the equatorial axis area. Each end of the core should be discarded, i.e. the skin and the flesh area immediately beneath it and also the soft pulpy seed area. The remaining flesh should be used to extract the juice testing.

Test by REFRACTOMETER – Sample preparation

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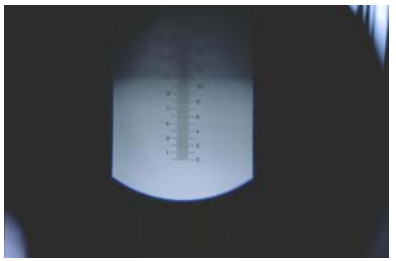
e.g. Watermelons
and alternative method for melons:







Two longitudinal slices (from stem end to calyx-end) are taken, one from the side that touched the ground during growth and one from the opposite side. From the middle of the slice a piece of fruit flesh is cut off, with the core and peel removed. The remaining flesh is squeezed to extract the juice for testing.

Test by REFRACTOMETER – Sample preparation

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Table grapes:

At least 5 berries are taken from each bunch or sales package at different places of the bunch or sales package.
These berries can be squeezed and tested individually or all together to get a mixture of juice from these berries. However, it is possible to squeeze the whole bunch.

Small fruits e.g. Strawberries, Cherries:

At least 5 fruits are taken from each primary sample or sales package at different places of the package. These fruits can be squeezed and tested individually or all together to get a mixture of juice from these fruits.

Citrus fruit:

Cut each fruit in half crosswise and squeeze to extract all the juice.

Test by REFRACTOMETER –Measurement

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e.g. Refractometer index:

An equal number of drops from the prepared fruit juice or the prepared fruit are placed onto the refractometer prism plate.

The reading on the prism scale is noted to one decimal place.

After each test the prism plate must be cleaned with (distilled) water and wiped dry with a soft tissue.

Test by REFRACTOMETER – Results

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Results:

- Record - the results, to one decimal place;
  - all details concerning method, variety, stage of maturity and ripeness.

- Each reading (individual fruit, bunch, primary sample ..) is noted.
  The sum total of all readings are averaged.

- If the juice is taken from two parts of the fruit (e.g. longitudinal slices, equatorial axis area, single berries)
  - in a first step, the two readings for each individual fruit are averaged;
  - in a second step the sum total of these readings should be averaged.

Test by REFRACTOMETER – Results

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Results - Interpretation:

- If the average readings of all fruit are equal to or greater than the limit:
  - the lot has reached the minimum maturity level.

- If the average readings of 3 or more of the 10 fruits are at least 10 per cent below the limit:
  - a second sample needs to be taken and analysed (with other fruits of the reduced sample or from a new sample).

- If the average of the two samples is at least 10 per cent below:
  - the lot fails the minimum maturity level and needs to be rejected. No tolerance is applied.

Firmness of a Fruit by PENETROMETER:

The firmness of a fruit is linked to the state of maturity and ripeness and may be influenced by the variety as well as the region of production and the growing conditions.

The penetrometer is used by producers, packers and distributors to help to determine the stage of ripeness of a fruit and by the retail trade to determine palatability for the consumer and shelf life for their own records.

The determination of firmness of a fruit by means of the penetrometer is based on the pressure necessary to push a plunger of specified size into the pulp of the fruit up to a specific depth.

Test by PENETROMETER – Sample preparation

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Penetrometers are available with dial gauges calibrated in both metric (kg) and imperial (lbs) measurements and can be obtained to cover different ranges of pressure suitable for measuring either soft or harder types of fruit, depending on the variety and the stage of ripeness of the produce to be tested.

- Particular care must be taken to ensure a smooth and uniform application of pressure when taking readings.

Test by PENETROMETER – Sample preparation

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Peaches & nectarines: (EC and UN/ECE Standards)

"In order to satisfy this requirement, the refractometric index of the pulp measured at the middle point of the fruit flesh at the equatorial section must be greater than or equal to 8° Brix and the firmness must be lower than 6.5 kg measured with a plunger of 8 mm diameter (0.5cm2) at two points of the equatorial section of the fruit, with the skin intact."

Sample Preparation:

From two opposite sides of the equatorial area of the fruit a disc of peel (only skin depth) of up to 2 cm² (¾ sq. ins) is removed.

Where fruit is of mixed colour, e.g. apples, the tests should be carried out where possible between the highest and the lowest coloured portion of the surface.

Test by PENETROMETER – Measurement

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- ✓ Hold the fruit firmly with one hand, rest it on a rigid surface, such as a table top or the plate at the base of the stand.
- ✓ Zero the penetrometer and place the plunger head against the flesh in the peeled area of the fruit. Apply steady downward pressure until the plunger has penetrated the flesh of the fruit up to the depth mark (half way up) on the plunger. Slow, steady pressure is essential as sharp uneven movements may give unreliable results. Remove the plunger and note the reading on the penetrometer dial, to one decimal place.
- ✓ Repeat the process on the opposite side of the same fruit after first zeroing the penetrometer.
- ✓ It is very important to conduct all tests as uniformly and carefully as possible in order to allow an accurate comparison of results.

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FRUIT ACID by titration and calculation of the SUGAR/ACID RATIO:

The Guidance describes in detail:

- ✓ Material
- ✓ Sampling
- ✓ Sample preparation
- ✓ Measurement - Methode using a coloured indicator and
  - Method using a pH meter
- ✓ Calculation of the Sugar/Acid Ratio

FRUIT ACID and SUGAR/ACID RATIO

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Calculation of the Sugar/Acid Ratio

As some products contain different acids the appropriate multiplication factor must be applied to each calculation.

Factor for:	- citric acid :	0.0064 (Citrus fruit)
	- malic acid :	0.0067 (Apples)
	- tartaric acid :	0.0075 (Grapes)

Using citric acid as an example, 1ml 0.1M NaOH is equivalent to 0.0064g citric acid.

Results expressed as percentage acid:

$$\text{Percentage acid} = \frac{\text{Titre x acid factor x 100}}{\text{10 (ml juice)}}$$

$$\text{The sugar acid ratio} = \frac{\text{°Brix value}}{\text{Percentage acid}}$$

Determination of the juice content:

Material

- Extractor or juice press (simple household press, citrus press, household centrifuge)
- Filter (muslin cloth, fine filter or strainer)
- Scale
- Beaker

Sampling

A sample of at least 2kg of fruits from the reduced sample.

Calculation of juice content

$$\text{Juice percentage} = \frac{\text{Total weight of juice (in g)} - \text{beaker weight (in g)} \times 100}{\text{Total weight of fruit (in g)}}$$

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DRY MATTER CONTENT by laboratory reference method or microwave-oven quick method

- The accepted method for determination of percent dry matter is drying the sample in a (vacuum) oven at 70 °C until consecutive weighings made at 2 h intervals vary by less than 3 mg (AOAC Methods 1980).
- Microwave drying technology has its merits due to its speed, simplicity, low cost, and repeatability, but it results in localised drying and gives a high variability in drying times dependant on power settings and sample type.
- The laboratory reference method shall be used in case of rejection and dispute.

Determination of Total Soluble Solids by VIS-NIR

To determine the optimum harvest date as well as fruit quality development in post-harvest period, rapid non-destructive sensing methods are available. Optical spectroscopy in visible (**VIS**) and near infrared (**NIR**) spectrum range have been successful for many years to study quality properties of agricultural products.

There exist many studies on food quality by using VIS-NIR spectroscopy analysing the reflectance and transmittance spectra of fresh fruit. It was concluded that it would be possible to predict simultaneously the contents of soluble solids, sugars and chlorophyll with a single spectrum from 400 to 1000 nm, which would allow to develop multidimensional predictors of consumer acceptance.

Determination of Total Soluble Solids by VIS-NIR

For the wavelength range from 400 to 1100nm very promising low-cost miniaturised spectrometer modules are commercially available with attached photometric sensors based on silicon. Therefore, this spectrum range is expected to be attractive for agricultural applications.

As the method described above is an indirect method to determine quality parameters, it is necessary to establish for each species, growing area, season and eventually variety a calibration curve adjusted to results obtained by appropriate laboratory reference methods.

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Determination of the STARCH CONTENT of apples and pears using an iodine solution

- Iodine turns a blue-black colour when it comes into contact with starch. As a fruit ripens more starch is converted to sugar, and the blue-black area becomes less prominent.

- This test is particularly suitable for fruit such as **apples**, and to a lesser extent to pears.
  - ☝ But it is useful only to determine the ripeness of fruit at harvest time.

  At the subsequent stages of marketing the starch content – even of underdeveloped and unripe fruit may have decreased without sufficient increase of ripeness.

STARCH CONTENT of apples and pears

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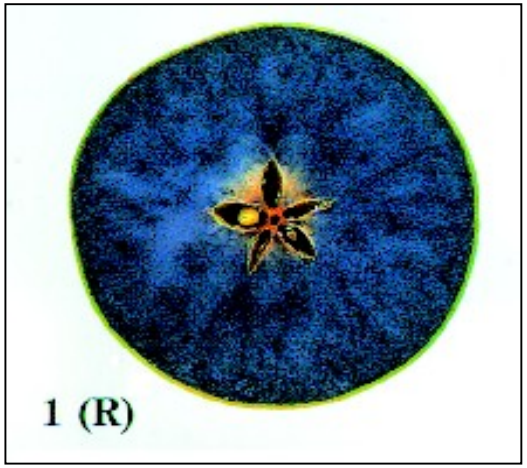
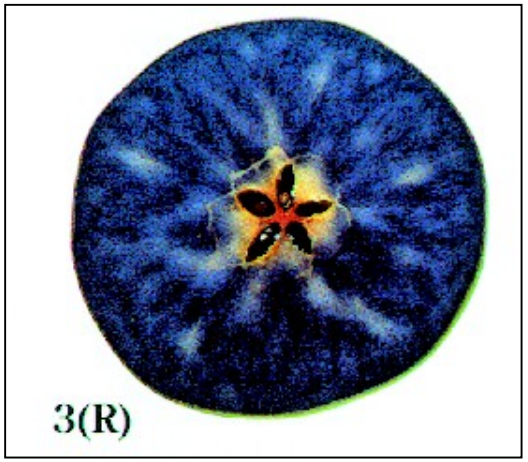
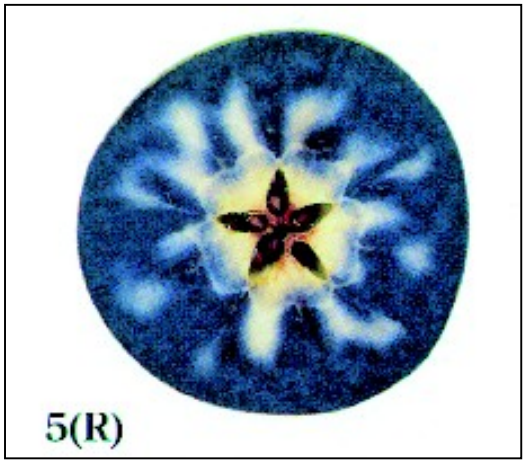
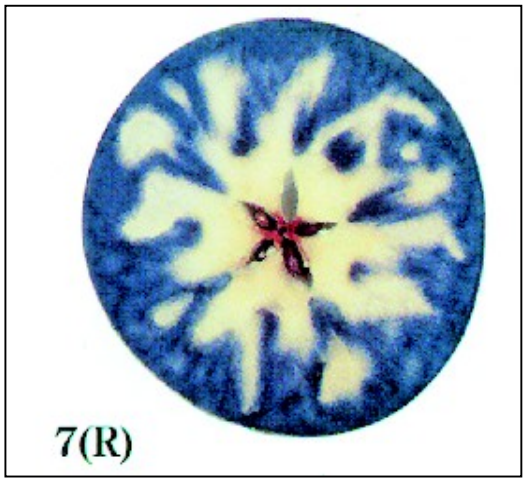
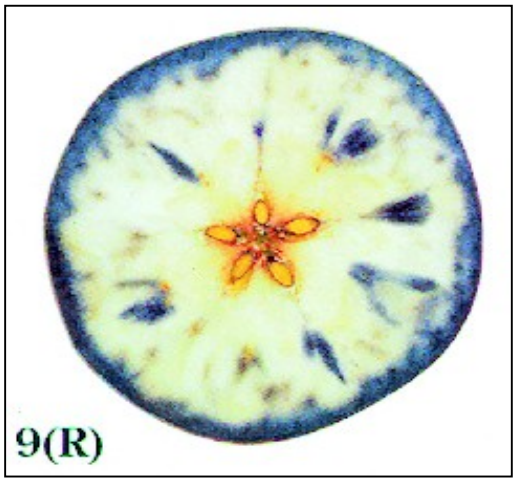
Starch conversion chart for apples (10 charts)

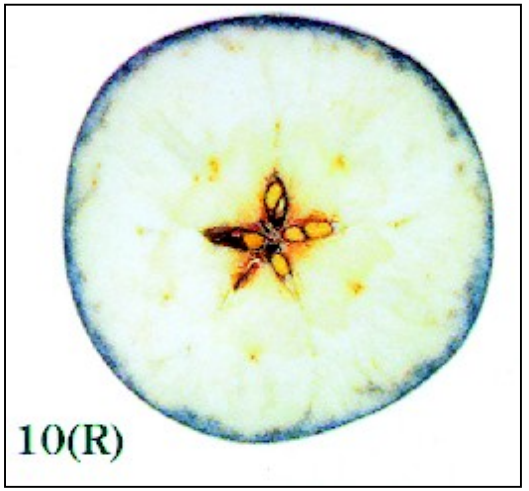






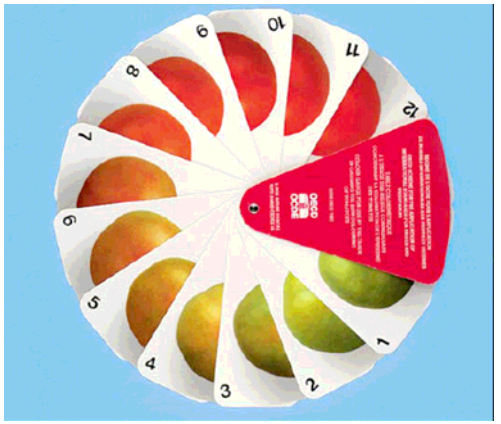






Determination of SKIN COLOUR by OECD colour gauges

- ✓ The colour of fruit skin is a good indicator to describe the ripeness of a fruit or uniformity concerning presentation.
- ✓ The use of colour gauges permits to define a colour stage or a range of colour stages to describe a certain grade of ripeness/maturity.
- ✓ To get an objective result different colour gauges are elaborated.



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Determination of the MOISTURE CONTENT for dried fruits and dry fruit

Dried fruits - as dried or desiccated apricots, figs, prunes, dates, grapes, apples, pears, etc.

Dry fruits - for inshell nuts and shelled nuts (kernels).

METHOD 1 - LABORATORY REFERENCE METHOD

METHOD 2: RAPID METHOD

as laid down in Annex I of standard layout for UNECE standards concerning the marketing and commercial quality control of dry and dried produce.

Thanks for your attention!

Questions?