

This paper guides the reader on basic testing equipment and methodology for long term storage of fruits. It talks about the two most important parameters which determine fruit quality: pressure and sweetness. The paper details usage of a penetrometer and a refractometer to measure values of the fruit. It also takes a real case of apple storage in controlled atmosphere conditions.

Fruit Testing during Long Term Storage

Specific Emphasis - CA Storage

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The Fruit Penetrometer

Introduction

Fruit firmness testing is a universally accepted measure of fruit quality and maturity. It can be used to help growers gauge when best to pick and ship their produce. A fruit penetrometer measures the force required to insert a plunger tip of a specific size into the flesh of a fruit. The fruit penetrometer can also be an effective tool used to help monitor fruit softening during storage.

There are countless variables which affect the appropriate firmness for harvest, such as plant variety, geographical location and temperature. Experience and consistency is important in establishing the best firmness value that applies to your specific set of variables

Table 1: Penetrometer model and Applications

Model no	Purpose	Diameter of tip	Fruits
GY-1	General Purpose	3.5 mm	Berries & Small Film Fruits
GY-2	Soft Fruit	3.5 mm	Soft Fruits: Citrus, Melons, Plums
GY-3 ¹	All Purpose	8 mm	Firm Fruits: Peaches, Tomatoes, Pears
GY-3 ²	All Purpose	11 mm	Apples & Harder Fruits

[Source: Operating manuals of Fruit penetrometer]

Table 2: Penetrometer model and Specifications

Model	Range	Diameter	Accuracy	Penetration depth	Size	Weight
GY-1	2-15 Kg/cm ³	3.5 mm	+0.1	10 mm	140x 60 x30mm	0.3 kg
GY-2	0.2-4 Kg/cm ³	3.5 mm	+0.02	10 mm	140x 60 x30mm	0.3 kg
GY-3	0.5 -12kg/cm ³ 1-24 kg/ cm ³	8 mm 11 mm	+0.1	10 mm	140x 60 x30mm	0.3 kg

[Source: Operating manual of Fruit penetrometer]

¹This model is being used at M/S Kailash Agro Private Limited

²This model is being used at M/S Kailash Agro Private Limited

Operating the Penetrometer

The followings things need to be followed before using the penetrometer:

1. Move the plunger in and out for 10 seconds to ensure the mechanism functions freely
2. Turn the small knob at the top right hand side of the meter to loosen faceplate and adjust starting value
3. Tighten again before use

For best results select a random sample of 15 to 25 fruits of uniform size and temperature of the variety to be tested.

Caution: Testing should always be done at room temperature, hence please wait till the fruit being tested attains room temperature after having taken it out of the chamber. Conduct test only once the fruit attains room temperature naturally.

The procedure of carrying out the test varies as per the type of fruit:

For large fruits: Remove a portion of skin on opposing sun and shade cheeks of the fruit midway between the stem and bottom

For small fruit: It is unnecessary to remove the skin. Make a puncture test on only one cheek halfway between the stem and the bottom. Penetration should be sufficient to obtain a reading.

Note: With the penetrometer upright, secure the fruit against a hard surface or in your hand and force the tip vertically into the pulp at a slow, uniform speed. The tip should penetrate to the scribed line (1 cm). Record the reading. The trailing pointer will indicate the highest resistance point tested.

Note: We recommend that one person should test the entire sample lot

Maintenance of the Penetrometer

The maintenance of these devices starts the moment test is completed. The following steps needs to be followed:

- Clean the penetrometer tips
- Clean the exposed gauge load shaft by flushing with water. To do this, carefully hold the gauge with the load shaft pointing down under a gentle stream of water for 15 seconds.
- Dry with a towel and allow drying further by leaving it with shaft pointing down.
- The penetrometer should never be lubricated with oil as this will affect the plunger friction and decrease instrument accuracy

The Handheld Refractometer

Introduction

The Hand-held refractometer is a precision optical instrument. It helps us in knowing the concentration of the liquids. In Food industry it is generally used to know the sugar level in the fruits. New devices are coming with the feature of ATC (Automatic Temperature Compensation)

Features of the device are:

- i. Easy and very convenient to use
- ii. Competitive Price
- iii. High Quality, Accurate testing result
- iv. ATC Compensation Range: from 10⁰C to 30⁰C (only in the models with ATC function)

Table 3: Refractometer model and Specifications:

S.no	Model	Range	Min div.	Accuracy
1	RHB-10/ATC	0-10% Brix	0.1% Brix	±0.10%
2	RHB-18/ATC	0-18% Brix	0.1% Brix	±0.10%
3	RHB-32/ATC ³	0-32% Brix	0.2% Brix	±0.20%
4	RHB-62/ATC	28-62% Brix	0.2% Brix	±0.20%
5	RHB-82/ATC	45-82% Brix	0.5% Brix	±0.50%
8	RHB0-50	0-50 % Brix	1 % Brix	±1%
9	RHB0-80	0-80 % Brix	1 % Brix	±1%
10	RHB0-90	0-90 % Brix	0.2 % Brix	±0.2%

[Source: Operating manual of Westover make Handheld Refractometer]

Note: For any new style or feature model, “N” will be added in the model name, such as RHBN-32ATC etc.

³ This model is being used by Kailash Agro (P) Ltd.

Fig 1: Refractometer Model RHB-32ATC



- 1 - Day Light Plate
- 2 - Calibration Screw
- 3 - Focus adjustment
- 4 - Eyepiece

Operating a Refractometer

Calibration

Before using a refractometer it is important to calibrate the device please find below a stepwise guide on calibration:

- i. Aim the front end of the Refractometer to the direction of the bright light, and adjust the eyepiece until the reticle can be seen clearly
- ii. Adjustment of Null:
 - a. Open the daylight plate and place 2-3 drops of distilled or R.O water on the main prism
 - b. Close the daylight plate and press it lightly so the water spreads across the entire surface of the prism without any air bubbles or dry spots and allow the sample to remain on the prism for approximately 30 seconds.
 - c. Adjust the calibration Screw until the light/dark boundary coincides with the null line. Adjustment of refractometer with temperature compensation function should be made under the condition of 20⁰ C (68⁰F) environment temperature.

Testing the Fruit

The following steps need to be followed:

- i. Open the daylight plate
- ii. Clean the surface of prism by soft cloth
- iii. Drop 2-3 drops of fruit juice on the main prism

- iv. Close the daylight plate and press it lightly, then read the corresponding scale of light/dark boundary. The reading is the Brix value of the measured solution
- v. After measurement, clean away the solution on the surface of the prism and daylight plate by moist cotton cloth. The prism easily gathers mold, so to keeping it dry is important.

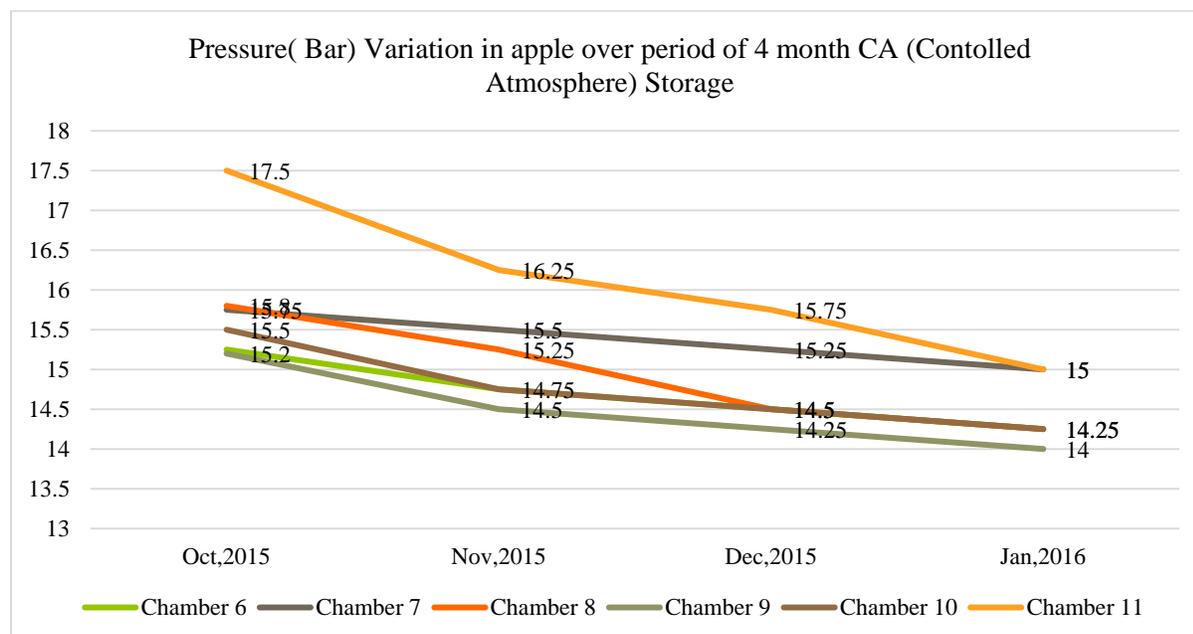
Maintenance of the Refractometer

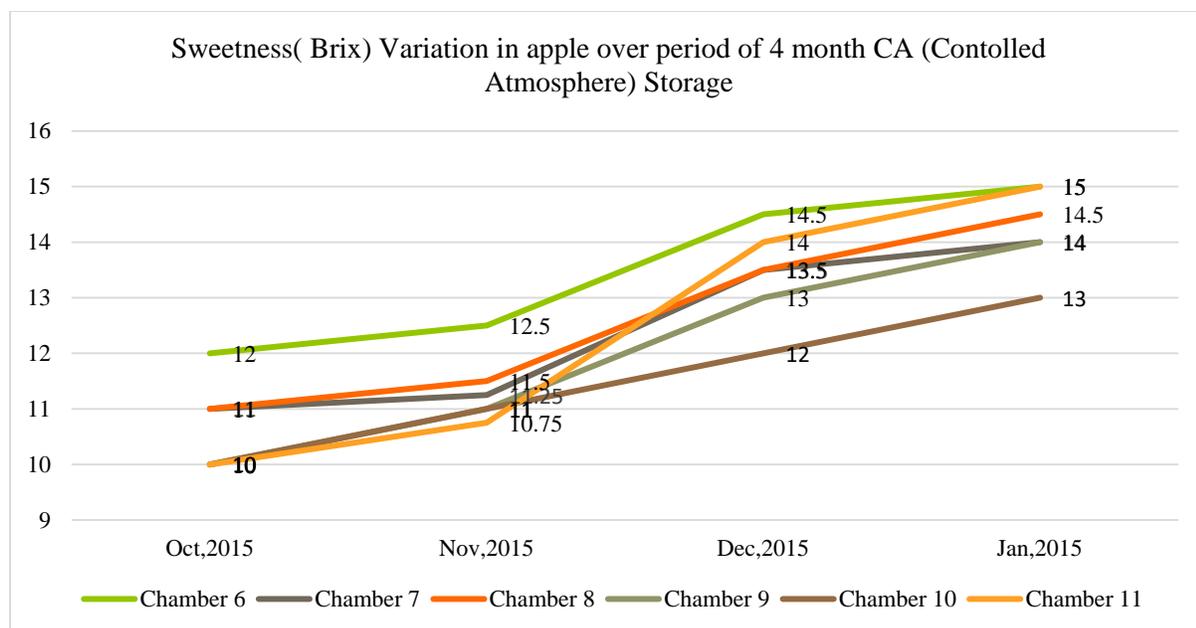
The following measures should be adopted for effective maintenance of the device

- i. To insure testing accuracy, recalibration occasionally is used to maintain accuracy.
- ii. Adjustment of Null: Liquid and Specimen should be under the same temperature. If the temperature varies greatly, the null point should be adjusted once every 30 minutes.
- iii. After usage, do not use water to wash the instrument, so as to prevent water from entering into the instrument.
- iv. Handle gently. Do not touch or scratch the optical surfaces.
- v. Keep instrument in an environment of dry, clean and non-corrosive air.

Actual Test Results and Analysis

Apples at M/s Kailash Agro were stored from October, 2015 through April, 2016 under well-defined CA conditions of 1-2⁰C temperature and 90-95 % relative humidity. Below mentioned are the graphs showing pressure variation in the apple stored under CA conditions followed by sweetness variations.





Apart from showing a regular behavior of temperature and pressure variation the results also help determine:

- i. Correct time for opening CA chambers with respect to ideal pressure and sweetness of fruit to fetch the best price.
- ii. A smooth variation in pressure and sweetness reinforces the effectiveness of storage conditions in the chamber i.e. proper gas tightness, no leakages, proper air circulation and a well-defined storage and stacking pattern.

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