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Methods for Determining Quality of Fresh Commodities

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VISUAL

The visual appearance of fresh fruits and vegetables is one of the first quality determinants made by the buyer whether the wholesaler, retailer or consumer. Often the appearance of the commodity is the most critical factor in the initial purchase (in addition to price) while subsequent purchases may be more related to texture and flavor.

Color

We perceive color when light reflected off the fruit or vegetable's surface falls upon the eye's retina; there is no color without light. Color perception depends on the type and intensity of light, chemical and physical characteristics of the commodity, and the person's ability to characterize color. Evaluating color can be subjective or objective:

Subjective: The human eye is used to evaluate color.

Advantages:

1. Faster and easier than objective measures.
2. Requires no specialized equipment.
3. Color charts or guides can be used as references for matching and describing colors as in bananas, nectarines and tomatoes.

Disadvantages:

1. Results can vary considerably due to human differences in color perception and human error.
2. Available light quantity and quality can influence color perception.

Objective: An instrument is used to provide a specific color value based on the amount of light reflected off the commodity surface or the light transmitted through the commodity.

Advantages:

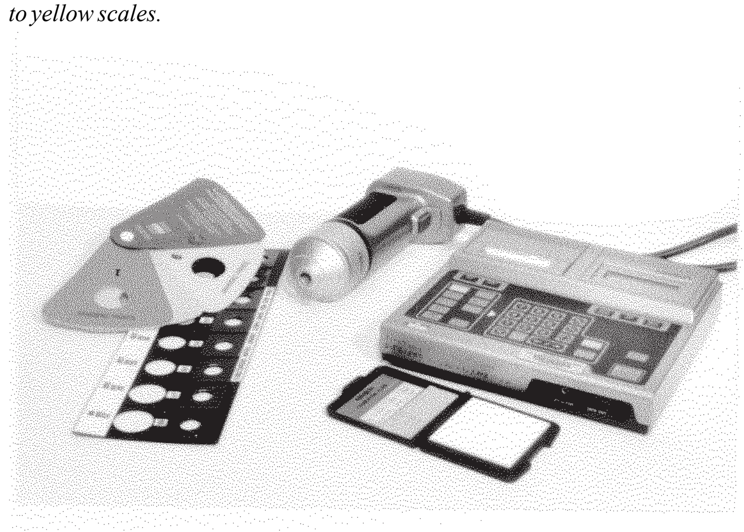
1. Less variability in color measurement.
2. Can measure small differences in color accurately.
3. Can be automated on the packingline.
4. Portable hand-held units are available (fig. 1).

Disadvantages:

1. Requires specialized equipment at a significant cost.
2. May be slower than subjective evaluation.

Subjective scoring of color may be more practical and faster and values can be referenced to objective color values and to pigment concentrations. For small leafy tissues, for example, samples representative of a 5 point color scale are evaluated for objective color values and chlorophyll and carotenoid concentrations. Routine evaluations are done by subjective scoring, but referencing to objective measurements adds valuable information to the scores.

Figure 1. *Determination of commodity color can be accomplished subjectively through the use of comparative color charts or objectively with a Minolta Colorimeter. Color charts can be very effective and useful if the colors truly match the color change in the commodity of interest. The Minolta Colorimeter can detect small differences in color and provides separate values for lightness to darkness, green to red and blue to yellow scales.*



Color Notation:

Hue: Red, yellow, green, blue, purple or intermediate colors between adjacent pairs of these basic colors, e.g. RY, YG, GB, BP.

Value of lightness: The degree to which an object is judged to reflect more or less light than another object.

Chroma or saturation: The degree of departure from the gray of the same lightness.

Gloss

Gloss is a visual aspect of quality that depends on the ability of a surface to reflect light. Products that are freshly harvested often have a bright, glossy surface and this appearance factor can be greatly reduced with weight loss and other postharvest handling conditions. There are small portable instruments from Minolta and BKY Gardner for measurement of gloss.

Shape & Size

Uniform and characteristic shape are important quality characteristics. Misshapen products may be more susceptible to mechanical injury and are generally avoided by consumers. Another example where shape is important is for broccoli. For the fresh market, compact broccoli florets are desirable while for fresh-cut, space between the florets is important to allow for cutting without injury. Size of product can also be important depending on its intended use. Consumers tend to associate large size with higher quality and view larger fruit as more mature.

A subjective evaluation of size and shape can be conducted on incoming product once the desirable and undesirable characteristics are determined. Size and shape charts are available for various commodities and weight is a fairly accurate measure of product size. The percentage of product which does not meet the desired characteristics can be recorded.

Absence of Defects

The product should be evaluated for the presence of defects. The level of tolerance for each type of defect such as cuts, bruises, disease, low-temperature injury, and physiological disorders should be determined. During quality evaluation, the percentage of fruit with each class of defect can be determined as a guide to overall product quality. A scoring system (such as 1 = none, 2 = slight, 3 = moderate, 4 = severe, and 5 = extreme) can be used to describe the incidence and severity of defects.

FIRMNESS

Firmness, or the degree of softness or crispness, is often measured using objective instruments. Subjective measure of firmness with the fingers can be useful for quick measures of gross differences in firmness, particularly of soft products.

Instruments

There are several firmness testers available including:

1. Magness-Taylor pressure tester - slide rule-type, spring-loaded penetrometer.
2. Effe-gi fruit penetrometer - hand-held probe with gauge for pounds-force.
3. Effe-gi penetrometer mounted on a drill-press stand.
4. UC Fruit Firmness Tester - Ametek penetrometer mounted on a drill-press stand.
5. Deformation Tester - determines deformation force for soft fruit.

Instruments #1 through 4 measure penetration force; instrument #5 measures deformation force and may be used for some fruits, such as tomatoes, papayas, and pears. Photos of some of these instruments can be seen in Figures 2 and 3.

The probes used in the instruments described above can also be mounted on computerized texture analyzers, which eliminate much operator variability. This allows not only determination of maximum force values, but also a texture profile. For example, a texture profile can show differences in the texture of chilled and nonchilled products.

Figure 2. *The most common way to measure firmness is resistance to compression or pounds-force (lbf.). There are three basic types of penetrometers available. The original Magness-Taylor has a slide-rule type device for measuring lbf. and is reliable, but bulky and heavy. The Effe-gi penetrometer is lightweight and easy to carry with an easy to read dial. Mounting the force guage on a drill-press stand, as seen in the UC Firmness Tester, increases the potential accuracy of results. Remove the peel before compression unless the peel is the tissue of interest for firmness measurement (usually is not).*

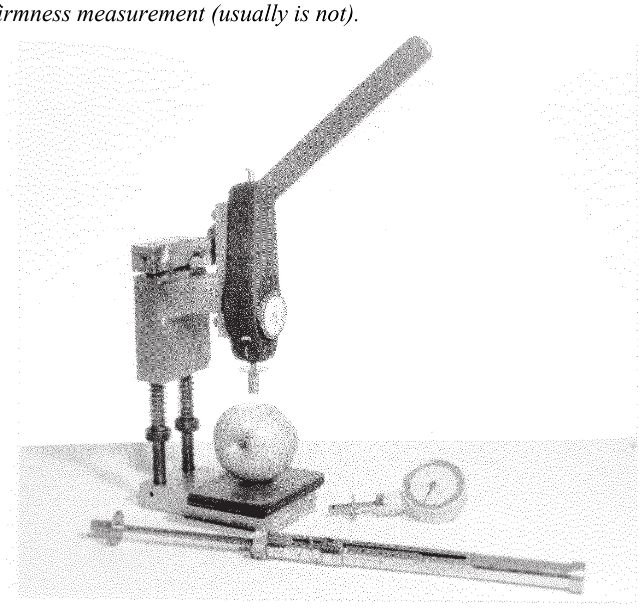


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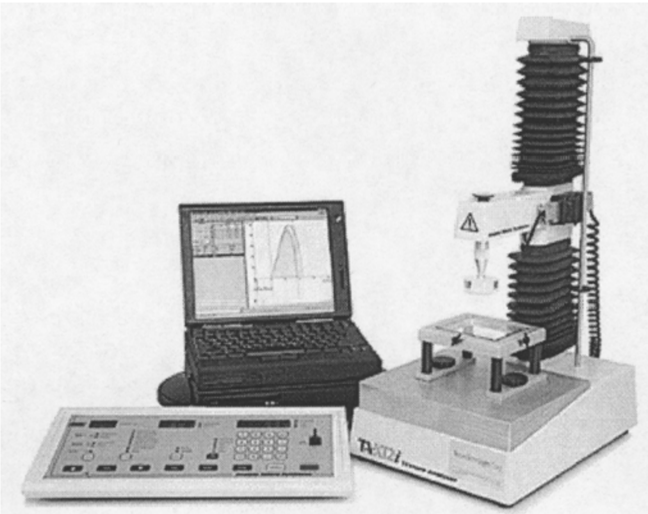
***Figure 3**. Texture Analysis system from Texture Technologies Corp.*



Sample Size and Selection for Firmness

1. Select a random sample of product from several representative boxes including at least 15 to 25 fruits or vegetables or 3% of the sample.
2. Select product with a uniform size to avoid variation in firmness due to size (large fruit are usually softer than smaller fruit).
3. Make sure all fruit tested are comparable in temperature since warm fruit are usually softer than cold fruit.

Proper Use of Firmness Testers

1. Make 2 puncture tests per fruit (except very small fruit), once on each opposite cheek, midway between the stem and blossom end on sun and shade sides; avoid sunburned areas.
2. Remove a disc (larger than the tip to be used) of the skin with a vegetable peeler or sharp knife.
3. Use an appropriate tip (plunger), see Table 1, for each commodity.
4. All determinations for a given lot should be made by one person to minimize variability.
5. Hold the fruit against a stationary, hard surface and force the tip into the fruit at a uniform speed (take 2 seconds).
6. Depth of penetration should be consistently to the scribed line on the tip.
7. Record reading to the nearest 0.5 lb-force or 0.25 kg-force.

***Table 1.** Recommended tip sizes for firmness measurements.*

Tip size	Commodities
11 mm (7/16-inch)	Apple
8-mm (5/16-inch)	Apricot, avocado, kiwifruit, mango, nectarine,papaya, peach
3-mm (1/8-inch)	Cherry, grape, strawberry
1.5-mm (1/16-inch)	Olive

Proper Units for Firmness

It is inappropriate to use the term "pressure" in association with firmness measurements using the devices described above. While pounds-force or kg-force are preferred in the industry, Newton (N) is the required unit for scientific writing. The conversion factors are as follows:

pound-force (lbf) x 4.448 = Newton (N)

kilogram-force (kgf) x 9.807 = Newton (N)

Maintenance of Firmness Testers

1. Before use each day, work the plunger in and out for 10 seconds to loosen up the springs inside the instrument.
2. Clean the tips after use to prevent clogging of the mechanism with juice.

Calibration of Firmness Testers

1. Hold the firmness tester in a vertical position and place the tip onto the pan of a scale.
2. Press down slowly on the firmness tester until the scale registers a given weight, then read the firmness tester. Repeat this comparison 3 to 5 times. If you find that the instrument is properly calibrated, it is ready to use.
3. If the instrument is not in agreement with the scale, find out the magnitude and direction of the differences and proceed as follows:

Magness-Taylor Pressure Tester:

- Remove the plunger assembly from the barrel of the instrument and remove the bolt and washers from the end of the plunger assembly.
- Pull the plunger and spring out of the metal cylinder, then shake the washers out of the cylinder.
- To make the instrument read lower, move washers from inside to outside the metal cylinder.
- To make the instrument read higher, move washers from outside to inside the metal cylinder.
- Reassemble and recheck for calibration.

Effe-gi Fruit Penetrometer:

- Unscrew the chrome guider nut to remove the plunger assembly.
- To make the instrument read lower, insert washers between the spring and the stationary brass guide.
- To make the instrument read higher, insert washers between the chrome guide nut and the stationary brass guide on the plunger shaft.
- Reassemble and recheck for calibration.
- If the indicator needle does not stop or does not release button hold, remove the plunger assembly, and then lubricate the inside of the instrument with an aerosol lubricant.

Firmness measurements may be useful for some fruit vegetables (melons, peppers) and even root vegetables (carrots, potato), but other measurements of texture are needed for stem and leafy tissues such as asparagus or celery (force for a blade to cut or shear). For lettuce, because of the variability of the structure of the leaves, it has been difficult to develop a standard assessment of crispness.

SOLUBLE SOLIDS CONTENT (SSC)

Sugars are the major soluble solid in fruit juice and therefore soluble solids can be used as an estimate of sugar content. Organic acids, amino acids, phenolic compounds, and soluble pectins also contribute to soluble solids. Soluble solids content (SSC) can be determined in a small sample of fruit juice using a refractometer (Figures 4 and 5). The refractometer measures the refractive index, which indicates how much a light beam will be slowed down when it passes through the fruit juice. The refractometer has a scale for refractive index and another for equivalent °Brix or SSC percent which can be read directly. Digital refractometers remove potential operator error in reading values.

For small products such as cherries, strawberries and grapes, the entire fruit can be juiced. For larger products, a sample wedge should be cut from stem to blossom end and to the center of the fruit to account for variability in SSC from top to bottom and inside to outside of the fruit. A garlic press works well for small samples. Cheesecloth may be necessary to remove pulp from the juice.

Figure 4. *A wedge is cut from the commodity from stem to blossom end and to the center. The juice is extracted with a garlic press and a few drops are placed onto the glass of the refractometer. The refractometer is closed and held up to the light for viewing through the eyepiece. The internal scale will show the SSC of the juice.*

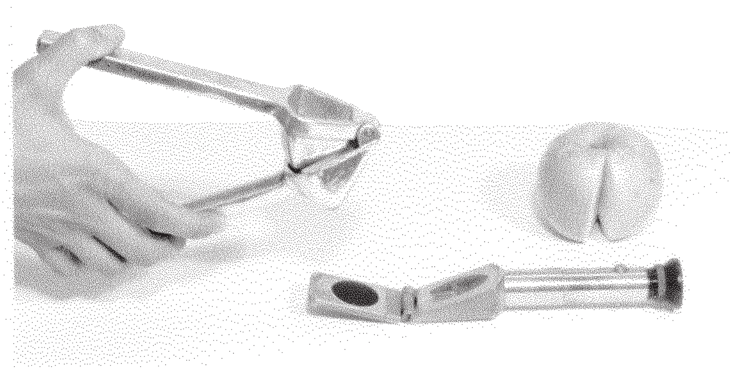
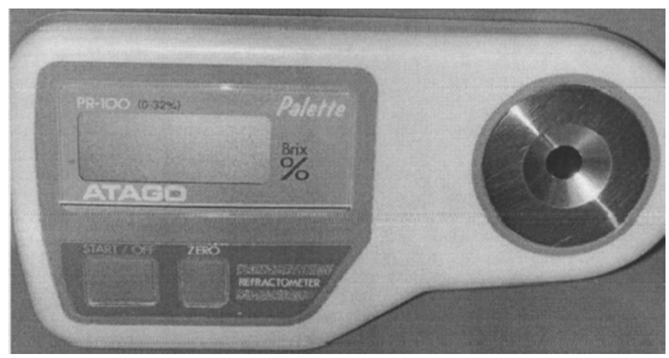


Figure 5. *Digital refractometer*



The temperature of the juice is a critical factor for accuracy because all materials expand when heated and become less dense. For a sugar solution, the change is about 0.5% sugar for every 5.6°C (10°F). Good quality refractometers have a temperature compensation capability or at least a thermometer attached to them so that the operator can make the necessary corrections. It is essential to clean the refractometer between each reading and to standardize it with distilled water (should read a refractive index of 1.3330 at 20°C (68°F) or 0% SSC).

TITRATABLE ACIDITY

Titratable acidity (TA) can be determined by titrating a known volume of fruit juice with 0.1 N NaOH (sodium hydroxide) to an end point of pH = 8.2 as indicated by phenolphthalein indicator or by using a pH meter. (NaOH is added to the juice until the pH changes to 8.2. The milliliters of NaOH needed is used to calculate the TA) The TA, expressed as percent malic, citric or tartaric acid, can be calculated as follows:

$$TA = \frac{\text{ml NaOH x N(NaOH) x } \textbf{\textit{acid meq.factor}} \text{ x 100}}{\text{ml juice titrated}}$$

Use the acid milliequivalent factor for the predominant organic acid in the commodity. The following table shows how to calculate TA for 3 organic acids.

Table 2. *Predominant organic acids to use for TA calculations of some commodities.*

Acid	**Formula Wt**	**Equivalent Wt**	***acid meq. factor***	**Commodities**
citric	192.12	64.0	*0.064*	berries citrus fruits pineapple
malic	134.09	67.05	*0.067*	apple, pear peach
tartaric	150.08	75.04	*0.075*	grape

Further Reading

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