

Packaging Lessons:

Evaluating Apples

Shipping fruit is a challenge. The question for the packaging professional is how much protection to provide. Ripeness of the fruit pieces prior to shipment is obviously a concern. Others include the distance that the fruit will travel during transit and the storage time/conditions before reaching the supermarket shelf. Apples may be one of the easier fruits to handle because they can endure a long time in storage.

One test method practiced by the fruit industry to evaluate apple firmness is the Texture Analyzer with the Magness Taylor Probe, a punch-like tool that can penetrate the apple skin. The Texture Analyzer measures the force required to puncture the skin and the consistency of the fruit flesh underneath. Ideally, fresh-picked apples will have hardy skins and firm flesh that allow for some passage of time before ripening completely and being ready for consumption.



Figure 1: Test Apples

Four different apples are tested in this example: McIntosh, Gala, Granny Smith and Red Delicious. See Figure 1. The objective is to measure the hardness of each apple and use this value as an indicator of ripeness. Two possible approaches to sample preparation are considered: storing at ambient conditions for 24 hours vs. refrigeration; in this case, the apples are stored in a refrigerator which means they are kept at 4° C prior to test.

The Texture Analyzer instrument is equipped with a 4500 gram load cell and outfitted with a Magness Taylor probe. See Figure 2. Various diameters and shapes are available in the choice of the specific Magness Taylor probe that is used. In this case the probe has a 4mm diameter with rounded end.

The instrument can be run either in standalone mode using the controls on the face to run the test or under PC control. In this case the PC is used because the data generated when measuring each apple will be compared to the other apples. This is the normal approach for investigative work by R&D when evaluating a method that will be used in the field by QC. Once the method is established, then the test can be run directly from the instrument.

Each apple is placed on the Base Table which can be adjusted in height so that the spatial separation between the tip of the probe and the apple is a relatively small distance. During the actual test the Texture Analyzer moves the probe downward at the rate of 1mm/sec. The probe penetrates the skin of the apple and pushes into the interior flesh a distance of 12mm. This method measures the amount of force required to break the apple skin and the steady state force needed to bite or chew the flesh. See the graph in Figure 3 which shows force vs. distance for the probe as it moves into the apple for all four apples.



Figure 2: Texture Analyzer with Magness Taylor Probe Positioned above Test Apple

As the probe moves through the apple flesh, the measured force values will fluctuate to some extent which indicates the crispness condition of the apple. The consumer notes this characteristic as an indication of crunchiness.

The probe is then withdrawn from the apple at the same test speed, 1mm/sec.

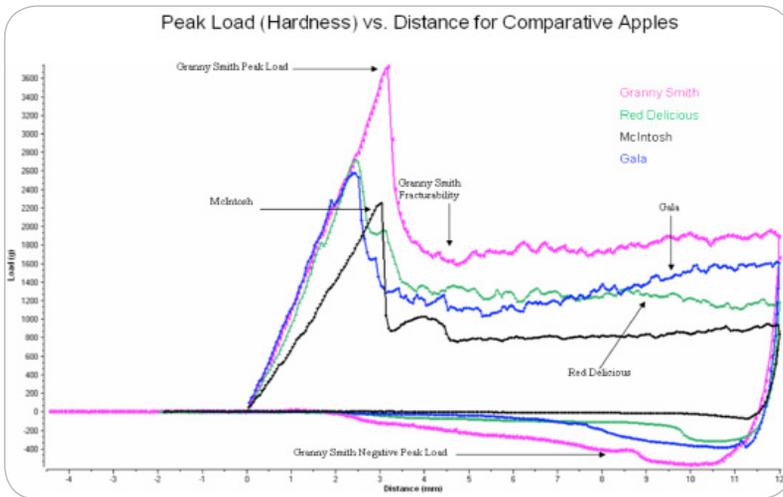


Figure 3: Graph of Load vs. Distance for Probe Movement into the Apple

The Texture Analyzer measures a negative force during this process which gives an indication of the apple density. Another expression used to characterize this measured value is "compactness". An apple with greater density will give more resistance to the removal of the probe from the flesh.

Test results are easily compared in tabular format as shown in Table 1. As you might expect, the Granny Smith has significantly higher values for Hardness and Fracturability. The Macintosh has the easiest skin to penetrate as reflected in the low value for Hardness. The Red Delicious has the lowest value for Fracturability.

#	Sample Description Product Name	Batch Name	Results Sample	Hardness Cycle 1 g	Fracturability g
1	Real Apple	Gala 5R	3	2576.50	2277.50
2	Real Apple	Granny Smith 5R	3	3727.50	3727.50
3	Real Apple	McIntosh 5R	2	2253.00	2253.00
4	Real Apple	Red Delicious 5R	3	2725.00	1835.00

Table 1: Comparative Results for Texture Test on Four Apples

Worth noting is that the software used with the Texture Analyzer will easily summarize the results in the Table as shown. Even more important is the possibility to run tests on multiple apples of each type and compute statistical averages. This ultimately gives the information needed to set test specifications for acceptability of apples measured by QC.

The Texture Analyzer takes the guesswork out of evaluating apples using traditional manual methods, like squeezing with your hand, biting into the apple, or chewing two or three times. Ultimately the packaging specialists who determine how much protection to provide for the safe transport of this consumable commodity need this data. Whether to package in loose bags or carefully arrange in cartons with layered cardboard separators is the question that must be answered. With data from this type of test, the design of the packaging has a much better chance to be successful.

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