

FRUIT FLESH FIRMNESS: CHOOSING THE RIGHT TOOL FOR THE SUPPLY CHAIN

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For many types of fruit, the flesh firmness is a useful indicator of maturity and ripeness. Objective measurement of flesh firmness is important for guiding harvest schedules, optimising postharvest handling, and increasing marketability of stone fruit. Measurement techniques can be divided into destructive and non-destructive methods. This fact sheet describes both methods, their applications, benefits and limitations, with a focus on stone fruit like nectarines and plums.

WHY FIRMNESS MATTERS

Fruit flesh firmness is a key parameter of ripeness, quality, and shelf life. Growers, retailers, and quality assessors typically assess firmness using destructive devices such as penetrometers. However, these measurements damage the fruit, rendering the sample unsaleable or unable to be reassessed

DESTRUCTIVE FIRMNESS TESTING: TRADITIONAL BUT LIMITED

Destructive firmness testing involves removing the fruit peel to measure the flesh's resistance to pressure. The penetrometer is a widely used tool, providing accurate readings of flesh firmness (Fig. 1 A). Used by industry for over 50 years, both analogue and digital penetrometer models are available. For higher precision, the Fruit Texture Analyser (FTA, Güss Manufacturing Pty Ltd, South Africa) uses a standardized probe at controlled speeds and depths to measure force (in Newtons or kg) and penetration depth (mm) (Fig. 1 B). The FTA is ideal for research and commercial quality control, efficiently handling large samples with adjustable test settings and data export via integrated software.



Figure 1. (A): Hand-held penetrometer mounted on a Dremel workstation.

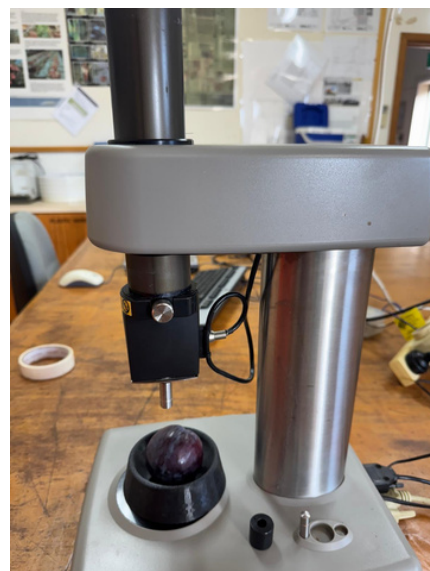


Figure 1. (B): Fruit Texture Analyser (FTA) used to measure flesh firmness of an 'Angelo' plum

NON-DESTRUCTIVE FLESH FIRMNESS TESTING: A SMART ALTERNATIVE

Recent development of handheld devices has made it possible to measure fruit firmness multiple times without damaging it. Several durometers are available in the market for non-destructive firmness measurement, including models developed by Turoni and Bareiss. This fact sheet focuses on the Bareiss HPE -III- FFF durometer, used in the study to measure the firmness of fruits without damage (Fig. 2). It features interchangeable test tips for various products and a spring-loaded sleeve that ensures consistent pressure for accurate, repeatable results.



Figure 2. Ultra-Precision Digital Durometer HPE-III-FFF determines non-destructive fruit flesh firmness

HOW IT WORKS

The HPE-III-FFF device measures fruit firmness on a 0-100 scale, providing immediate feedback with a sound signal upon completion. It uses the Shore A hardness scale, where higher values indicate harder materials. Data is stored for easy export and analysis, helping growers track fruit quality over time.

Table 1. Comparison of key features between destructive (penetrometer-based) and non-destructive (durometer-based) flesh firmness measurement methods.

Feature	Destructive (Penetrometer)	Non-Destructive (Durometer)
Speed	Manual, slower	Fast, automated readings
Reusability	Single use per fruit	Can test same fruit multiple times
Data Storage	FTA - stores up to 1000 measurements	Stores up to 300 measurements
Suitability	Small-scale testing	Large-scale and ongoing monitoring
Cost Efficiency	FTA - \$8050 Simple penetrometer - ~\$600	Turoni 53215TT (single anvil) - \$800 Bareiss (multiple anvil) - \$3200
Advantages	Simple, cost effective, easy to use	User-friendly, large display, non-destructive, error indication and less variation between operators.
Disadvantages	Puncturing the fruit, the difference in data between operators	Higher upfront cost, needs calibrations

PRACTICAL APPLICATIONS FOR GROWERS, RETAILERS, AND QUALITY ASSESSORS.

- Monitor fruit maturity before harvest to optimize harvest timing.
- Assess firmness during storage and transport for quality control.
- Ensure flesh firmness and marketability throughout the supply chain.
- Quickly evaluate quality uniformity across orchard blocks for on-farm decisions

WHICH METHOD IS RIGHT FOR YOU?

Growers, storage operators, and quality assessors can enhance fruit quality management by using non-destructive handheld firmness testers for ongoing monitoring. These tools allow for tracking fruit condition without damage, while destructive methods are useful for routine spot-checking and compliance verification. Combining both approaches helps reduce waste and ensure the best products reach retail and export markets.

FOR MORE INFORMATION



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Dr Muneer Rehman has expertise in both pre- and post-harvest physiology which allow him to understand the entire fruit production system. This experience is highly relevant to the project's goals of improving fruit quality and managing crop loads, as it allows him to integrate strategies that are important to the entire lifecycle of the fruit, from growth to market.



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