Food Technology Corporation

Your path to consistent quality

Fruits & Vegetables

Some simple guidelines for texture testing...

www.foodtechcorp.com

Food Technology Corporation

What does Texture Analysis mean to the Fruits & Vegetables Industry?

Fruit & vegetable texture properties and requirements are dependant upon the product itself, as well as, subsequent use or consumption. The same fruit or vegetable may be consumed raw or cooked, while different varieties and stages of maturity will result in different physical properties and ultimately, expectations from the consumer or processor.

The generic category of fruits and vegetables contains a wide and varying range of tissue types from complex leafy structures to inhomogeneous berries and fleshy fruits to homogeneous tubers and root vegetables. The texture test and ultimately the test fixture used depends upon these considerations.

Texture measurements provide the fresh produce sector with objective means to put numbers to very subjective characteristics.

- From a ***manufacturer's*** perspective, this could be a canned or frozen pea producer measuring the tenderness of peas at harvest and paying the farmer accordingly.
- From a ***customer's*** perspective, this could be the consistency of a mashed potato or firmness of a fruit compote.

Some Texture Analysis Experiences with the Total Quality Loop

RESEARCH & DEVELOPMENT

"...texture analysis measured the effect of potato variety on French fry texture during plant breeding trials"

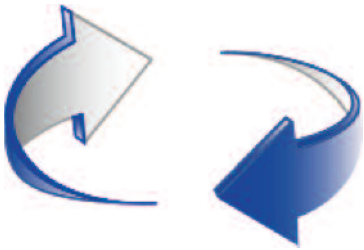
"...we used it to investigate the effect of processing aids in the prevention of structural damage of canned potatoes"

QUALITY DEPARTMENT

"...we measured the texture of chopped tomatoes at goods-in to make sure they had the right texture for our process"

"...texture testing gave us a quick and simple way to measure the ripeness and maturity of our strawberries"

Total Approach to Quality



PRODUCT DEVELOPMENT

"...texture analysis helped us to optimize the mouthfeel of our mashed potato to maximize customer satisfaction"

"...we used it to measure shelf-life changes to texture of our prepared fruit slices"

PROCESS DEVELOPMENT

"...texture testing helped us to understand the effect of downtime on starch gelation in our vegetable puree"

"...we used the Kramer Shear Cell to improve product consistency of our roasted vegetables"

How do I know that I need to measure the texture of my fruit or vegetable product?

Food texture analysis is primarily concerned with how food material feels, behaves and performs. There are two approaches that can be taken to measure food texture:

Sensory based

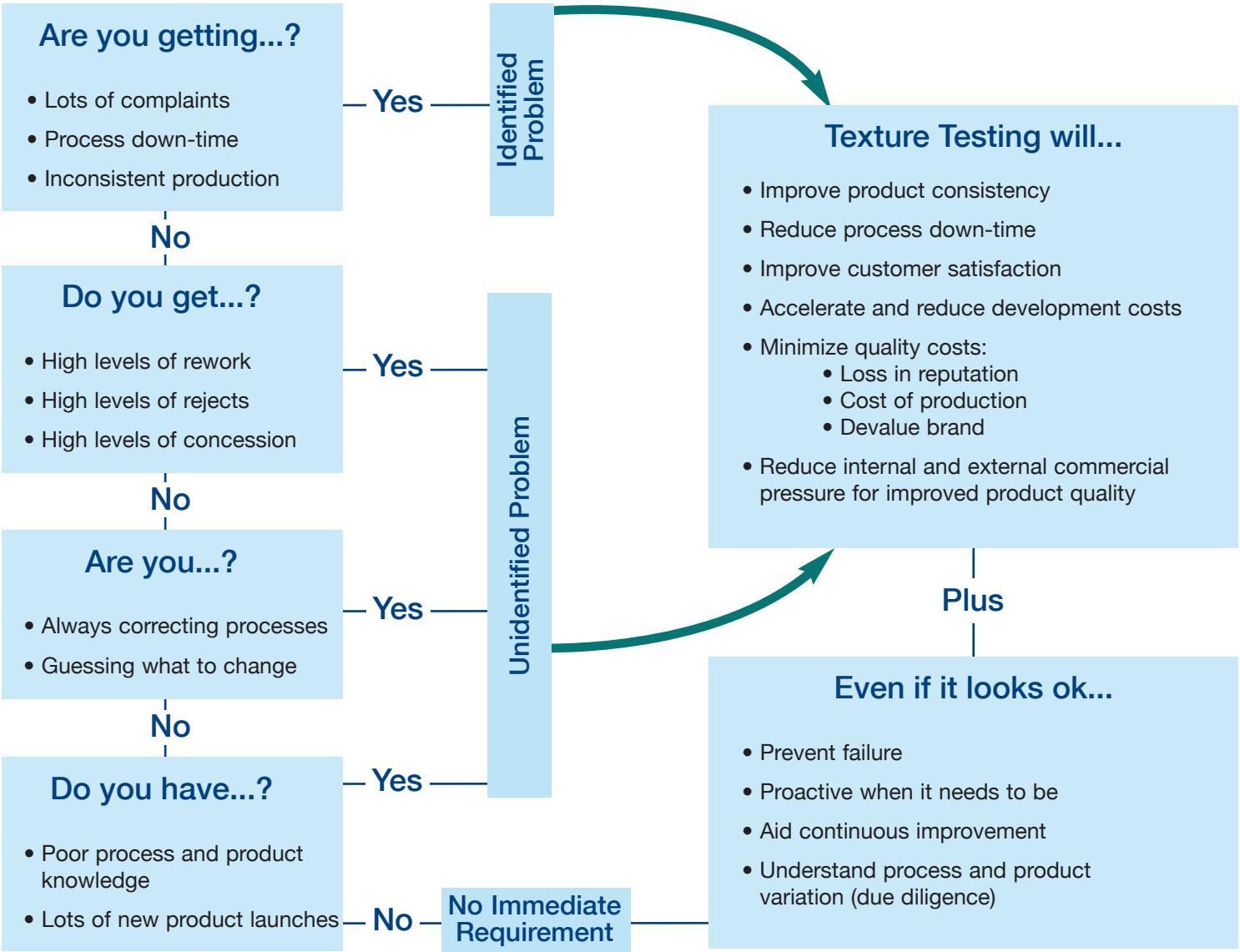
Texture treated as a perception or human experience, which is correlated to what we feel.

Engineering based

Texture treated as a condition, which can be monitored and manipulated during manufacture.

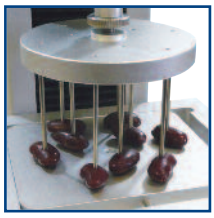
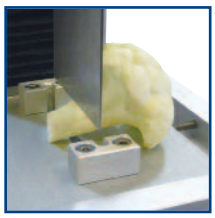
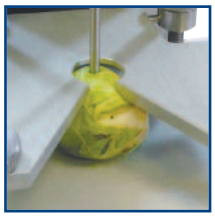
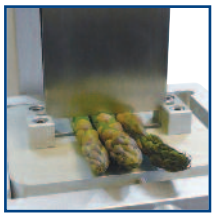
Whatever approach is taken, the methods followed should be simple, practical and, most importantly, generate information of "real" value on the product being tested.

Do I have a texture related problem?



Food Technology Corporation

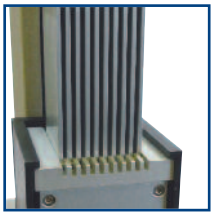
Product	Description	Core Characteristics
Pastes & Pulps Purées Pulps Mashed Potato	Very thick and viscous slurries made from processed vegetables to produce a semi-solid state. Additional ingredients are added to manipulate consistency and processing properties.	• Stringiness (tailing) when deposited • Flow characteristics on pumping • Mouthfeel during consumption
Legumes & Kernels Peas Beans Pulses Sweet Corn	Starchy beans, kernels, peas, grains and pulses either tested succulent in hydrated state or in dried form. Generally consist of a tough outer skin with succulent pasty inner structure that softens on hydration or during cooking. Can become pasty when chewed.	• Hydration/drying properties • Skin toughness • Maturity, tenderness and ripeness • Cooking time optimization • Functionality in fermentation, blending & cooking • Resilience to processing and handling
Florets Broccoli Cauliflower	Irregular shaped floret type vegetables with tough stalks and tender flower heads. Floret head will often soften prior to stalk that has more fibrous consistency. Stalk is used as batch quality predictor.	• Stalk toughness from shearing • Resilience to compression of whole floret • Blanched texture & degradation
Leafs & Stems Cabbage Sprouts Celery Fennel Rhubarb	Thin layer(s) of tissue incorporating venial structures to aid photosynthesis. May be singular as in the case of spinach and salad leaves or tightly bound together to form clusters or balls as with Dutch cabbage and Brussel sprouts.	• Break strength & flexibility of celery sticks & batons • Bite strength & eating quality • Blanch hardness & firmness post cooking • Crispness over shelf-life in modified atmosphere packaging • tensile strength & toughness of vertical fibers
Pods & Modified Stems Asparagus Green Beans Runner Beans Mange Tout	Cylindrical or flattened samples with varying texture across the length of sample. Encased by tough outer skin, while pods contain seeds. Texture can vary along cross-section of shoot.	• Pod/stem tenderness • Chewiness of fibrousness • Crispness or freshness • Toughness of skin & fibers

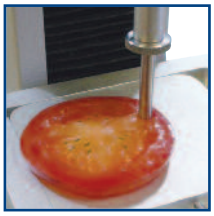
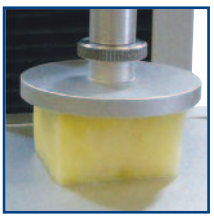






Product	Description	Core Characteristics
Prepared Chopped Tomatoes Chopped Green Beans Chopped Onions Diced Vegetables Salsa	Small, irregular and non-uniform pieces of vegetables with fleshy or starchy structure. High degree of variation between individual pieces and even within individual pieces themselves. May include skin where appropriate, which can influence textural properties	• Flesh firmness • Cook quality and heat degradation on blanching • Process stability and consistency • French fry crispness • Processing stability • Shelf-life and pH degradation
Grains & Seeds Pumpkin Seeds Poppy Seeds Animal Feeds Cooked Rice	Small, tough and regularly sized seeds with tough outer shell and mealy inner consistency. Irregular surface properties and brittle texture makes individual analysis highly variable.	• Roasting profile • Bite force • Resilience & strength • Consistency & fracture properties
Bulbs Onion Shallot Garlic	Small bulbs made up from layers of leaf like material. Penetration through layers provides indication of structure at each layer.	• Flesh firmness/harness • Resilience to cooking process • Crispness in prepared salads • Softening during storage (pickling)
Multiple Textured & Fleshy Tomato Peppers Zucchini (Courgette) Cucumber Egg Plant (Aubergine) Squash	Variable anatomical tissue, which supports and protects internal seeds. Skin or peel surrounds fleshy pericarp material. Samples are anisotropic where orientation directly influences results (if you squash a tomato in different directions you will get different results)	• Flesh firmness • Skin toughness & Bio-yield • Resilience to cooking & processing • Variety differentiation • Softening on storage • Crunchiness as an indicator of freshness
Roots & Tubers Carrots Parsnip Swede Turnip Celeriac Potato Yam	Homogeneous large and starchy roots and tubers with predominantly uniform structures. Taproots may incorporate central woody core, which will influence texture results and sample isotropy - if sample is presented to analyzer in different directions different results will be obtained.	• Bite strength & resilience • Softening on cooking • Toughness through season and changes pre/post harvest • Cooked texture for mashing & purées • Performance in size reduction unit operations

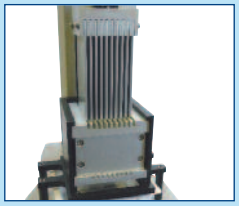
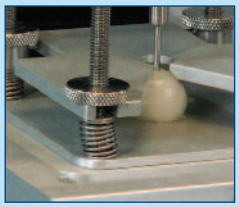
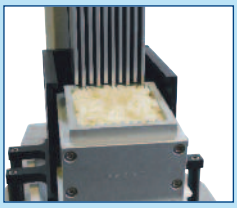
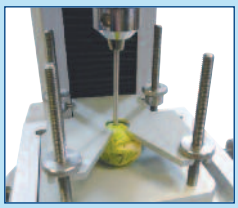
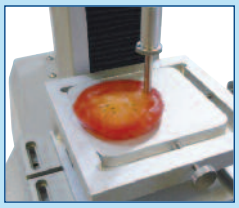
Semi-solid
Flows if unsupported, poured, pumped, extruded or spread during handling or consumption

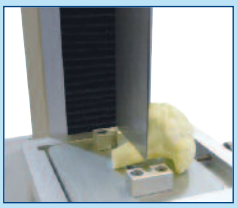
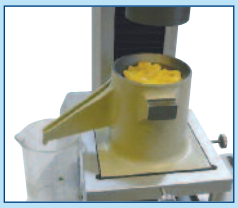
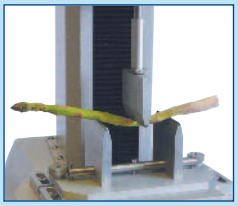
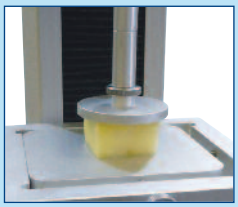
Solid
Self-supporting structure, deformed, squashed, sheared or snapped during handling or consumption



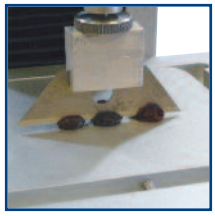
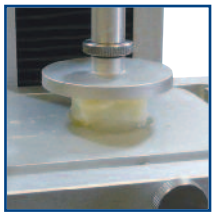
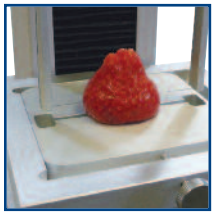
Choosing The Right Fixture

	Extrusion	Bulk Analysis	Multiple Point Analysis
	Make a thick liquid flow, just like squeezing tomato purée from a tube or shaking sauce from a bottle	Measure individual pieces in bulk like eating a spoonful of peas or scooping out some salsa	Multiple site tests are used to measure products with variable textures like pushing a fork into a tomato
Pastes & Pulps Purées Pulps Mashed Potato	• TMS Extrusion Cell (432-026) • TMS Extrusion Cone (432-027) • TMS Extrusion Platen Set (432-029)		Measure bulk structure of chopped vegetables to predict process integrity 
Prepared Chopped Tomato Chopped Green Beans Chopped Onions Diced Vegetables Salsa	Extrude tomato purée to measure flow and consistency properties 	• FTC Standard Shear Compression Cell (432-240)	
Legumes & Kernels Peas Beans Pulses Sweet Corn		• FTC Standard Shear Compression Cell (432-240)	• TMS Junior Multiple Probe Fixture (432-252)
Grains & Seeds Pumpkin Seeds Poppy Seeds Animal Feeds Cooked Rice		• FTC Standard Shear Compression Cell (432-240)	Measure the firmness of pickled onions through penetration 
Florets Broccoli Cauliflower		• FTC Standard Shear Compression Cell (432-240)	
Bulbs Onion Shallot Garlic	Measure the effect of cooking conditions on rice texture 		
Leafs & Stems Cabbage Sprouts Celery Fennel Rhubarb		Penetrate into cooked sprouts to assess hardness 	
Multiple Textured & Fleshy Tomato Peppers Zucchini (Courgette) Cucumber Egg Plant (Aubergine) Squash	Hold containers in place when carrying out extrusion tests with the TMS Container Grips (432-038) 		Penetrate into the pericarp tissue of the tomato to measure ripeness 
Pods & Modified Stems Asparagus Green Beans Runner Beans Mange Tout			
Roots & Tubers Carrots Parsnip Swede Turnip Celeriac Potato Yam			

Penetration	Shearing	Compression	Snapping
Use small cylinders, balls, needles and cones to push into a sample like pushing your finger into a piece of potato	Cut across a section of the sample just like biting into a carrot or cutting through broccoli stalks	Squash a small sample with a flat or rounded probe like squeezing a piece of cooked carrot in your hand	Snap baton shaped samples with rigid or elongated structures just like breaking an asparagus stem
• 1” Perspex Hemispherical (432-096) • 1” Ball Probe (432-088)			
• 2mm ø Needle Probe (432-087)	Cut through the stalks of blanched florets to predict final cook quality 		Measure the succulence of sweetcorn kernels in the FTC Succulometer Cell 
• 2mm ø Needle Probe (432-087)		• FTC Succulometer (432-266)	
• 2mm ø Needle Probe (432-087)		• TMS 50mm ø Compression Platen (432-009)	
• 2mm ø Needle Probe (432-087)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)		
• 5mm ø and Smaller S.S. Cylinders (432-071 to 432-074)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)		
• 5mm ø and Smaller S.S. Cylinders (432-071 to 432-074)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)		Measure flexure properties of asparagus to assess freshness over storage 
• 5mm ø and Smaller S.S. Cylinders (432-071 to 432-074))	• TMS Large Craft Knife (432-295)	Use small deformation compression tests to assess integrity of cooked potato 	
• 5mm ø and Smaller S.S. Cylinders (432-071 to 432-074)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)		• TMS Lightweight Three Point Bend (432-248)
• 10mm ø Smaller S.S. Cylinders (432-066 to 432-074)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) • TMS Wire Shear Probe And Plate (432-242)	• TMS 75mm ø Compression Platen (432-010) • 1” Ball Probe (432-088)	**Please Note:** Accessories listed in each category are examples of those most suited to the application. Only one accessory is normally required per application to perform the majority of tests.

Food Technology Corporation

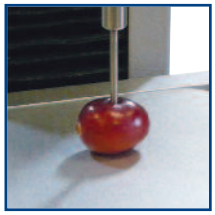
Product	Description	Core Characteristics
Pastes & Pulps Purées Pulps Weak Jellies & Sauces	Very thick and viscous slurries made from processed fruit. Pulps and purées are often concentrated and include fibrous material that adds structure.	• Stringiness (tailing) when deposited • Flow characteristics on pumping • Structural recovery
Dried & Chopped Currants Raisins Dates Candied Fruit (Peels etc) Freeze Dried Fruits	Sticky, dried preserved fruits with tough and fibrous consistency. Very irregular in shape and highly adhesive. Can have extremely brittle, almost crisp, consistency depending on method of drying.	• Skin toughness • Storage hardening • Moisture content • Resilience in baking and handling • Toughness or chewiness • Tooth packing and pulling • Crispness & crunchiness of brittle pieces
Fleshy Fruits (including pomaceous) Apples Pears Quinces Melons	Fleshy fruits with high pectin content consisting of outer skin, firm and juicy inner flesh and central core containing seeds. Homogeneous texture to outer flesh, which gives good reproducibility	• Bruising potential • Ripeness - Flesh firmness • Skin toughness & Bio-yield • Juicing potential (pressing) • Hardness to touch/squeeze
Soft Fruits (Drupelets & Berries) Blackberries Raspberries Strawberries	Small berries with large content of seeds and irregular geometries. High variability between individual fruit sizes make comparisons difficult. Standardization in fruit size and treatment should be maintained where possible.	• Ripeness and softening • Process resilience • Breakdown of structure
Citrus Fruit Oranges Lemons Limes Grapefruit	Cellular and particulate high moisture content cell sacks bound together to form individual segments. Encased in tough peel, which protect the fruit.	• Physical strength & resilience • Internal pith & skin tensile strength • Flesh firmness

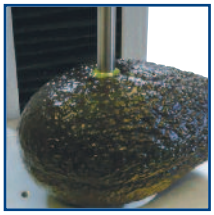





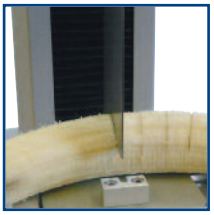

Product	Description	Core Characteristics
Small Berries Redcurrants Blackcurrants Blueberries Cranberries Grapes	Berries of varying sizes predominantly with tough outer skins and soft succulent centres. High variability within same sample batch large sample set.	• Maturity & ripeness • Resilience to processing & handling • Harvest resistance • Bio-yield point or skin toughness • Whole fruit firmness
Elastic Gels Jams Preserves Jellies	Pectin set gels with either homogeneous smooth consistencies or containing fruit pieces. Often supplied in jars unless highly gelled with pectin to form jellies.	• Gel strength • Elasticity & consistency comparisons • Relaxation & failure properties over time • Spreading consistency
Stoned Fruit (Drupes) Peaches Apricots Plums Avocadoes Cherries & Olives	Fruits that have an outer skin encasing a soft flesh centre surrounding a hard stone. The skin will yield once penetrated and the flesh may be analyzed using a squeezing action.	• Skin strength & toughness • Yield point & resilience • Ripeness & softening profile • Pitting properties for processing
Starchy Fruit Bananas Plantain	Pasty homogeneous starchy fruits with very soft texture. Easily mashed to pulp or follow viscous behavior when squashed.	• Ripening process changes & effect of modified environments • Firmness & rigidity

Semi-solid
Flows if unsupported, poured, pumped, extruded or spread during handling or consumption

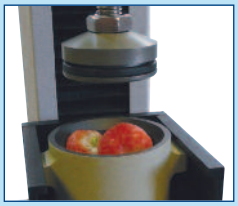
Solid
Self-supporting structure, deformed, squashed, sheared or snapped during handling or consumption

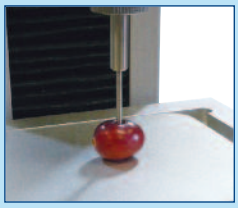
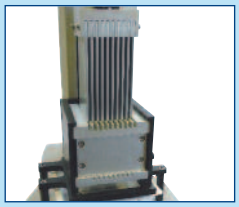
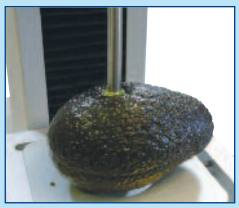
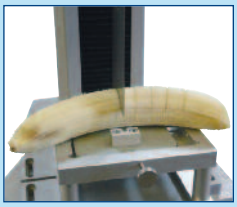
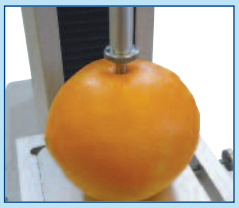






Choosing The Right Fixture

	Extrusion	Bulk Analysis
	Make a thick liquid flow, as if spooning a strawberry purée	Test small irregular berries and fruit pieces in bulk, like eating a handful of raisins
Pastes & Pulps Purées Pulps Weak Jellies & Sauces	• TMS Extrusion Cell (432-026) • TMS Extrusion Cone (432-027) • TMS Extrusion Platen Set (432-029)	
Whole Particulates Redcurrants Blackcurrants Blueberries Cranberries Grapes	Extrude thick purées and fruit pulps to measure flow characteristics	• FTC Standard Shear Compression Cell (432-240) • FTC Universal Cell (432-032)
Dried & Chopped Currants Raisins Dates Candied Fruit (Peels etc) Freeze Dried Fruits		• FTC Standard Shear Compression Cell (432-240)
Elastic Gels Jams Preserves Jellies	Use the multiple needle probe to measure set firmness of fruited jams and jellies	
Fleshy Fruit (including Pomaceous Apples Pears Quinces Melons		• FTC Standard Shear Compression Cell (432-240)
Stoned Fruit (Drupes) Peaches Apricots Plums Avocadoes Cherries & Olives		• FTC Standard Shear Compression Cell (432-240)
Soft Fruits (Drupelets & Berries) Blackberries Raspberries Strawberries		• FTC Standard Shear Compression Cell (432-240) • FTC Universal Cell (432-032)
Starchy Fruit Bananas Plantain	Bulk compression of comparably sized soft fruits acts as a predictor to final integrity	
Citrus Fruit Oranges Lemons Limes Grapefruit		

Multiple Point Analysis	Penetration	Shearing	Compression
Multiple site tests are used to measure products with variable textures like pushing a fork into a tomato	Use small cylinders, balls, needles and cones to punch into fruits and measure their firmness	Cut across a section of the sample just like biting into an apple or cutting through a strawberry	Squash a small sample with a flat or rounded probe like squeezing a fruit in your hand
	• 1” Perspex Hemispherical (432-096) • 1” Ball Probe (432-088)		Penetrate large batches of individual berries to measure skin toughness 
Measure bulk structure of chopped vegetables to predict process integrity 	• 2mm ø Needle Probe (432-087) • 1mm ø Needle Probe (432-086) • TMS Magness Taylor Probe Set (432-241)		
	• 2mm ø Needle Probe (432-087) • 1mm ø Needle Probe (432-086)	• TMS Craft Knife (432-019)	
• TMS Multiple Needle Probe Fixture (432-249)	• 5mm ø and Smaller S.S. Cylinders (432-071 to 432-074) • TMS Magness Taylor Probe Set (432-241)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)	• TMS 50mm ø Compression Platen (432-009)
Measure ripeness and storage changes in apples using penetration testing 	• 5mm ø and Smaller S.S. Cylinders (432-071 to 432-074) • TMS Magness Taylor Probe Set (432-241)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)	• TMS 50mm ø Compression Platen (432-009)
Simply penetrate into fruit flesh to assess skin strength and flesh texture for ripeness 	• 5mm ø and Smaller S.S. Cylinders (432-071 to 432-074) • TMS Magness Taylor Probe Set (432-241)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)	• TMS 50mm ø Compression Platen (432-009)
	• 2mm ø Needle Probe (432-087) • 1mm ø Needle Probe (432-086) • TMS Magness Taylor Probe Set (432-241)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295)	Cut through peeled banana to measure bite characteristics 
Penetrate citrus fruit to measure peel characteristics 	• 10mm ø Smaller S.S. Cylinders (432-066 to 432-074) • TMS Magness Taylor Probe Set (432-241)	• TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) • TMS Wire Shear Probe And Plate (432-242)	
	• 5mm ø Smaller S.S. Cylinders (432-071 to 432-074) • TMS Magness Taylor Probe Set (432-241)		• TMS 75mm ø Compression Platen (432-010) • 1” Ball Probe (432-088)
			Please Note: Accessories listed in each category are examples of those most suited to the application. Only one accessory is normally required per application to perform the majority of tests.

Food Technology Corporation

Your path to consistent quality

Who is Food Technology Corporation?

Founded in 1966, Food Technology Corporation is the industry's longest standing provider of quality texture measurement systems. With over 40 years experience evolving from the groundbreaking Kramer Shear Press, our company is able to provide systems for the field, factory and laboratory test environments. Our extensive experience in practical food texture measurements, combined with our cost-effective solutions makes us the ideal partner for your texture instrumentation needs.

Food Technology Corporation

45921 Maries Road, Suite 120,
Sterling, Virginia, 20166 USA.

t: 703-444-1870
f: 703-444-9860
e: info@foodtechcorp.com

431-909-03