

Fruits & Vegetables



Spectronic
CamSpec Ltd

Some simple guidelines for texture testing...

Spectronic CamSpec Ltd

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"

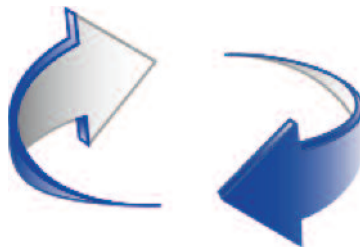
"...we used it to investigate the effect of processing aids in the prevention of structural damage of canned potatoes"

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.

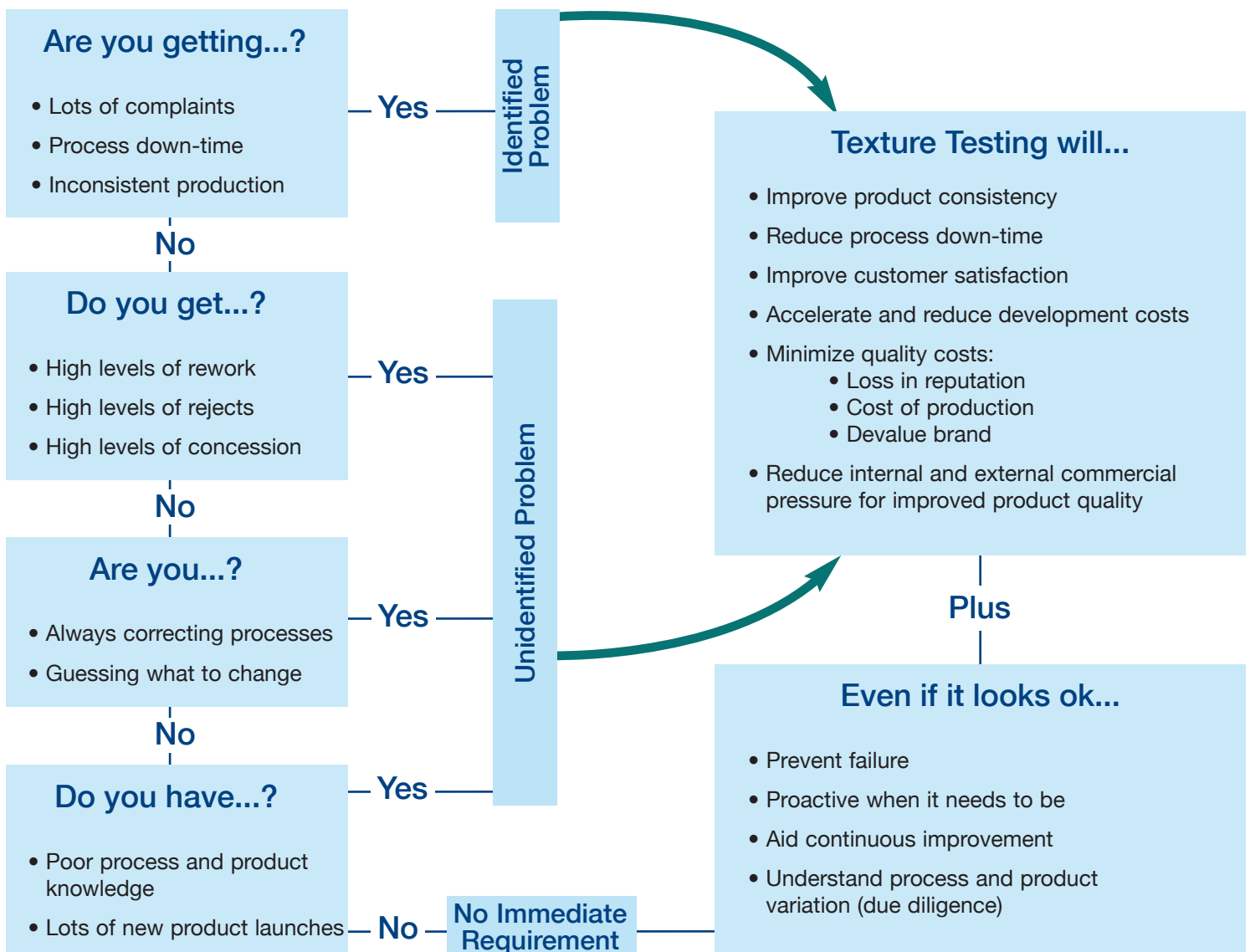


Engineering based

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

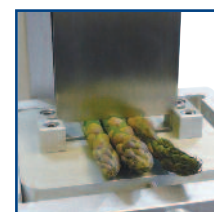
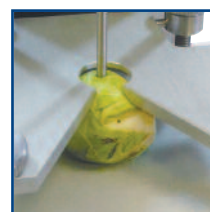
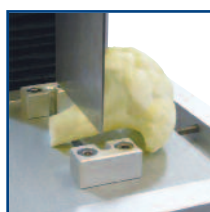
Whatever approach is taken, the methods followed should be simple, practical and, most importantly, generate information of “real” value on the product being tested.

Do I have a texture related problem?

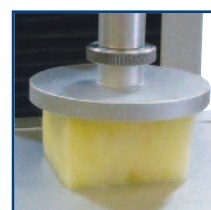
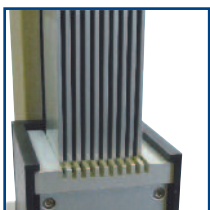


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Product	Description	Core Characteristics
Pastes & Pulps Purées Pulps Mashed Potato	Very thick and viscous slurries made from processed vegetables to produce a semi-solid state. Additional ingredients are added to manipulate consistency and processing properties.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • Stalk toughness from shearing • Resilience to compression of whole floret • Blanched texture & degradation
Leaves & 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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> Flesh firmness Cook quality and heat degradation on blanching Process stability and consistency French fry crispness Processing stability Shelf-life and pH degradation 	Semi-solid Flows if unsupported, poured, pumped, extruded or spread during handling or consumption
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.	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> 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 	



Choosing The Right Fixture

Extrusion

Make a thick liquid flow, just like squeezing tomato purée from a tube or shaking sauce from a bottle

- TMS Extrusion Cell (432-026)
- TMS Extrusion Cone (432-027)
- TMS Extrusion Platen Set (432-029)

Extrude tomato purée to measure flow and consistency properties



Measure the effect of cooking conditions on rice texture



Hold containers in place when carrying out extrusion tests with the TMS Container Grips (432-038)



Bulk Analysis

Measure individual pieces in bulk like eating a spoonful of peas or scooping out some salsa

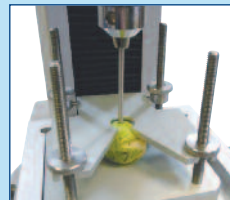
- FTC Standard Shear Compression Cell (432-240)

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Penetrate into cooked sprouts to assess hardness



Multiple Point Analysis

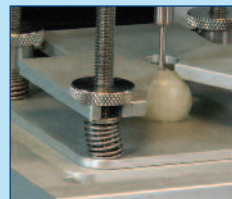
Multiple site tests are used to measure products with variable textures like pushing a fork into a tomato

Measure bulk structure of chopped vegetables to predict process integrity

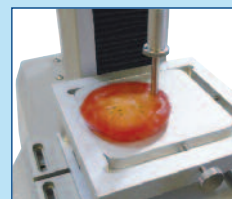


- TMS Junior Multiple Probe Fixture (432-252)

Measure the firmness of pickled onions through penetration



Penetrate into the pericarp tissue of the tomato to measure ripeness



Pastes & Pulps

Purées
Pulps
Mashed Potato

Prepared

Chopped Tomato
Chopped Green Beans
Chopped Onions
Diced Vegetables
Salsa

Legumes & Kernels

Peas
Beans
Pulses
Sweet Corn

Grains & Seeds

Pumpkin Seeds
Poppy Seeds
Animal Feeds
Cooked Rice

Florets

Broccoli
Cauliflower

Bulbs

Onion
Shallot
Garlic

Leafs & Stems

Cabbage
Sprouts
Celery
Fennel
Rhubarb

Multiple Textured & Fleshy

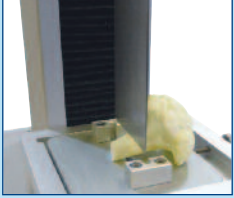

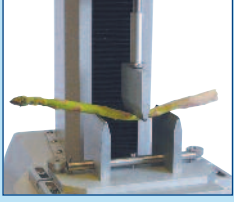
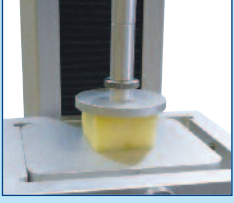
Tomato
Peppers
Zucchini (Courgette)
Cucumber
Egg Plant (Aubergine)
Squash

Pods & Modified Stems

Asparagus
Green Beans
Runner Beans
Mange Tout

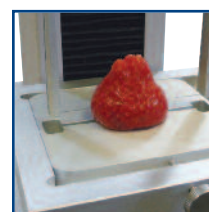
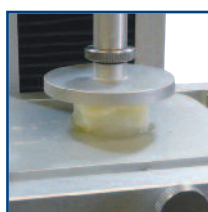
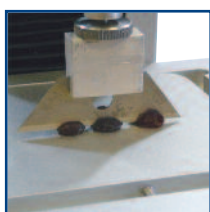
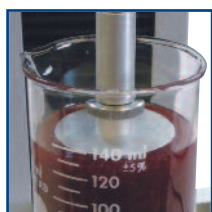
Roots & Tubers

Carrots
Parsnip
Swede
Turnip
Celeriac
Potato
Yam

Penetration	Shearing	Compression	Snapping
<p>Use small cylinders, balls, needles and cones to push into a sample like pushing your finger into a piece of potato</p> <ul style="list-style-type: none"> • 1" Perspex Hemispherical (432-096) • 1" Ball Probe (432-088) 	<p>Cut across a section of the sample just like biting into a carrot or cutting through broccoli stalks</p>	<p>Squash a small sample with a flat or rounded probe like squeezing a piece of cooked carrot in your hand</p>	<p>Snap baton shaped samples with rigid or elongated structures just like breaking an asparagus stem</p>
<ul style="list-style-type: none"> • 2mm ϕ Needle Probe (432-087) 	<p>Cut through the stalks of blanched florets to predict final cook quality</p> 	<ul style="list-style-type: none"> • FTC Succulometer (432-266) 	<p>Measure the succulence of sweetcorn kernels in the FTC Succulometer Cell</p> 
<ul style="list-style-type: none"> • 2mm ϕ Needle Probe (432-087) 	<ul style="list-style-type: none"> • TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) 	<ul style="list-style-type: none"> • TMS 50mm ϕ Compression Platen (432-009) 	
<ul style="list-style-type: none"> • 2mm ϕ Needle Probe (432-087) 	<ul style="list-style-type: none"> • TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) 		
<ul style="list-style-type: none"> • 5mm ϕ and Smaller S.S. Cylinders (432-071 to 432-074) 	<ul style="list-style-type: none"> • TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) 		
<ul style="list-style-type: none"> • 5mm ϕ and Smaller S.S. Cylinders (432-071 to 432-074) 	<ul style="list-style-type: none"> • TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) 		<p>Measure flexure properties of asparagus to assess freshness over storage</p> 
<ul style="list-style-type: none"> • 5mm ϕ and Smaller S.S. Cylinders (432-071 to 432-074) 	<ul style="list-style-type: none"> • TMS Large Craft Knife (432-295) 	<p>Use small deformation compression tests to assess integrity of cooked potato</p> 	<ul style="list-style-type: none"> • TMS Lightweight Three Point Bend (432-248)
<ul style="list-style-type: none"> • 5mm ϕ and Smaller S.S. Cylinders (432-071 to 432-074) 	<ul style="list-style-type: none"> • TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) 		
<ul style="list-style-type: none"> • 10mm ϕ Smaller S.S. Cylinders (432-066 to 432-074) 	<ul style="list-style-type: none"> • TMS Lightweight Blade Set (432-245) • TMS Large Craft Knife (432-295) • TMS Wire Shear Probe And Plate (432-242) 	<ul style="list-style-type: none"> • TMS 75mm ϕ Compression Platen (432-010) • 1" Ball Probe (432-088) 	<p>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.</p>

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Product	Description	Core Characteristics
Pastes & Pulpes Purées Pulpes Weak Jellies & Sauces	Very thick and viscous slurries made from processed fruit. Pulpes and purées are often concentrated and include fibrous material that adds structure.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • Physical strength & resilience • Internal pith & skin tensile strength • Flesh firmness



Product	Description	Core Characteristics
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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.	<ul style="list-style-type: none"> • Maturity & ripeness • Resilience to processing & handling • Harvest resistance • Bio-yield point or skin toughness • Whole fruit firmness
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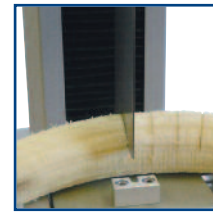
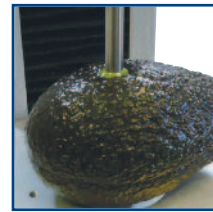
Semi-solid
 Flows if unsupported, poured, pumped, extruded or spread during handling or consumption

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.	<ul style="list-style-type: none"> • Gel strength • Elasticity & consistency comparisons • Relaxation & failure properties over time • Spreading consistency
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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.	<ul style="list-style-type: none"> • Skin strength & toughness • Yield point & resilience • Ripeness & softening profile • Pitting properties for processing
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Starchy Fruit Bananas Plantain	Pasty homogeneous starchy fruits with very soft texture. Easily mashed to pulp or follow viscous behavior when squashed.	<ul style="list-style-type: none"> • Ripening process changes & effect of modified environments • Firmness & rigidity
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Solid
 Self-supporting structure, deformed, squashed, sheared or snapped during handling or consumption



Choosing The Right Fixture

	Extrusion	Bulk Analysis
Pastes & Pulpes Purées Pulpes Weak Jellies & Sauces	• TMS Extrusion Cell (432-026) • TMS Extrusion Cone (432-027) • TMS Extrusion Platen Set (432-029)	Test small irregular berries and fruit pieces in bulk, like eating a handful of raisins
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	• FTC Standard Shear Compression Cell (432-240)
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
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Multiple site tests are used to measure products with variable textures like pushing a fork into a tomato

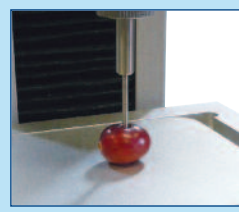
Use small cylinders, balls, needles and cones to punch into fruits and measure their firmness

Cut across a section of the sample just like biting into an apple or cutting through a strawberry

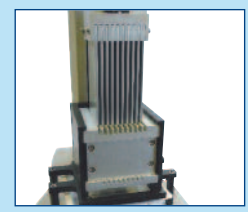
Squash a small sample with a flat or rounded probe like squeezing a fruit in your hand

- 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)

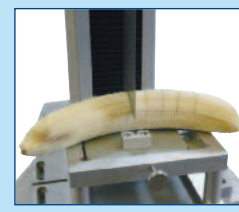
- TMS Lightweight Blade Set (432-245)
- TMS Large Craft Knife (432-295)

- 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



- 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)

- 5mm ø Smaller S.S. Cylinders (432-071 to 432-074)
- TMS Magness Taylor Probe Set (432-241)

- TMS Wire Shear Probe And Plate (432-242)

- TMS 75mm ø Compression Platen (432-010)
- 1" Ball Probe (432-088)

Penetrate citrus fruit to measure peel characteristics



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.

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.

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