TEXTURE ANALYSIS FOR ASSESSING MEAT TENDERNESSS

tenderness, juiciness, flavours

The quality of meat is determined by a number of factors that affect palatability (tenderness, juiciness and flavour). Such factors include the degree of maturity, colour of lean, texture, and finally the degree and distribution of marbling. The determining factors for meat quality however, are multi-factorial and complex. This is because of the highly organized and complex structure of muscle tissue and the various processes the raw meat will undergo such as slaughter methods, storage time, storage temperature (freezing, chilling), salting and smoking amongst others all of which will affect the final texture.

Meat tenderness is an important attribute for meat texture and palatability such that any variations in tenderness will influence a consumer's decision making process to repurchase (Bindon & Jones, 2001). The texture of meat is influenced by the cook time and temperature. A correlation between meat texture and heat-induced denaturation of meat proteins has been reported for beef (Bertola et al 1994). The tenderness of cooked meat will be largely influenced by connective tissue and myofibrillar components. This is because during heating, a number of chemical changes associated with the muscle fibres and connective tissues occur. The cooking temperature therefore has a marked effect on the force deformation curve for meat.

Heat on meat will also change its water holding capacity (WHC). Meat generally contains 75% water. At high temperatures greater than 55o, myofibrillar proteins denature and coagulate causing shrinkage of fibres and tightening of the myofilaments. This results in an increase in evaporation and drip loss and a much drier meat texture that is less juicy and tender. The texture of cooked meat therefore depends on the combination of intrinsic factors (water loss, collagen content and denaturation of myofibrillar proteins) and extrinsic factors (cooking time and temperature) Meat Science 80 (2008) 960–967.

The main textural characteristics of meat are firmness (toughness or degree of tenderness), cohesiveness and juiciness. There are various methods of evaluating meat texture. Such methods include sensory, instrumental and indirect (collagen content and amount of dry matter etc). Instrumental methods are mechanical tests that measure the applied resistance of the meat to a force acting on it. Common methods for assessing meat tenderness include shearing as with the Kramer Shear Cell and Warner Bratzler shear blades. Other tests include tensile testing using dual grips or compression tests using a Texture Profile Analysis (TPA) test which is a two bite test. In these tests, the meat tenderness is measured as the force or energy required to cut (penetrate), tear or compress (deform) the meat. Samples need to be large enough and precisely defined. A TPA test simulates the biting action in the mouth. It consists of a 2-cycle compression test. Here the sample should have a smooth level surface with a diameter smaller than the flat faced cylindrical probe. This test gives the textural parameters of tenderness (hardness), adhesion, springiness, cohesiveness, chewiness and gumminess.

The Warner Bratzler shear blades measure the force required to cut through the meat simulating the cutting of meat in the mouth during the first bite. Such tests are not pure shear tests but a combination of shearing, compressive and tensile stresses. The sample is positioned such that the cut is perpendicular to the muscle fibres this way shorting the muscle fibres and making the meat more malleable. Cutting the meat parallel to the grain gives cuts with long muscle fibers that ultimately make the meat tough to chew on. Thin slices cut against the grain makes very short cuts of muscle fiber that are hardly held together making the meat tender. However, the width of the slices and length of the muscle fibers for each cut needs to be consistent and so does the angle between the probe and muscle fibers set at about 90 degrees.

Tensile methods are used for structural assessments of beef or pork using cooked or raw samples. The meat sample is gripped using pneumatic grips and extended in the tensile direction at a set speed during which time the sample is torn apart. The sample can be griped such that the tensile force is applied transverse or parallel to the muscle fibres. However, as with many test types, the width and thickness of the sample needs to be consistent.

The Kramer Shear Cell

The Kramer shear cell with its multiple blades allows for samples of variable geometry to be sheared. The results for hardness and work done are therefore an average of the forces required to shear the sample of variable geometry. This fixture incorporates the textural methods of compression, shearing and extrusion through slots in the base of the cell. Prior to the test, cut cubes of the meat sample are weighed then placed into the cell ensuring a level surface.

Here we show the tenderness of cut cooked chicken chunks using the Kramer Shear Cell. 30 g of chicken cubes have been weighed and filled into the Kramer Shear Cell. At the start of the test, the blades approach the meat surfaces at a pre-test speed of 2 mm/s. When a trigger force of 10 g has been detected at the sample surface the blades proceed to compress, shear and penetrate through the sample over target distance of 35 mm at a test speed of 2 mm/s as shown in Figure 2.

The maximum force value on the graph is a measure of sample hardness/firmness (see Figure 1 and Figure 2). This value correlates with the amount of force required by the teeth to compress and cut into the sample; the higher the value, the firmer the sample.

The area under the graph from the start of the test to the target distance of deformation (see Figure 2 load/distance graph) is a measure of work done. This value correlates with the amount of energy required to overcome the strength of the internal bonds within the sample. The higher the value, the more energy required to breakdown the sample.

The table below summarises the results taken from 4 tested samples of cooked chicken from the same batch:

Sample	Hardness (g)	Work Done (mJ)
Cooked Chicken	10038 + 699	1598 ± 14.1

The graphs to show the firmness and work done to shear and penetrate 30 g of cut and cooked chicken chunks using the Kramer Shear Cell.
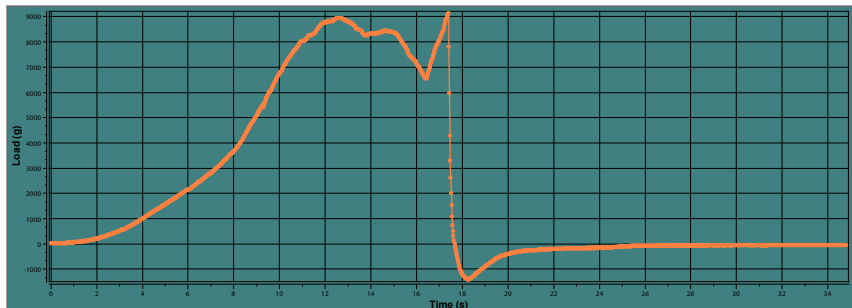

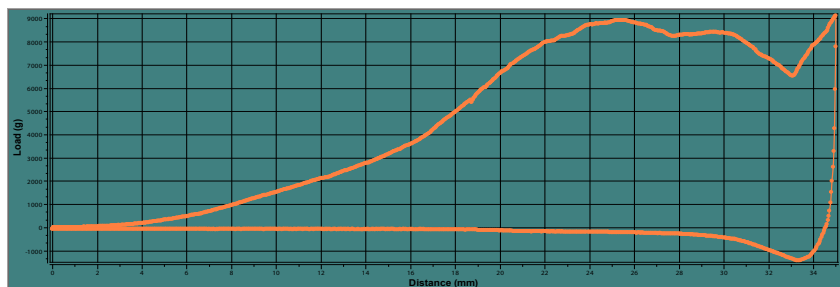Figure 1: The firmness of meat is measured as the peak force value as seen on the graph

Figure 2: The firmness of meat is measured as the peak force value as seen on the graph and the work done as the area under the graph.

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