TEST PRINCIPLE

Evaluating the hardness of dry cooked beans by bulk compression.

BACKGROUND

The compression test is a common method used to measure the force required to cause sample failure. The maximum force characterizes the hardness of the sample. The area under the curve for the force applied vs. sample deformation is a measure of the energy required to crush the sample.

METHOD

EQUIPMENT:
 CT3 with 50 kg load cell
 Fixture Base Table (TA-BT-KIT)
 Ottawa Cell (TA-OC)
 Extrusion Plate
 Catchment Drawer
 TexturePro CT Software

SETTINGS:

Test Type:	Compression
Pre-Test Speed:	2.0 mm/s
Test Speed:	2.0 mm/s
Post-Test Speed:	Select return at test speed
Target Type:	Distance
Target Value:	10 mm
Trigger Force:	50 g
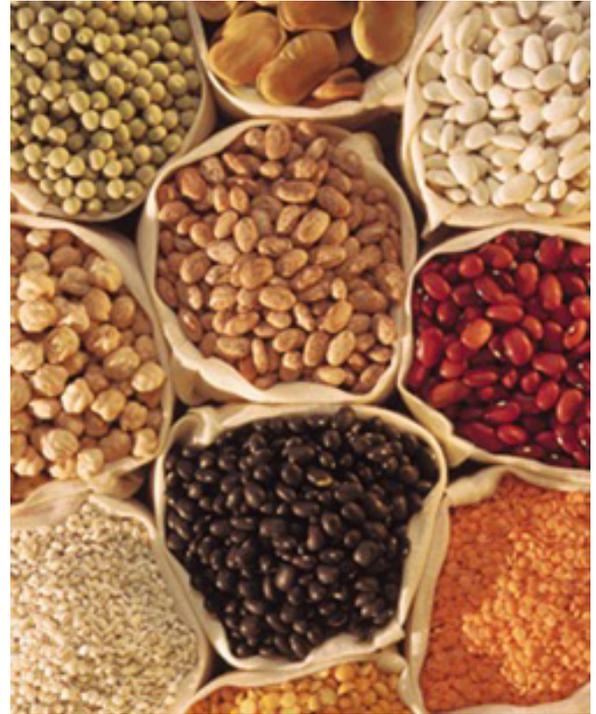
SAMPLE PREPARATION

Remove the beans from their storage bags just prior to testing. Weigh out 30 g of beans and pour the sample into the Ottawa cell (this quantity will be sufficient to fill approximately 50% of the Ottawa cell).

PROCEDURE

1. Attach the plunger to the instrument.
2. Place the fixture base table to the base of the instrument and loosely tighten the thumb screws to enable some degree of mobility.
3. Insert an empty Ottawa cell onto the base table and tighten into position using the side screws.
4. Align the plunger to the Ottawa cell by lowering the plunger and re-adjusting the position of the Ottawa cell such that the plunger can be lowered into the cell without touching the edges of the cell.
5. Once alignment is complete, tighten the thumb screws of the base table to prevent further movement.
6. Place a catchment drawer under the Ottawa cell to catch any extruded sample.
7. Raise the plunger to enable easy removal of the cell.
8. Place the weighed sample into the Ottawa cell and spread it out to create a level surface.
9. Return the cell containing the sample back onto the base table remembering to tighten the side screws.
10. Lower the plunger to a few millimeters above the sample surface.

Note: For comparison purposes, the starting distance above the sample surface should remain the same for all samples tested. The plunger was lowered to 50 mm from its starting position so that it was only a few millimeters above the sample surface. The chosen starting position should be such that the plunger does not come into contact with the sample surface before the test.

11. Commence the test.
12. When proceeding to the next test, clean the plunger, extrusion plate and Ottawa cell to remove any trace of a previous sample.

Note: When optimizing test settings, the hardest sample is best tested first in order to predict the maximum testing range for subsequent samples.

RESULTS
The following graphs show the hardness of dry cooked beans for different cooking time intervals.
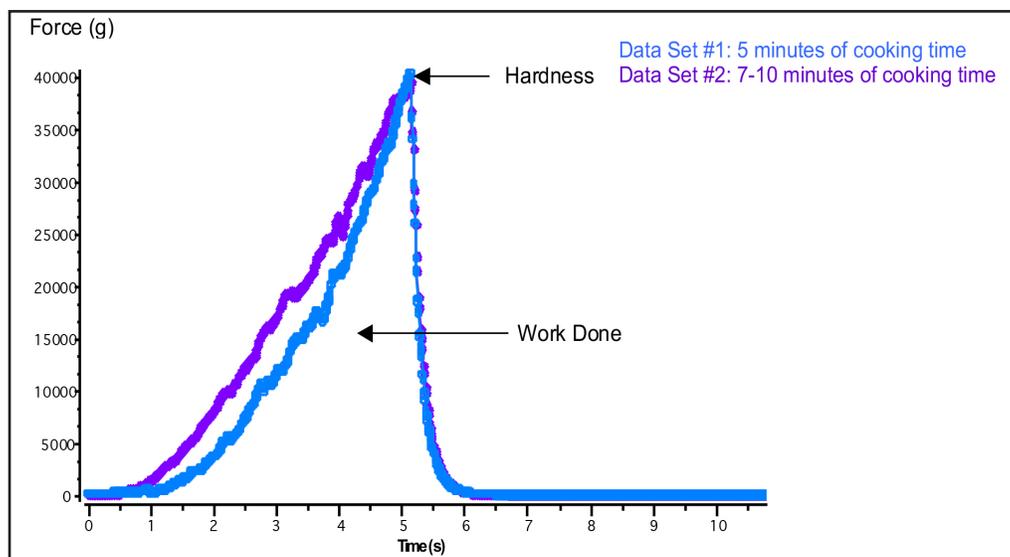
Figure I

Figure I shows force versus time; the peak value is the hardness of 30 g of beans cooked for 5 minutes and 7-10 minutes respectively. Test have been carried out a room temperature.
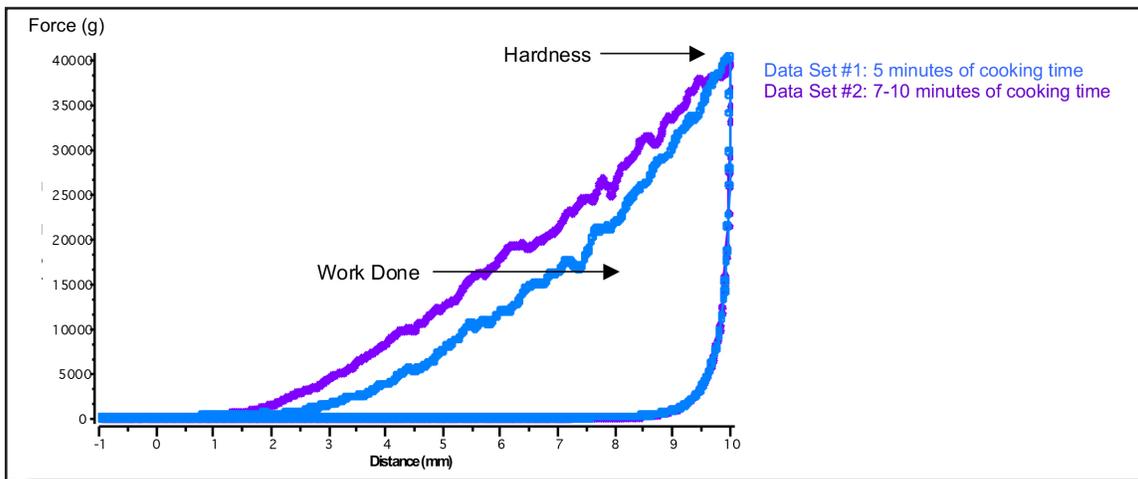
Figure II

Figure II shows force versus distance; the peak value is the hardness of 30 g of beans cooked for 5 minutes and 7-10 minutes respectively. As the plunger compresses the sample over a distance of 10 mm, the load is seen to increase. Once the specified distance has been attained, the plunger withdraws from the sample, returning to its starting position as indicated on the lower part of the graph.

DISCUSSION

When a trigger load of 50 g has been attained at the sample surface, the probe proceeds to compress the sample to a specified distance of 10 mm. During this time, the force increase, as the sample begins to fracture.

The maximum force value obtained over the specified distance is a measure of hardness. The higher the maximum force value, the harder the sample. The area under the curve is a measure of the hardness work done; the larger the area under the curve the harder the sample. From figure 1, 7-10 minutes beans are harder requiring more energy to compress than those cooked for 5 minutes.

Bean Cook Time	Hardness (g)	Work Done (mJ)
5 minutes	40185	1107.2
7-10 minutes	39465	1454.9