Cheese Anyone?

Texture of cultured dairy products, such as cheese, is a very important characteristic to most consumers. Texture is a physical property that is usually characterized by sensory evaluation, but it may also be measured by mechanical testing. Optimally, the test results of both methods should be well correlated. This article considers how mechanical testing can affect the quality of the results and how these results correlate with those of sensory evaluation.

Figure 1: Brookfield Texure Analyzer

The machines used for physical texture testing are texture analyzers. (See Figure 1) These are fundamental compression and tensile test instruments that control both the rate and amount of deformation for a sample material while measuring the resistive force. This type of test can mimic the action of biting into an object, like a piece of cheese. The raw test output is therefore in the form of force versus deformation data. In other words, how much force is required to compress a sample of cheese. A data table of test results is difficult to comprehend by visual examination, so graphical data is typically presented. An example of testing cheddar cheese can demonstrate this process.

Effect of changing sample size

Cubes of sharp cheddar cheese were prepared in two sample geometries. Cubes 2cm and 4cm on a side are used to demonstrate the impact on results of changing sample size. Temperature effects were eliminated by conditioning all samples at 4°C overnight. Each sample was then removed from refrigeration and immediately tested. Testing was performed on a Brookfield Engineering CT3 Texture Analyzer using a 50kg load cell and compression top plate. A graph of force vs deformation shows two cheese cubes that have undergone uniaxial compression to half their initial height. The force-deformation graph shows a 20mm compression of the 4cm cube, and a 10mm compression of the 2cm cube with very different forces. Figure 2 shows the test results.

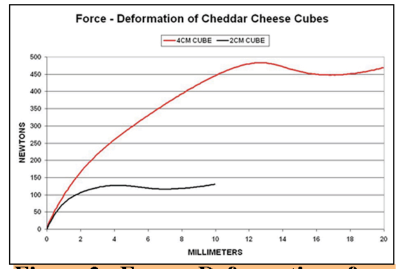

Figure 2: Force - Deformation of Cheddar Cheese Cubes

If one were to consume these cubes of cheese, we would most likely conclude they both have similar mouth-feel. Not so to the machine according to Figure 2. If the raw force and deformation data are converted to stress and strain, the effect of size differences are removed and data between different size samples can be more easily compared. (See Figure 3) This is because both stress and strain include sample size information.

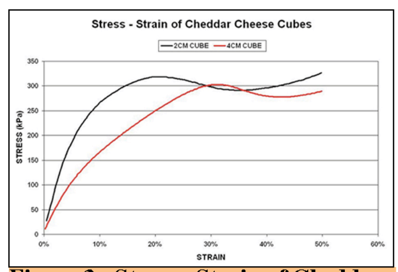

Figure 3: Stress - Strain of Cheddar Cheese Cubes

It must be emphasized that exact sample dimensions must be known in order to accurately convert force and deformation to stress and strain. The size and shape of the samples must be accurately entered into the test method software in order for this conversion to fully compensate for size differences.

Larger sample dimensions usually produce more repeatable test results in instrumental testing. Some size variation will inevitably occur during sample cutting. These variations, no matter how small, have a greater effect upon smaller samples than upon larger ones. Figure 4 shows that test results with larger samples are easier to reproduce, and the data are more repeatable, than with smaller samples.

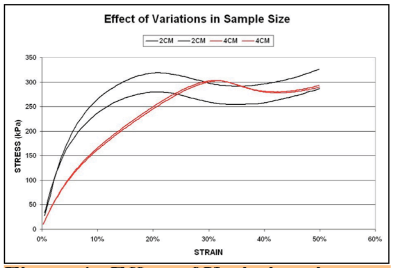

Figure 4: Effect of Variations in Sample Size

Effect of changing test speed

The speed of a compression test can also have a significant effect upon the test result. The magnitude of the effect is determined by properties of the material being tested. Figure 5 shows the stress vs strain test

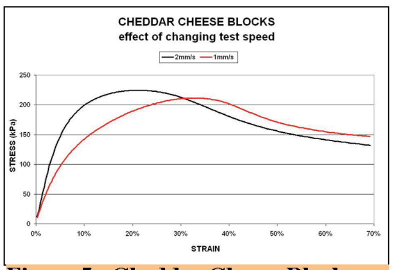

Figure 5: Cheddar Cheese Blocks effect of changing test speed

result of two 4cm cubes of the same cheese. Test speed is the only difference. The relaxation rate of this particular cheese is one of the reasons these two curves are not identical. Most products will relax while held under constant strain. Relaxation causes the measured load force at that strain to decrease. The load force at 1mm/s is lower than at 2mm/s early in the test because at 1mm/s the test takes longer. Since the cheese is relaxing during the test, a longer test time results in a lower load force. Notice there is a cross over point at which the relationship between the curves changes. This is because the peak stress occurs just before the cheese specimen begins to fracture. Prior to the fracture point, the cheese is flowing. When strain is applied more gradually, this cheese can sustain a higher strain before it fractures. After the fracture strain is reached, stress decreases in both cases.

Conclusion

It should come as no surprise that there are a number of considerations concerning mechanical (instrumental) measurements that need to be recognized in order to achieve results that will be correlated to those of a rigorous sensory method. These concern both sample preparation and test method parameters. In general, larger rather than smaller samples are preferable and a decision on test speed should include some consideration of sample relaxation rate.

Additional considerations include the following: a) Making sure the top and bottom surfaces of each cube are parallel b) The probe diameter should be larger than the sample under test c) All sample surfaces should be lubricated so that the specimen is free to expand as it is compressed.

Our technical staff at Brookfield Engineering will be happy to discuss these, and any other sample testing issues, with you.

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