Texture Evaluation of Potato Crisps

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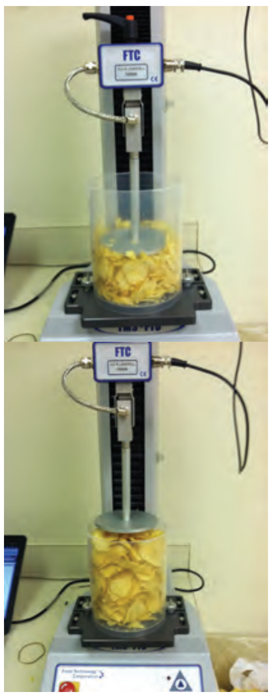
The following data was gathered for a potato crisp processor, in an effort to come up with a consistent and objective way to evaluate their potato products, specifically its hardness. Current methods include mostly subjective sensory type testing. While sensory is important, it is subjective and varies from person to person.

Three different samples were evaluated. They were as follows:
- Regular Potato Crisps (Sample A)
- Kettle Crisps (Sample B)
- Kettle Crisps (Sample C)

This study was completed by a manufacturer of texture analysers (Food Technology Corporation, Sterling, VA, USA). They were tasked by the crisp producer to develop a method that would be able to show a difference in the product that was sent. In order to fine tune the method without destroying the product that was sent by the client, additional product was purchased at a local store in order to come up with the best method. Once they were satisfied with the methodology, testing moved on to working with the actual product that was sent by the customer.

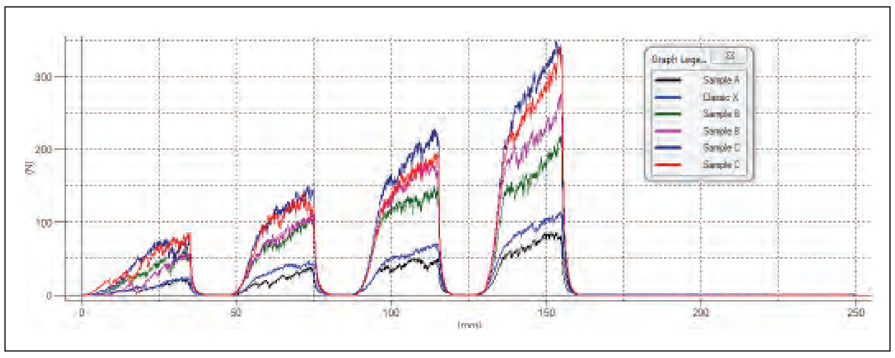
Materials and Methods

All testing was done using FTC's TMS-Pro Texture Analyzer, fixed with a 1000N Intelligent Load Cell (ILC) that was fitted with a custom setup designed by FTC. The actual fixture setup for the test included a 100mm compression plate and a plastic cylinder approximately 125 mm in diameter and 165 mm tall to contain the crisps while they were being compressed. As potato crisps are a product with extreme variation from crisp to crisp and bag to bag, the method had to be designed in a way that took this in to account, while still being about to consistently measure the texture of the product overall.



Each test replication involved the texture analyser doing 4 compressions to increasing levels of displacement. Each compression was at a speed of 1000 mm/min. The displacements were 120 mm, 100 mm, 80 mm, and 60 mm respectively. The displacement is based on the distance from the bottom of the container; which in this case was set to be absolute zero. After each compression, the system relaxed or backed off 10 mm from the compression displacement. The test program was designed to mimic the act of chewing. Once the test was complete, the work (or area under the curve) needed to for the system to 'chew' the crisps was calculated using the Texture Lab Pro software.

Below is the graphical representation of the samples that were tested. The X-axis is displacement and the Y-axis is force.



Below is a table showing the calculations that were done on the above graph.

Units	mJ	mJ	mJ	mJ	mJ
Sample A	3333	311.8	543.2	941	1528.2
Sample A	4471	366.6	786.8	1245.9	2054.1
Average	***3902***	***339.2***	***665***	***1093.5***	***1791.2***
Standard Deviation	***804.7***	***38.8***	***172.2***	***215.6***	***371.9***
COV	***20.62%***	***11.43%***	***25.90%***	***19.71%***	***20.76%***
Sample B	9055.1	918.8	1706.3	2752.6	3668.8
Sample B	10561.7	720.7	1843.3	3314.4	4672.5
Average	***9808.4***	***819.8***	***1774.8***	***3033.5***	***4170.7***
Standard Deviation	***1065.3***	***140***	***96.9***	***397.2***	***709.7***
COV	***10.86%***	***17.08%***	***5.46%***	***13.09%***	***17.02%***
Sample C	13960.9	1388.2	2516.3	3945.1	6104
Sample C	12888.1	1396.4	2367.9	3432.9	5674.6
Average	***13424.5***	***1392.3***	***2442.1***	***3689***	***5889.3***
Standard Deviation	***758.6***	***38.8***	***172.2***	***215.6***	***371.9***
COV	***5.65%***	***2.78%***	***7.05%***	***5.84%***	***6.31%***

Results and Discussion

Each individual peak represents a compression cycle. As each cycle goes to a further displacement, each peak is higher than the one previous. Looking at the graph, it appears that the clearest definition is between the 3 products in the last compression cycle. Graphically speaking, the difference between the samples is significant. This especially the case when comparing sample A (classic style potato crisp), to samples B and C (small batch kettle style crisps).

The table of results shows the work that was done during the test for each compression and the total of the 4 compressions. Based on this data, the total amount of work done gives the best overall picture of the product when trying to make a differentiation between the 3 sample groups, specifically the two kettle style crisps. In comparing the averages of sample B and sample C as a percentage, sample C requires more than 25% more work to compress the sample 4 times than does that of the sample B samples. Based on past experience in texture testing, this would be considered a significant difference. The standard deviation and coefficient of variation (COV) is higher than ideal but that is due the inherent variation in this product. Also, these results were produced with a limited amount of product. Additional replications should narrow the results to more acceptable levels of variation in the data points.

Conclusions

Based on the results, a significant difference between all three products can be produced using the described method. The final data concludes both kettle style crisps require more energy to 'chew' than the regular style crisps. Furthermore, it can be concluded that the sample C Kettle crisps require more energy in this test than the sample B Kettle crisps. Utilising the client's terminology, the sample C crisps would be considered to be harder. This was the expected result and the point of most interest to the customer.

While the product is quite variable and will need multiple replications to obtain good statistical data, the methodology for this application is capable of producing consistent, repeatable results. This consistency was accomplished by increasing the sample size to a point where the extreme variation from crisp to crisp in regards to size, shape, starch dispersion, water dispersion, etc., did not have as much of an effect on the overall texture of the product. Being able to evaluate the samples as a whole, instead of on an individual crisp basis is important as the consumer generally quantifies this product overall and not individually.

The ultimate goal with this study and all texture measurement using analytical instrumentation is to correlate the objective data from the texture analyser with the historical sensory data. The reason this is important is that even the best sensory evaluation is subjective. Every person is different and that extends to the way each of us view texture. By correlating with something that is objective and unchanging, processors can be assured that any differences are due to variances in the product instead of differences in how each person evaluates the texture of any product.

Once a processor has correlated the data from the two sources, they are able to determine a target range that they know is acceptable. Using the software for the texture analyser, this target can be loaded directly into the system. The producer would then have immediate and objective measurements as to whether their product falls within the range that they deemed as acceptable (pass/fail). This gives them the ability to adjust the processing formulation in real time instead of waiting for sensory study to be completed, reducing downtime, rework and cost in the process.