APPLICATION NOTE

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Crunchiness of biscuits – Texture analysis on a rheometer

Author:
Klaus Oldörp,
Thermo Fisher Scientific, Karlsruhe, Germany

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Introduction

Biscuits or cookies, no matter what they are called, they need to have the right taste and the right bite. While the first is a rather subjective matter and can lead to lengthy discussions, the latter can be tested in a very objective way with a rheometer.

Apart from the classic measuring parameters shear rate, deformation and stress, a modern rheometer comes equipped with an additional sensor to detect normal force. Thus, combined with its precise lift a rheometer can do texture analysis as well.

Figure 1: The Thermo Scientific HAAKE MARS iQ Rheometer

Materials and methods

For testing biscuits, a Thermo Scientific™ HAAKE™ MARS™ iQ Rheometer (Figure 1) was equipped with the 3-point bending-accessory [1], using the 8 mm plate as the probe (Figure 2). Other probes can easily be adapted to the measuring head using the universal adapters U1 with a 6 mm bore or U2 with a 4 mm bore.

The measuring protocol starts with zeroing the normal force and lowering the probe to a position still high enough to allow a quick placement of a fresh biscuit onto the lower supports of the 3-point-bending accessory. For the tests discussed here, a position about 2 mm above the biscuits upper surface has been used.

The lower supports of the 3-point-bending-tool were positioned 5 cm apart from each other to support the biscuit approximately 0.8 cm from its edges. The biscuit was placed onto the lower supports with its centre under the probe (Figure 2).

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Figure 2: Setup for breaking biscuits in start position

From its starting position, the probe moved towards the biscuit with a speed of 0.1 mm/s. The measurement was started when the surface of the biscuit was detected with a trigger force of 0.1 N. The corresponding lift position was used as zero position Δh = 0, from which the amount of bending was measured. From this point on, the probe went downwards with 1 mm/s while 200 data points per second were recorded.

At the end of its downwards movement the probe automatically went up again to the starting position. The Thermo Scientific™ HAAKE™ RheoWin™ Software then displayed a message to place the next biscuit and start the next measurement from the touchscreen or with a mouse click. The number of required cycles was programmed in the RheoWin Job. At the end of every cycle the data from the last measurement was saved using an automatically generated filename (Figure 3). The user only had to place the biscuits and confirm to start the next measurement.

The measurements have been done in two sessions. During the first session, biscuits have been tested directly after opening their sealed package. Afterwards, the remaining biscuits were left on the lab bench in their opened packaging. The main change that can be expected is the absorption of moisture from the ambient air, which usually leads to a slight softening of the biscuits. After 14 days, the remaining biscuits were tested with the same test method.

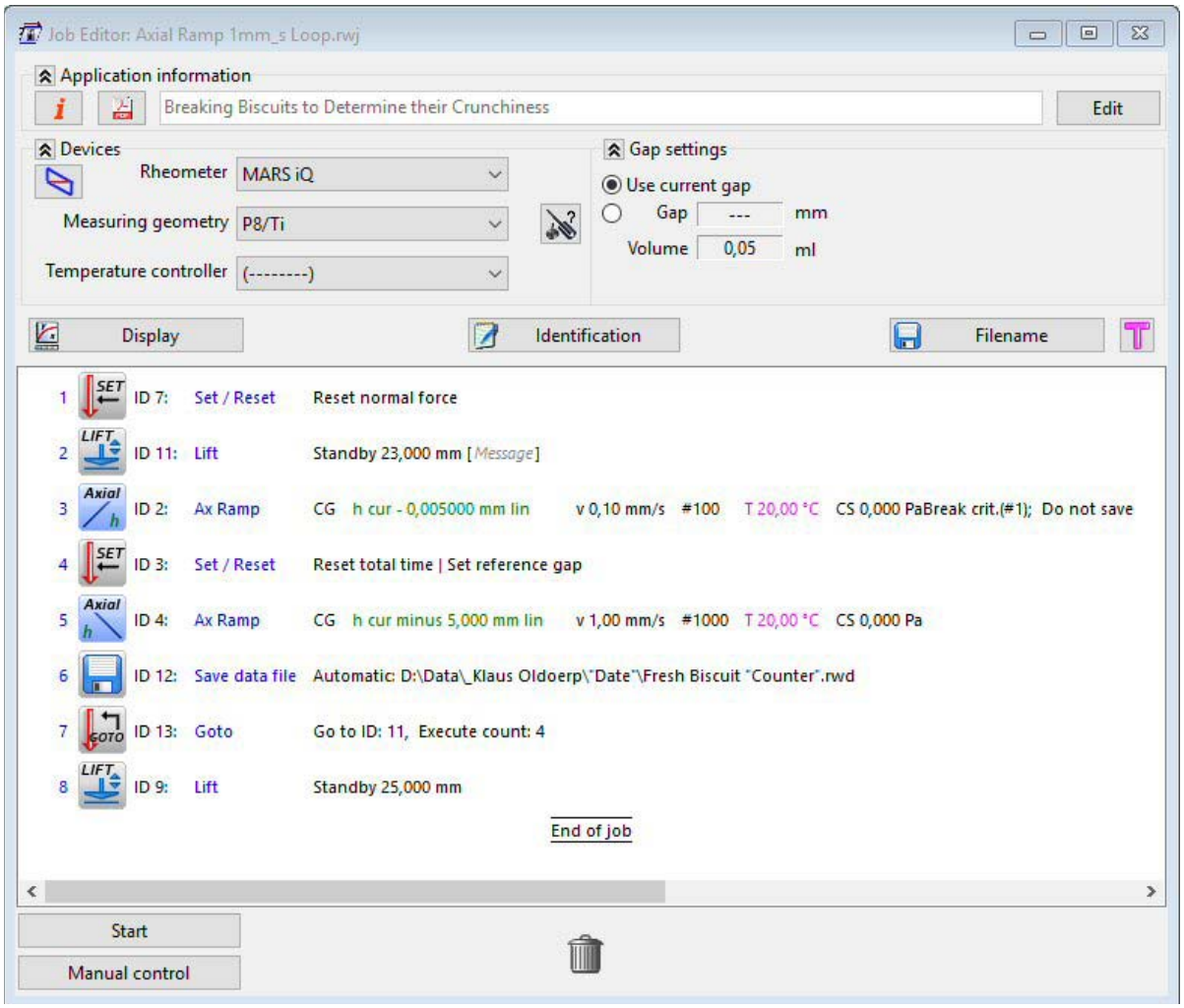

Figure 3: RheoWin Job using the GOTO-element to create a loop to perform the same breaking test 5 times and saving the results separately during each cycle

Results

To evaluate the data, the axial force F_N is plotted as a function of the probe position Δh and the maximum of the curve is determined (Figure 4, Figure 5).

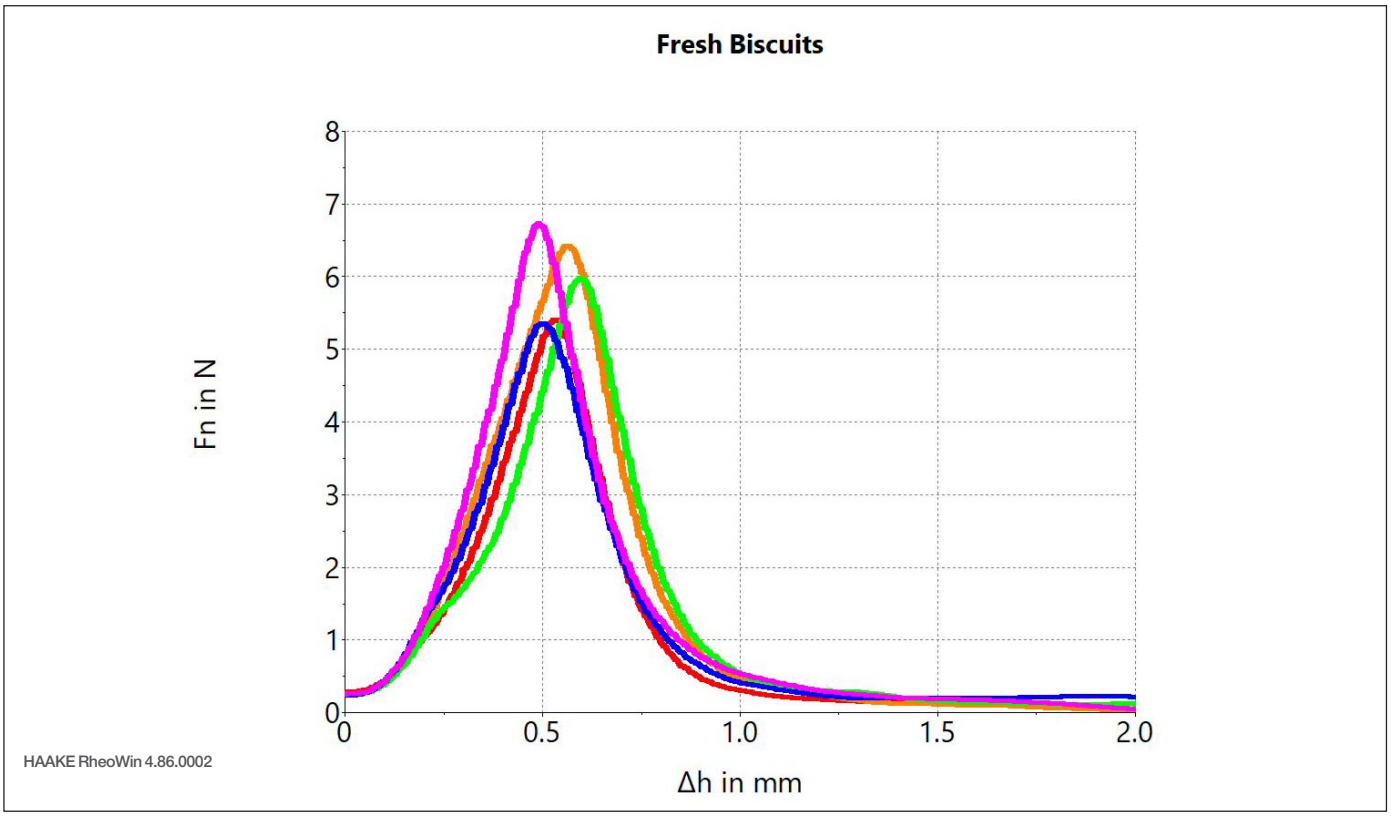

Figure 4: Breaking tests on fresh biscuits (5 repetitions)

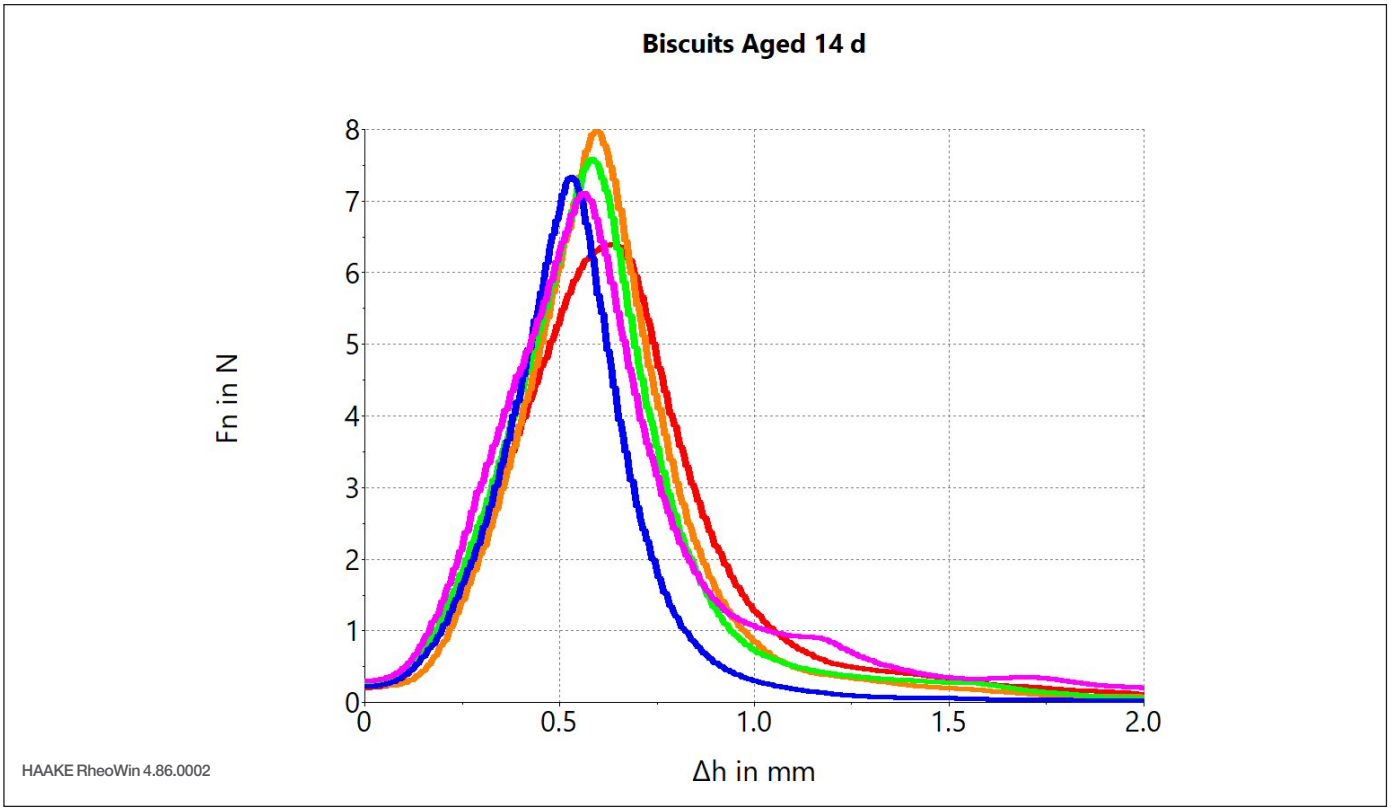

Figure 7: Breaking tests on biscuits aged for 14 days in the opened package (5 repetitions)

The results scatter around an average value, which is absolutely normal because no two biscuits have exactly the same density distribution and pore structure. It is therefore recommended to always perform a certain number of breaking test on the same product to get a statistically sound result.

Table 1: Amount of bending and force at curve maximum of fresh and aged biscuits

	Fresh biscuits		Biscuits aged for 14 days	
No.	Δh / mm	Fn / N	Δh / mm	Fn / N
1	0.633	5.384	0.633	6.395
2	0.563	6.395	0.596	7.927
3	0.596	5.943	0.584	7.545
4	0.501	5.332	0.530	7.289
5	0.490	6.684	0.562	7.065
Mean value	0.537	5.948	0.581	7.244
StdDev	0.039	0.536	0.034	0.512
rel. StdDev	7.31 %	9.02 %	5.90 %	7.07 %

From the individual results, the mean average and the standard deviation were calculated as a basis for the comparison (Table 1).

Compared to the fresh biscuits, the aged biscuits broke on average at a 22 % higher force. The absorption of moisture has resulted in a more flexible structure. This assumption is supported by the bending of the biscuits at maximum force, which is increased by 8 % on average.

Conclusions

Supplemented by a simple accessory, the HAAKE MARS iQ Rheometer is able to measure the influence of the storage of biscuits in the open pack on their texture. The absorption of humidity softens the cookies over time and will therefore change their crunchiness and their perception by the consumer.

In addition to the rheological characterisation of the ingredients and the dough prepared from them, the HAAKE MARS iQ Rheometer also allows to quantify the texture of the final product, offering a full analysis of every step from the raw materials to final product.

References

1 Thermo Fisher Scientific Product information P014 “Sample fixture for bending and breaking tests for HAAKE MARS Rheometer“ Cornelia Küchenmeister-Lehrheuer, Klaus Oldörp

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