Analysis of Pasta Using Controlled Humidity
Dynamic Mechanical Analysis and Moisture Sorption Analysis

ABSTRACT

This paper discusses the dynamic mechanical analysis and moisture sorption analysis of pasta under varying conditions of temperature and relative humidity.

INTRODUCTION

Moisture content in cooked pasta is the primary factor affecting texture and mouth-feel, two properties which are directly related to the mechanical behavior of the material. The control of these parameters is of great interest to pasta manufacturers, as precooked products are becoming increasingly popular. It is known that a distinctive moisture distribution in pasta can be correlated to the so-called "al dente" state. The goal is to develop precooked pasta with an al dente texture similar to that of freshly prepared pasta. However, the texture of pasta deteriorates very rapidly after cooking and during distribution to stores. It is thus important to understand the combined effect of temperature and humidity on the pasta structure, so as to optimize the production, transportation and storage stability, as well as to control the texture and end-use properties.

The TA Instruments DMA-RH Accessory allows the mechanical properties of a sample to be analyzed under constant and/or varying conditions of both relative humidity and temperature. It is designed for use with the Q800 Dynamic Mechanical Analyzer. The DMA-RH accessory is an integrated unit and contains the following components:

Figure 1: The TA Instruments Q800 Dynamic Mechanical Analyzer and DMA-RH Accessory

1. The sample chamber mounts to the DMA in place of the standard furnace and encloses the sample. Peltier elements in the chamber precisely control the temperature to within ±0.1°C. The sample chamber accommodates standard DMA clamps including tension,

cantilever, and 3-point bending, and can be easily removed for rapid conversion back to the standard DMA furnace.

2. The DMA-RH Accessory contains the humidifier and electronics which continuously monitor and control temperature and humidity of the sample chamber. The DMA Q800 and the DMA-RH Accessory are fully software-integrated.
3. A heated vapor transfer line is maintained above the dew point temperature of the humidified gas in order to avoid condensation and provide accurate results.

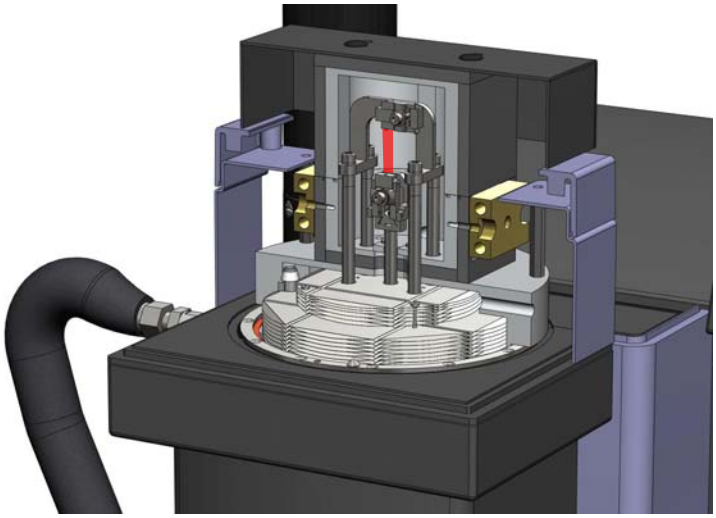

Figure 2: Sample Chamber of the DMA-RH Accessory

The DMA-RH accessory allows for the control of temperature over the range 5-120°C, and humidity over the range 5-95% RH. As such, it is well-suited to pasta and other food materials in which mechanical properties are of interest in this temperature and humidity range.

RESULTS & DISCUSSION

A dry fettuccine pasta sample (10.6mm x 4.7 mm x 1.4 mm) was measured in single cantilever mode, at 60°C with a frequency of 1 Hz and amplitude of 20 µm (0.06% strain).

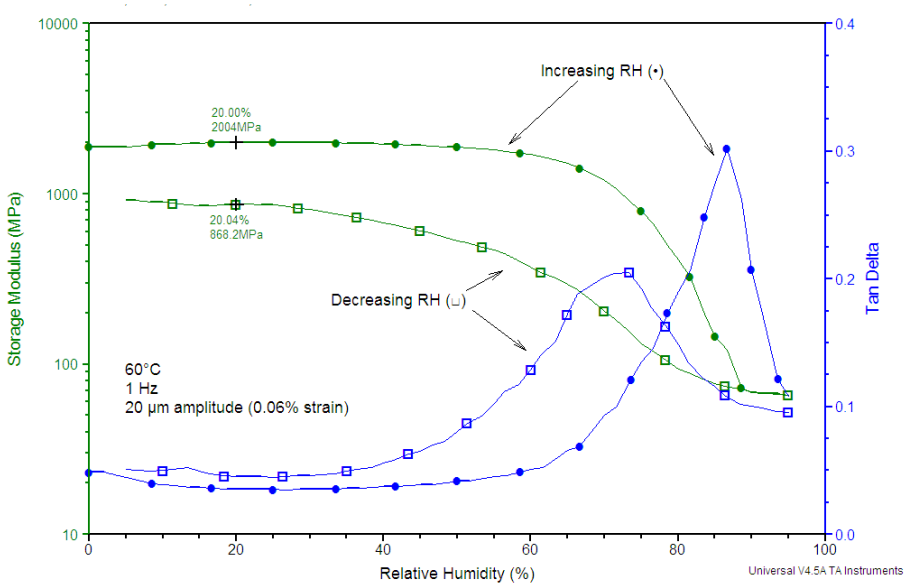

Figure 3: DMA Results for Pasta with Increasing and Decreasing RH

The relative humidity was stepped over the range 5-95-5% RH in 5% RH increments, followed by an isohume at each RH level for 60 minutes to ensure sample equilibration. The data are shown in Figure 3. It is clear from the results in Figure 3 that the structure of the pasta material undergoes a significant softening near 70%RH. The relatively sharp tan delta peak suggests a rapid decrease in mechanical strength, which could be correlated to the onset of the al dente texture. Upon decreasing the RH, the transition exhibits reversibility; however the material does not regain the original modulus of the dry pasta. This could be attributed to water retention in the structure which plasticizes the material, or to an irreversible change in morphology, such as gelation or gelatinization of the starch molecules.

To further investigate the mechanism, a sample of the pasta was analyzed by gravimetric moisture sorption analysis on the Q5000SA moisture sorption analyzer. An analogous temperature/RH profile was applied, except that the sample was initially dried at 0% RH for 2 hours. The moisture sorption results are shown in Figure 4.

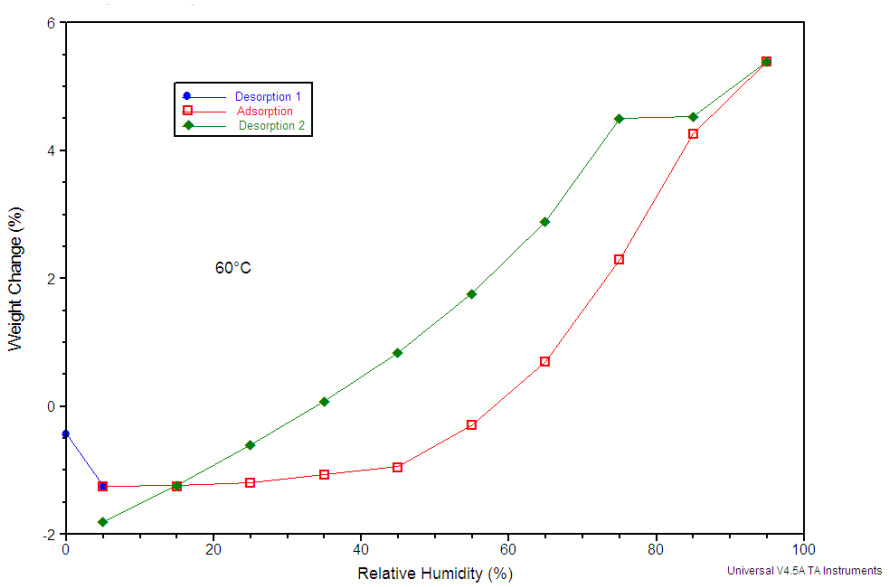

Figure 4: Moisture Sorption Analysis of Pasta Material

These results correlate well with the DMA analysis, in that the material exhibits a significant adsorption of moisture near 70% RH. However, this uptake is completely reversible, as indicated by the green desorption line in the results. This suggests that the measured irreversibility of the modulus is not due to water retention and plasticization, but rather to an irreversible morphological change in the material.

CONCLUSIONS

The data presented illustrates the effect of relative humidity on the mechanical properties of pasta. These properties can be directly correlated to the texture and mouth-feel of the material. They are also very useful in predicting the transportation and storage stability of the pasta. The TA Instruments Q800 DMA and DMA-RH Accessory along with the Q5000SA Moisture Sorption Analyzer provide the ideal platforms for these studies.

REFERENCES

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