AN FTIR STUDY OF COOKING AN EGG

Figure 1. The DiaMaxATR™ with its heated cell and temperature controller.

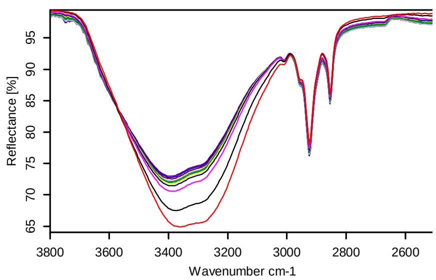
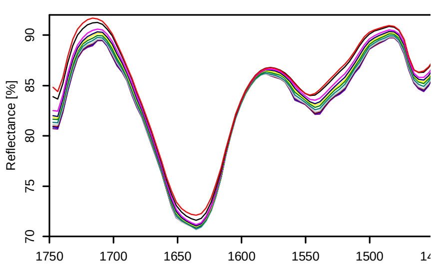


Figure 2. ATR spectra of an egg yolk cooking. The spectrum recorded at ambient temperature is shown in red and one recorded after ~40 minutes is in teal.



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INTRODUCTION

Heating foods and beverages can lead to a variety of chemical changes. These changes can effect storage lifetime and nutritional value. Hence there is a continuing need for highly sensitive methods to detect these changes.

This applications note explores the potential of using a high-throughput single-reflection diamond ATR to detect structural changes in an egg upon heating.

EXPERIMENTAL

Infrared spectra were collected on an FT-IR spectrometer equipped with the Harrick DiaMaxATR™ single-reflection diamond ATR accessory with its Temperature Controlled Liquid Cell and Temperature Controller (Figure 1). The system was purged to remove water vapor and CO_2. Spectra were collected at 8 cm^{-1} resolution and signal averaged over 32 scans. A background was collected from the clean ATR crystal under ambient conditions.

The egg yolk was separated from the egg white. Then ~0.3 mL of the yolk or white was extracted using a syringe. The sample was then injected into the thermostated cell.

The first sample spectrum for each sample was collected at ambient temperature. Then the cell was heated to 100° C using the compatible Temperature Controller. Another spectrum was collected when the cell temperature stabilized and at 2 minute intervals thereafter. Data collection was controlled by Harrick ATC-Link™ software.

RESULTS AND DISCUSSION

The resulting spectra from measurements of the yolk are shown in Figures 2 and 3. With increasing temperature, the OH stretching band around 3500 cm^{-1} decreases in intensity as the water evaporates from the yolk and begins to appear as two underlying broad bands, centered around 3390 cm^{-1} and 3285 cm^{-1}. The former indicates the presence of amines and the latter carboxylic acids, both of which become more concentrated in the yolk as the water is driven off. In addition, changes are evident in the 1500 to 1700 cm^{-1} region, as expected from changes in the proteins induced by heating. The amide I bands at 1650 cm^{-1} and 1635 cm^{-1} are likely from the α and β helixes respectively. The broad underlying band in that region may indicate unordered amides. The peaks at 1560 cm^{-1}, 1540 cm^{-1} and 1522 cm^{-1} are amide II bands. The C-H stretches at 2959 cm^{-1}, 2924 cm^{-1} and 2856 cm^{-1} show no significant impact from heating. These bands are from the proteins, cholesterol, carbohydrates and fat in the yolk.

Figures 4 and 5 show the ATR spectra of an egg white with increasing temperature. The change in intensity of the O-H stretch in the egg white (Figure 4) is much greater than that in the yolk (Figure 2), as expected from the greater concentration of water in the egg white. Egg white is nearly 92% water by weight. This is consistent with the much weaker C-H stretches in the spectrum of the egg white which result from the lower concentrations of proteins, vitamins and glucose. In the 3600 cm^{-1} to 3300 cm^{-1} region, the N-H and O-H bands from the proteins, vitamins and glucose in the egg white become better resolved with temperature. In the 1500 cm^{-1} to 1700 cm^{-1} region (Figure 5), band shifts similar to those observed in the egg yolk are seen which are likely to a result of amide conformational changes.

Single reflection ATR spectroscopy is valuable for examining thermally induced changes in materials. Changes in the water concentration and amide bands of egg yolk and egg white were observed using the Harrick DiaMaxATR accessory. Further analysis is possible to obtain more rigorous identification of the heat-induced structural changes.

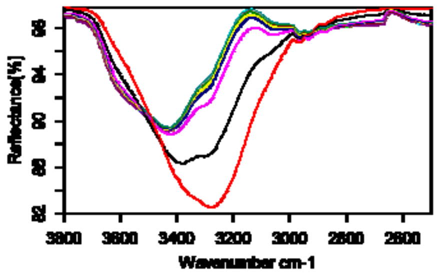

Figure 4. ATR spectra of an egg white cooking. The spectrum recorded at ambient temperature is shown in red and one recorded after ~40 minutes is in light blue.

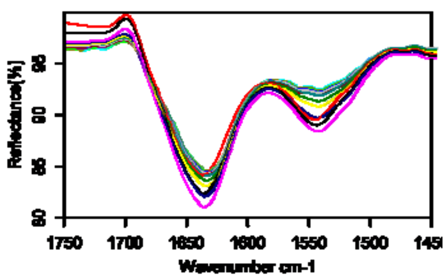

Figure 5. ATR spectra of an egg white cooking. The spectrum recorded at ambient temperature is shown in red and one recorded after ~40 minutes is in light blue.

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