Characterising Red Cabbage Anthocyanin Droplets Using Raman, Infrared and UV-Vis Spectroscopy

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1. Introduction

Red cabbage anthocyanins are water soluble plant pigments. They have natural indicator properties giving potential application in the determination of the pH of droplets.

Aerosol droplets, especially coloured absorbing droplets are difficult to stabilise in an optical trap and have unique optical properties differing from the bulk solution.

Use of anthocyanins is limited by difficulty in extraction and their instability, which is primarily due to pH, storage temperature and light making characterisation difficult.

The aims of this project was to trap an aerosol droplet in an optical trap and to develop a pH sensor for the determination of the pH in droplets.

https://www.organicfacts.net, 16/09/2016

2. Monitoring the Degradation of Anthocyanins by Infrared Spectroscopy

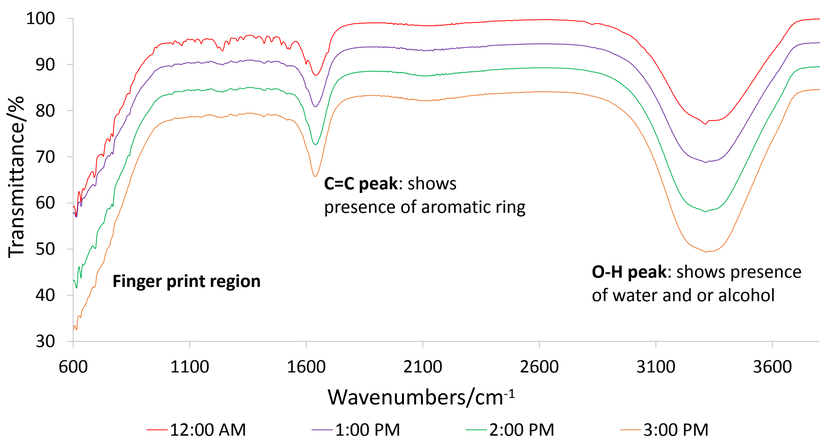
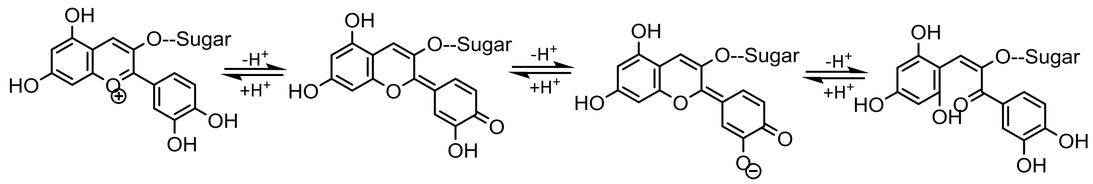


Figure 1: Anthocyanin prepared by boiling red cabbage in deionized water in darkness. Samples stored at room temperature in a dark place subsequent to analysis.

Method: With infrared spectroscopy bulk solution anthocyanin vibrational modes were recorded giving characteristic chemical information.

Results: The anthocyanins degraded rapidly; the resolution and detail of the spectrum was noted to deteriorate in the first hour.

3. Recording the Effect off pH on the Electronic Structure of the Anthocyanin Ring by UV-Vis



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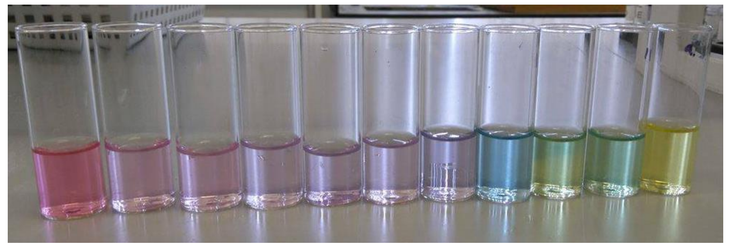


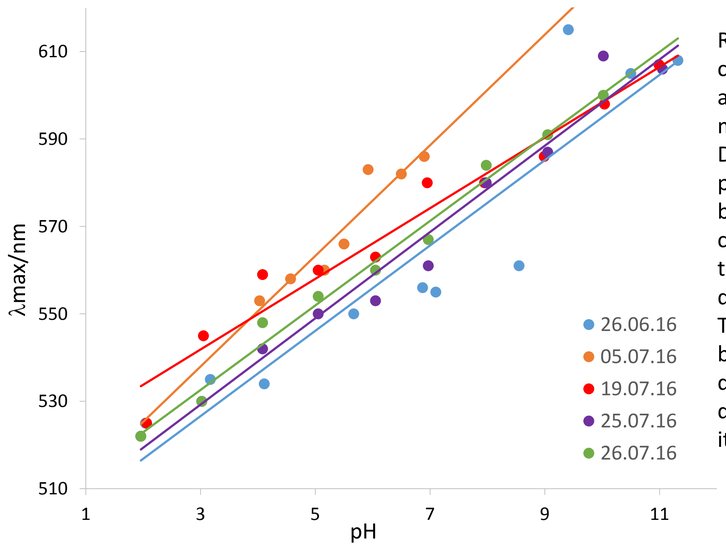
b

Figure 3a: Proposed schematic of the structural rearrangement of red cabbage anthocyanins at different pH .
Figure 3b: Photograph of aqueous red cabbage anthocyanins at pH 2-11.

The anthocyanin electronic structure is sensitive to pH, $[H^+]$; rearrangement gives derivatives with different colours.

Method: Red cabbage was used as a natural indicator to obtain an approximate value of pH for bulk solutions. The extent of the relationship between the pH and colour was recorded by UV-Vis for solutions of pH 2-11.

4. UV-Vis: Results and Discussion



Results: There is linear correlation between the pH and the absorbance maximum, λmax. Disregarding the change in properties differing between bulk solution and droplets, a crude method can be used to calculate the pH of a droplet by λmax.

The pH of a droplet alters its behaviour, and so the determination of the pH of a drop is then important for its characterisation.

Figure 4: Dependence of the absorbance maximum of red cabbage solution at different pHs. 0.001 M stock solution of NaOH and HCl was used to achieve the correct pH of red cabbage solution.

5. Characterising Anthocyanin Droplets by Raman Spectroscopy

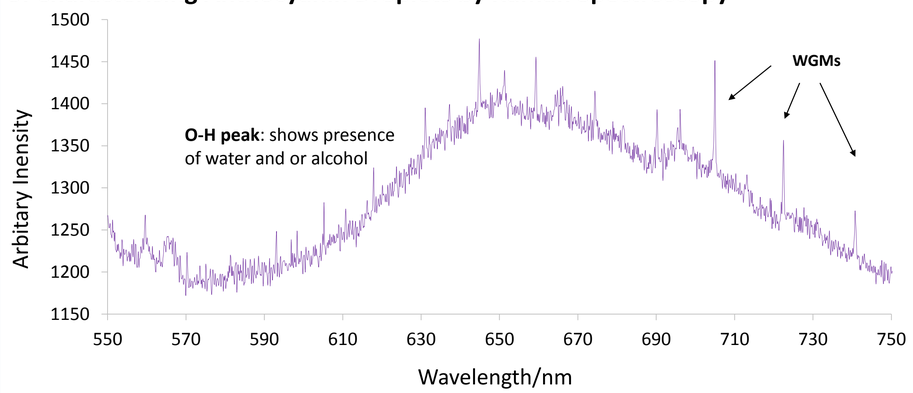


Figure 5: Red cabbage anthocyanin droplet obtained by optical tweezing, sample was prepared with 50% NaCl (100 g/l) solution and 50% conc. cabbage solution. AQUIS 10 s, grating 300 nm and laser power 46%.

Method: Raman spectroscopy recorded the scattering of light from the molecular vibrations of a coloured droplet, hence a unique chemical fingerprint was obtained.

Result: Whispering gallery modes (WGM) were recorded from light circling the droplet by internal reflection at the liquid-air interface. WGMs were used to obtain the refractive index and to size droplets.

6. Conclusion

Despite the instability of anthocyanins; a unique chemical fingerprint was obtained, yielding an approximate sense of composition. Furthermore, a timescale of decomposition has been collected.

The optical trapping of an absorbing droplet was accomplished. WGMs of an have been observed; there is also evidence of higher order optical effects in spectra obtained.

A method for the determination of a droplet pH has been achieved, however further work is needed.

Future work includes using amber glassware in the extraction off anthocyanins to reduce the rate of decomposition.

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