P-07-20

Development of Raman spectroscopy as a tool to discriminate between grass and grain fed beef carcases (#400)

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Introduction

The variability in Australian climates means that cattle cannot always be grown out in extensive production systems and are therefore finished in intensive production systems. Currently, carcases are audited through the individual supply chain which represents a significant cost to industry and an even greater cost if there is a failure in the auditing process and market access is lost for grass fed products. Alternative processes include the analysis of stable isotopes, trace elements, fatty acids, volatile organic compounds, carotenoids and vitamin E [1]. Yet,these analyses are expensive, resource and labour intensive and not suited to routine use by processors. Continued innovation in Raman spectroscopy devices has facilitated the development of smaller more powerful devices which are rapid, robust and suitable for real time analysis of chemical composition in processing plants. Subsequently, a method was developed to investigate the potential to use Raman spectroscopy to authenticate production systems of Australian beef carcases.

Methods

The subcutaneous fat from 20 carcases was measured using a Mira handheld Raman device (Metrohm®). The Mira device is a hand held Raman device with a 785 nm orbital raster scan laser, capable of measuring wavenumbers from 400 – 2300 cm^{-1} with a spectral resolution of 8 – 10 cm^{-1} and a working distance of 7.6 mm and a measuring spot size of 2.5 mm.

Carcases were measured at 25 min and 24 hours post mortem on the neck and brisket. Five spectra were taken from each carcase at each location and time point using combinations of integration times (0.05 s, 2 s, 3 s, 4.05 s, 4.48 s, 9.45 s, 10 s) and accumulations (1, 3, 5, 6). Spectra for each carcase were averaged for each time point and graphed to allow for examination of the quality of the signal including the noise to signal ratios, presence of fluorescence and intensities of peak wavelengths.

Results

Examination of the spectra revealed that the lowest signal to noise ratio and least fluorescence were evident when spectra were collected with an integration time of 3 s and 5 averages, resulting in a total scan time of 15 s per position. The average spectra from pre-rigor and post-rigor carcases demonstrated that spectra collected at 24 hours post mortem yielded the most Raman information (Fig 1). This is particularly evident at between 1030 – 1156 cm^{-1} which have low intensities when the subcutaneous fat of hot carcases is measured.

It is plausible that these improvements in the quality of spectra are associated with the temperature of carcases at time of measurement as temperature of the sample influences the light scattering, changing the amount of Stokes and anti-stokes scattering and as a consequence Raman spectra can become more diffuse [if supportFields]><spanlang=EN-US style='font-size:11.0pt;font-family:"Arial","sans-serif";mso-fareast-font-family:Batang;mso-ansi-language:EN-US;mso-fareast-language:KO;mso-bidi-language:AR-SA'><spanstyle='mso-element:field-begin'><spanstyle='mso-spacerun:yes'> ADDIN EN.CITE<EndNote><Cite><Author>Fujioka</Author><Year>1929</Year><RecNum>3897</RecNum><DisplayText>[2]</DisplayText><record><rec-number>3897</rec-number><foreign-keys><keyapp="EN" db-id="arz002rrlffz9jer9wavset2t9z0fxxazpra"timestamp="1554093156">3897</key></foreign-keys><ref-typename="Journal Article">17</ref-type><contributors><authors><author>Fujioka,Y.</author></authors></contributors><titles><title>Influenceof Temperature on RamanLines</title><secondary-title>Nature</secondary-title></titles><periodical><full-title>NATURE</full-title></periodical><pages>11-11</pages><volume>124</volume><number>3114</number><dates><year>1929</year><pub-dates><date>1929/07/01</date></pub-dates></dates><isbn>1476-4687</isbn><urls><related-urls><url>https://doi.org/10.1038/124011a0</url></related-urls></urls><electronic-resource-num>10.1038/124011a0</electronic-resource-num></record></Cite></EndNote><spanstyle='mso-element:field-separator'><![endif][2][if supportFields]><spanlang=EN-US style='font-size:11.0pt;font-family:"Arial","sans-serif";mso-fareast-font-family:Batang;m

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so-ansi-language:EN-US;mso-fareast-language:KO;mso-bidi-language:AR-SA'><spanstyle='mso-element:field-end'><![endif]. Therefore, measurements at 24 hrs post mortem once the carcases have cooled yield the highest quality spectra with the most evident peaks.

The point end brisket was identified as the best location to collect spectral data on the carcase as spectra collected at that position also yielded the best Raman spectral information. This is most likely due to the hide removal processes where the carcase is not trimmed or prepared for the removal of hide around the head and neck and the hide on the carcase at this location is tighter compared to the brisket. Subsequently, the subcutaneous fat on the neck is subjected to a higher amount of hide puller damage resulting in an uneven fat cover and consequently poor Raman spectra with higher stray light and more contributions from the meat.

Conclusion

This preliminary investigation demonstrated that it is possible to get high quality Raman spectra of beef subcutaneous fat using a hand-held Raman device. Examinations of location, time post mortem and measurement parameters indicated that the most useful information on the chemical composition of fat is evident from spectra collected from the point end brisket at 24 hours post mortem once carcases have cooled using an integration time of 3 s and 5 accumulations.

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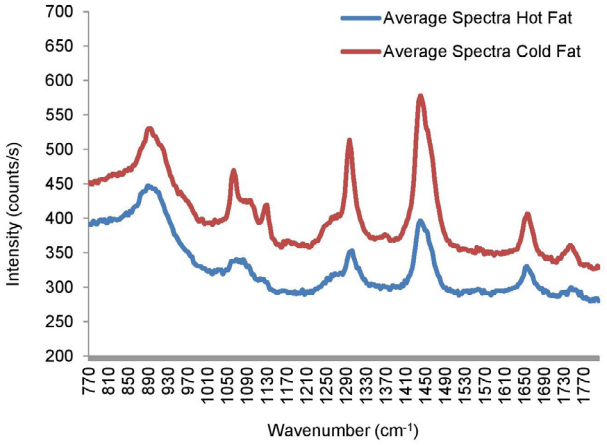

Figure 1

Spectra collected from beef subcutaneous fat from the point-end brisket at 25 min post slaughter (blue) and 24 hrs post slaughter (red)

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