Developing a prototype device for assessing meat quality using autofluorescence imaging and Machine learning technique.

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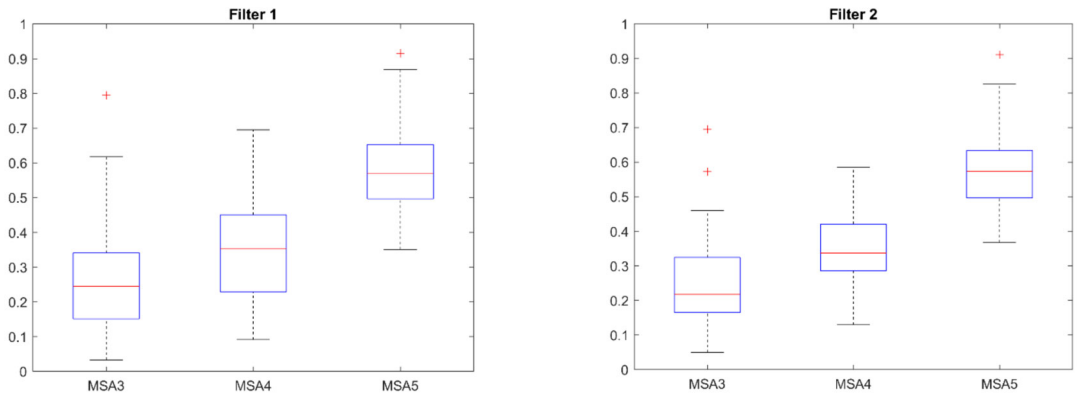
Supplementary material

1.1 Statistical analysis

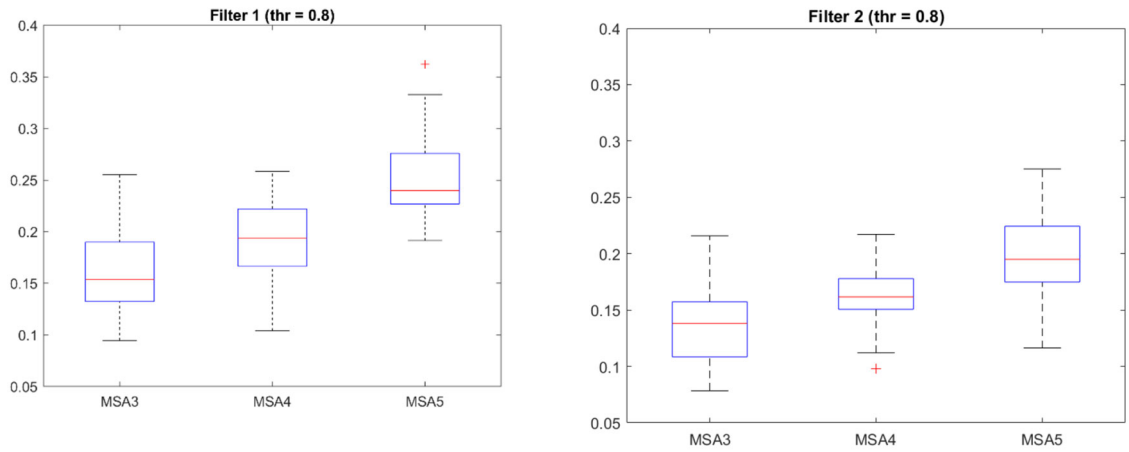
The excitation-emission plots yielded significant results, highlighting the IMF2 (Ex 316-330nm/ Em 425-475nm) and IMF4 (Ex 316-330nm/ Em 370-410nm) and thus assisting in the design procedure where the excitation and emission values for these regions would determine the wavelength of the LED to be used for excitation, and the filters used to capture the emission from the sample. Using these calculated values in the prototype device, images were successfully acquired and analyzed. The ratio of the IMF content over the total area of the sample size was acquired from each meat sample to generate a box plot categorized by grades to discern whether a distinction could be made with these results. The boxplots, as seen in **Supplementary Figure 1** displays a clear variance in median values between the meat grades where the median and interquartile ranges can be displayed, with boxes to signify the range in which the majority of the values lie.



Supplementary Figure S1: Boxplot of the ratio of IMF/Total area in the X-axis Vs sample category in the Y-axis

1.2 Masking

After identifying that the spectral signature emitted by the collagen (connective tissue) was of a higher degree than that of the IMF, a range was located to distinguish between this connective tissue and the IMF being used to characterize the meat quality. To remove the connective tissue data, a range of values between 0.8 and 1.1 were tested to evaluate the best threshold that could be used to mask out the collagen values to get the clearest distinction between MSA grades, with values exhibiting a value greater than 0.8 being masked out to generate the images seen in Figure 2. After performing the masking on all the images and determining that a threshold of 0.8 yielded the best results, the ratio of the IMF content over the total area of the image was then taken again and the data was then plotted in a box plot, **Supplementary Figure 2**. Inspecting these plots, a median could be clearly distinguished between the grades and further comparison of the boxplots for each grade, it can be observed that MSA5 can be clearly identified from MSA3 and MSA4 for both filters, whereas the data acquired for MSA3 and MSA4 are much closer and thus it may be more difficult to differentiate between the two as they have much more overlap in values. Inspecting the upper adjacent values for each of the grades in **Supplementary Figure** 2 shows a 0.07247 and 0.05806 difference between MSA5 and MSA 4 for filter 1 and filter 2 respectively, whereas comparing the upper adjacent values between MSA 4 and MSA3 shows a difference of 0.00333 and 0.0013 (for filter 1 and filter 2 respectively). This is a substantial difference in magnitude that demonstrates the extremities of each grade and how the MSA5 beef can be easily distinguished apart from the other two meat grades. This is expected as the MSA4 beef is typically MSA3 that has been aged for 14 days in vacuum packaging, this is done as aging is a widely recognized method that improves eating quality as the moisture is drawn out, but also the natural enzymes in the beef break down connective tissue resulting in a more flavourful and tender steak. Therefore, when comparing the quality of MSA3 and MSA4 meat, the data acquired can be expected to be quite similar and thus harder to distinguish.



Supplementary Figure S2: Boxplot (threshold = 0.8) of the ratio of IMF/Total area in the X-axis Vs sample category in the Y-axis