COMPARISON OF PORTABLE VISIBLE SPECTRAL IMAGING (443 – 726 NM) AND CONVENTIONAL RGB IMAGING FOR PREDICTING STORAGE DAY OF POULTRY PRODUCTS THROUGH PLASTIC LIDDING FILM

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For highly perishable foods such as poultry, reliably determining the amount of time a product has been stored is a matter of both product quality and consumer safety. Current methods of determining poultry quality are destructive and occur prior to products reaching the retail level (e.g., bacterial plating, chemical assays, sensory panels). Common factors such as fluctuations in the cold chain can drastically increase microbial growth and reduce the predicted shelf-life of poultry products [1], [2]. If consumers could non-destructively identify products that behave like those beyond their recommended shelf-life, they could avoid consuming products of lesser quality and safety. Spectral imaging or RGB imaging could potentially be used as non-destructive, fast alternatives to conventional methods for evaluating poultry products. Spectral cameras measure the complete spectral signature within a defined wavelength range, whereas RGB cameras use sensor filters to capture the relative intensities of red, green, and blue colours. By reducing the visible wavelength range to three colours, unique information from spectral signatures may be lost. However, RGB cameras are inexpensive, produce smaller data sets and are widely available. The objective of this study is to compare portable visible spectral imaging (443 – 726 nm) and conventional RGB imaging for predicting the number of days poultry products have been stored. Twelve packages of chicken thighs with skin on were stored at 4°C and imaged daily in pack through plastic lidding film using spectral and RGB imaging over 10 days. The wavelength range of spectral images was cropped to 443 – 726 nm, to match the spectral range of the LED illumination. Spectra were then pre-treated by standard normal variate (SNV) pre-processing followed by Savitzky-Golay (SG) smoothing (13-point window size, 2^{nd} order, 1^{st} derivative) to reduce variability introduced by scattering effects of polymer films [3]. Both spectral and RGB images were manually cropped to exclude the background and sticker labels on top of the lidding films. Oversaturated pixels due to glare were masked out using a manual threshold. Spectral images were then masked to segment chicken from the plastic tray by Otsu's method of automatic threshold selection on the score image of the first principal component (PC1) [4] . RGB images were masked by converting images into the L*a*b* colour space and using Lazy Snapping graph based segmentation to mask chicken from the plastic tray [5]. For both spectral and RGB image set, datasets were split by assigning images from 8 packages to the calibration set (n = 80) and from a separate 4 packages to an independent test set (n = 40). Partial least squares regression (PLSR) models were built using the calibration set to predict the storage day of samples at the object level by using mean spectra and RGB values per image. Models were evaluated using R^2, RMSEC and RMSEP values. To prevent model overfitting, Jaggedness was used to estimate the number of latent variables to be included in the model [6]. Finally, the respective models were applied pixel-wise to spectral and RGB images to visually assess the differences between the model predictions. The PLSR model built using spectral images ($R^2 = 0.81$, RMSEC = 0.76, RMSEP = 1.25) was more suitable than the model built using RGB images ($R^2 = 0.55$, RMSEC = 1.91, RMSEP = 2.08) for predicting storage day of poultry products. The most important wavelengths from the regression model vector of coefficients for prediction were determined to be at 446.5, 466.8, 493.0, 463.9, 675.7, 672.8, 469.7, 490.1, 449.4, 708.6 nm. Successful prediction is likely a consequence of colour changes due to myoglobin oxidation during storage. The colour changes were too subtle for RGB imaging to successfully predict storage days.

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