ABSTRACT

Rapid and simple measurement of freshness is essential for the monitoring of fish and the quality of its products. To date though, most freshness evaluation methods are complicated and time consuming. During the storage of fish, dynamic primary changes are taking place in numerous parts of the fish, including the eyes, skin, gills and muscle characteristics of the fish. An index like K value is generally used to quantify chemical changes in fish flesh; it requires elaborate sample preparation and only provides discrete measurement points. On the other hand, the opaqueness of fish eyes has a broad relationship to freshness, and thus has the potential to monitor the spoilage of fresh fish. In this study, the ability to predict fish freshness from ultraviolet-visible (UV-VIS) absorbance spectral properties of eye fluid in the range of 250-600 nm using multivariate analysis methods was investigated. Two hundred and forty model specimens of Japanese dace (*Tribolodon hakonensis*) fish were killed and stored at 20°C and 90% relative humidity for subsequent spectra acquisition and K value measurement of fish flesh by a paper electrophoresis technique.

Firstly, the fresh and spoiled fish classification models were developed using UV-VIS spectral properties of eye fluid by support vector machine (SVM), linear discriminant analysis (LDA) based on principal component analysis (PCA) scores and soft independent modeling of class analogy (SIMCA) classification technique. These models were evaluated in terms of their sensitivity, specificity and accuracy. In the SVM model, the sensitivity was 100% for both the fresh and spoiled group fish, whereas it was 100% and 90% in the LDA model, and 80% and 90% in the SIMCA model for fresh and spoiled group respectively. In addition, the specificity result was 100% in SVM, while it was 90% for the LDA and SIMCA models for fresh group fish, and 100% and 80% in the LDA and SIMCA models for spoiled group fish respectively. The classification accuracy for SVM, LDA and SIMCA were 100%, 93% and 87% respectively.

Then partial least squares (PLS) regression was used to determine the correlation between spectra data and K value of fish flesh. The PLS regression models were developed with several different spectral preprocessing techniques, such as smoothing (moving weighted average), normalization, multiplicative scatter correction (MSC), Savitzky-Golay first-order derivative and Savitzky-Golay second-order derivative for comparison. Finally, an improved, high performance, robust and simple prediction model for K value of fish flesh was developed using an interval partial least squares (*i*PLS)

regression method and comparison of the performance of the models was developed by PLS regression. The quality of the final model was evaluated according to the determination coefficient of prediction (R^2_{pred}) and root mean square error of prediction (*RMSEP*) in the prediction set. A student's t-test was also performed in order to evaluate the significance level of the developed model. The results showed that a regression model developed from PLS regression and based on MSC preprocessed spectra resulted in the best performance compared with those models developed from other preprocessing methods, with an R^2_{pred} and *RMSEP* of 0.81 and 7.74% respectively. Compared to models developed by PLS, the results showed that the regression model developed by *i*PLS based on MSC preprocessed spectra gave the best performance model with a determination coefficient of prediction (R^2_{pred}) of 0.96, and a root mean square error of prediction (*RMSEP*) of 5.12 %. Furthermore, the 700 variables that were included in the PLS calibration model were reduced to 260 variables in the *i*PLS calibration model. A 95% confidence student's t-test showed that there were no significant differences between the actual K value measured by paper electrophoresis technique and that predicted by UV-VIS spectroscopy.

Therefore, the dissertation show that the use of UV-VIS spectroscopy combined with appropriate multivariate analysis has the potential to accurately predict fish freshness.