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PREDICTION OF CHICKEN BREAST MEAT FRESHNESS BASED ON HYPERSPECTRAL IMAGING TECHNIQUE AND HIGH-THROUGHPUT SEQUENCING

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I. INTRODUCTION

Chilled chicken meat is easy subject to spoilage by microbial contamination and endogenous enzyme decomposition [1]. Traditional approaches are hard to realize fast and non-destructive detection of chicken meat freshness [2]. Hyperspectral imaging (HSI) which combines computer engineering and fiber-optic signal processing techniques, is more convenient than traditional detection methods, and can realize real-time online detection [3]. In order to improve the validity of freshness detection, the current study this study proposed to combine high-throughput sequencing technology with HSI to accurately reflect freshness changes through characteristic bacteria.

II. MATERIALS AND METHODS

The chicken breast meat samples were chopped into square pieces of 4 cm*4 cm*2 cm and refrigerated at 4 ℃. All samples were tested within 7 days. 15 samples were taken out per day for scanning using HSI. 3 parallel samples were for measuring freshness indicators and bacterial diversity analysis. Spectral information was collected using a hyperspectral imaging equipment. Using PLS, SVM, ANN, CNN and RNN algorithms to construct the model.

III. RESULTS AND DISCUSSION

In this study, we performed physicochemical testing (TVB-N, TBARs, etc.) and microbial sequencing (16S rRNA), and analysed the correlation between the freshness indicators and characteristic microbiological content with the changes in freshness. In Figure 1, the microbial indicators showed significant correlations with freshness indicators, which effectively reflected the changes in the freshness of the samples. Then, we used hyperspectral imaging(HSI) to collect spectral data. In Figure 2, the reflectance spectra showed a decreasing trend, and had clear absorption peaks in the region of 430, 550, 560, 700 and 980 nm. Finally, the HSI prediction model of characteristic microbial content was constructed based on neural network algorithm to achieve the non-destructive assessment of yellow feather chicken freshness.In Table1,the accuracy of the model prediction results based to the CNN algorithm are generally higher than that of ANN and RNN, with the result of 0.9123 for Rp2, 0.4782 for RMSEP and 2.1958 for RPD.

Table 1 – Modelling prediction results of various indicators under neural network algorithm

		Calibration		Prediction		
Model	indicator	Rc^2	RMSEC	Rp^2	RMSEP	RPD
ANN	*Pseudomonas*	0.9712	0.6088	0.8977	0.5893	1.9967
	Brochothrix	0.9770	0.5832	0.8725	0.4749	1.7869
	Escherichia	0.9685	0.6507	0.8829	0.5315	1.8649
CNN	*Pseudomonas*	0.9736	0.6037	0.9123	0.4782	2.1958
	Brochothrix	0.9851	0.5637	0.9162	0.4295	1.9504
	Escherichia	0.9359	0.5273	0.9297	0.5782	2.0414
RNN	*Pseudomonas*	0.9429	0.6756	0.9205	0.5516	1.8486
	Brochothrix	0.9312	0.5684	0.8968	0.6043	1.6836
	Escherichia	0.8930	0.3573	0.9278	0.3175	1.7832

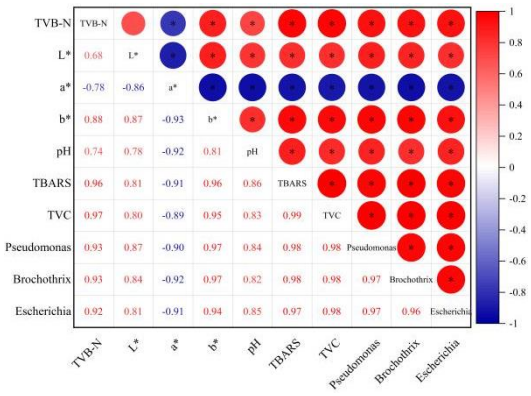


Figure 1. Correlation coefficient of freshness indicators during storage of chicken breast meat.

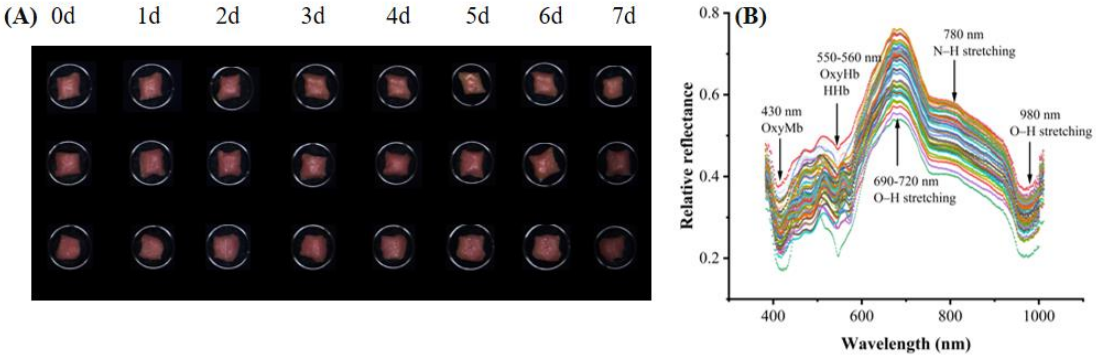


Figure 2. Reflection spectra of yellow feather chicken during storage.

(A) Images of samples collected by HSI during storage. (B) Raw spectral curves extracted in the region of interest.

IV. CONCLUSION

Combined with high-throughput sequencing results, Pseudomonas, Brochothrix and Escherichia count were selected as characteristic indicators. Among all the models, the CNN model within Pseudomonas content had stronger predictive abilities. Hence, the Pseudomonas content was chosen as the characteristic indicator combined with HSI to predict the chicken freshness.

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