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WINDOWS GUI PROGRAM FOR THE EVALUATION OF MEAT COLOR AND MYOGLOBIN DERIVATIVES BY REFLECTANCE SPECTROPHOTOMETRY

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Background:

When consumers choose meat, the first response is color by the sight. Color is one of the important quality items of the meat. The color is mainly influenced by the amount of myoglobin(Mb) and the relative proportions of three derivatives: oxymyoglobin(oxyMb), reduced myoglobin(redMb) and metmyoglobin(metMb). So, the derivative has been measured for extract from meat by analytical chemistry. However, redMb changes into oxyMb in the extracting process so that all three derivatives can't be measured. Therefore, reflectance spectrophotometry without extraction process is the excellent way and direct measurement.

Objectives:

K/S , the ratio of the absorption/scattering coefficient, derived from reflectance R_∞ have been well used for the direct analysis of Mb in meat.

$$K/S = (1 - R_\infty)^2 / (2 \cdot R_\infty)$$

Because this is a nonlinear equation, the numerical analysis becomes complex very much as for this equation. K/S and the reciprocal reflectance (λ) can be considered to be same properties at less than ca. 40% (Izumimoto, M. et al., 1984).

$$\frac{dK/S}{d\lambda} = (1 - R^2)/2$$

They have regression to Mb content of reflectance. Using λ function, the objectives in this research are to develop Windows GUI (Graphical User Interface) program and computer system for the direct assay of Mb in meat.

Methods:

Mb derivatives, oxyMb, redMb and metMb, in beef sample for the reference were each prepared as described previous report (Izumimoto, M. et al., 1993). The reflectance spectra were measured by reflectance spectrophotometer. The base line as an achromatic matrix of the sample was derived by powder's function using bleached meat.

Reciprocal reflectance, λ, was converted to $\hat{\lambda}$ defined as attenuation using the base line of the sample.

$$\hat{\lambda} = \lambda - \lambda_0$$

The characterized wavelength of spectrum was selected and the coefficients of matrix equation were derived to calculate Mb derivative ratios as follows.

$$\begin{pmatrix} \hat{\lambda}_O(480/525) & \hat{\lambda}_R(480/525) & \hat{\lambda}_M(480/525) \\ \hat{\lambda}_O(560/525) & \hat{\lambda}_R(560/525) & \hat{\lambda}_M(560/525) \\ \hat{\lambda}_O(580/525) & \hat{\lambda}_R(580/525) & \hat{\lambda}_M(580/525) \end{pmatrix} \begin{pmatrix} o \\ r \\ m \end{pmatrix} = \begin{pmatrix} \hat{\lambda}(480/525) \\ \hat{\lambda}(560/525) \\ \hat{\lambda}(580/525) \end{pmatrix}$$

Where, the variables o, r and m are the answer's ratio of oxyMb, redMb and metMb, respectively. Example $\hat{\lambda}_O(480/525)$ means constant of the ratio of $\hat{\lambda}$ at 480nm and $\hat{\lambda}$ at 525nm of isosbestic point for oxyMb prepared as standard sample. Also, $\hat{\lambda}_R$ and $\hat{\lambda}_M$ mean for redMb and metMb samples, respectively. The right side $\hat{\lambda}$ is the value of the measurement sample.

The other hand, CIEXYZ values were calculated, then CIEXYZ characteristics were analyzed and converted to CIELAB color values.

Results and Discussion:

The example of evaluation by Windows computer program for Mb derivatives in meat is shown in figure. Reciprocal reflectance was measured by personal computer connected with reflectance spectrophotometer and analyzed at real time. The Mb derivative ratios obtained were well agreement with color appearance and characteristic of the spectrum.

Achromatic muscular material imagined as pigment free colorless meat has been unknown in order to non-exist. However, a characteristic of reflectance spectrum of the pigment free material is extremely important as a base line for a light reflectance spectrometry (Izumimoto et al., 1993). The curve was obtained by computer simulation, and it would be helpful to be able to obtain the characteristics of spectral reflectance in detail and the information for quality control of meat.

Conclusions:

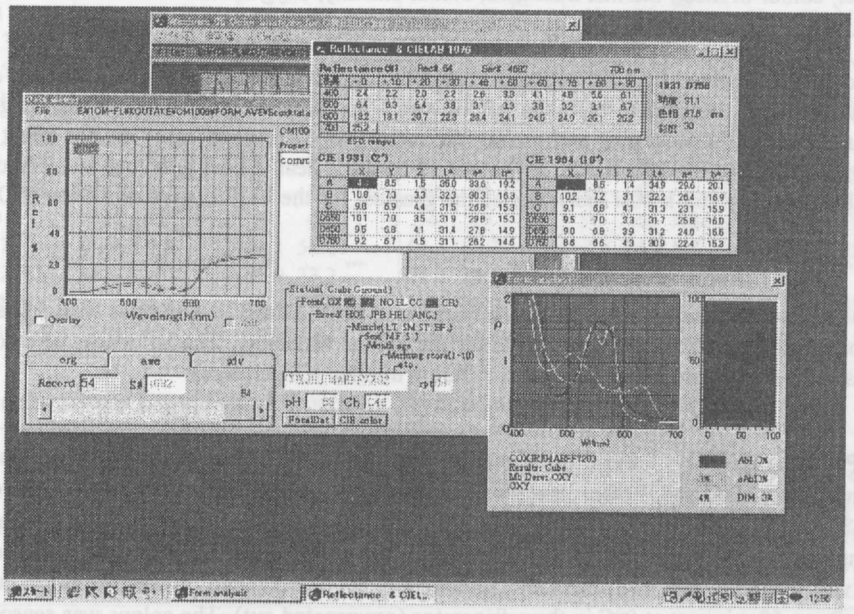
Reflectance spectrophotometer and personal computer were online connected and data was automatically analyzed in real-time. Operation was carried out by Windows GUI program. Three derivatives of Mb in meat which could be directly assayed at real time without extraction.

Pertinent literature:

Izumimoto, M. and H. Miura, 1984. A Direct Method for the Assay of Heme Pigment in Processed Meat. Jpn. J. Zootechnical Sci., 55:76-81.

Izumimoto, M. and S. Ozawa, 1993. Reflectance Spectrophotometric Methodology on the Myoglobin in Intact Beef. Jpn. J. Dairy and Food Sci., 42:157-169.

Data:



Example of computer screen for the evaluation of meat color and myoglobin derivatives.

The program performs sequential job; controls spectrophotometer, measures reflectance, analyzes the data, calculates the color value and calls stored data.