**THESIS**

# EVALUATION OF THAI FISH SAUCE QUALITIES BY NEAR-INFRARED SPECTROSCOPY

**PITIPORN RITTHIRUANGDEJ**

**A Thesis Submitted in Partial Fulfillment of**
**the Requirements for the Degree of**
**Doctor of Philosophy (Agro-Industrial Product Development)**
**Graduate School, Kasetsart University**
**2006**

Pitiporn Ritthiruangdej 2006: Evaluation of Thai Fish Sauce Qualities by Near-Infrared Spectroscopy. Doctor of Philosophy (Agro-Industrial Product Development), Major Field: Agro-Industrial Product Development, Department of Product Development. Thesis Advisor: Assistant Professor Thongchai Suwonsichon, Ph.D. 182 pages.

Application of near-infrared (NIR) spectroscopy for both quantitative and qualitative analyses of the commercial Thai fish sauces was investigated. The NIR transflectance spectra in the region of 1100-2500 nm were measured. Subsequently, two wavelength interval selection methods named moving window partial least squares regression (MWPLSR) and searching combination moving window partial least squares (SCMWPLS) were applied to find out the suitable input wavelength variables of each chemical, physical and sensory properties. For quantitative analysis, the predictive models were developed by using the partial least squares (PLS) regression. Results showed that the PLS developed models for the chemical and physical properties yielded the best prediction results with the lowest root mean square error of prediction (RMSEP). The lowest RMSEP for the total nitrogen content, sodium chloride, pH, reducing sugar, density, baume, total soluble solid, refractive index, color L*, color a*, and color b* were 0.100 %w/v, 0.647 %w/v, 0.155, 0.407 mg/mL, 0.007 g/cm$^3$, 0.118 °Baume, 0.435 °Brix, 0.00079, 2.914, 1.023, and 4.803, respectively. While the PLS models for the sensory properties was compared in terms of the range error ratio (RER) of prediction. Results showed that the PLS models for sensory attributes which were fishy aromatic, salty flavor and fishy flavor obtained good RER values in the range of 5.85 - 7.96. For qualitative analysis, Thai fish sauce samples were divided into three groups based on their total nitrogen content (TN). These groups were i) standard pure fish sauce (TN ≥ 0.9 %w/v), ii) standard mixed fish sauce (TN ≥ 0.4 %w/v) and out of standard fish sauce (TN < 0.4 %w/v). The classification methods used for developing the models were Linear Discriminant Analysis (LDA), Factor Analysis-Linear Discriminant Analysis (FA-LDA), Soft Independent Modeling of Class Analog (SIMCA), K Nearest Neighbors (KNN), and Artificial Neural Networks (ANNs). All methods were analyzed the optimized informative regions of NIR spectra based on the total nitrogen content. Results showed that all methods were potentially used the NIR spectra to classify the fish sauce samples with the corrective classification rate of more than 82%. Moreover, the ANNs classified model provided the best corrective classification rate (100%).

_____ _____ ____/____/____

Student's signature Thesis Advisor's signature

## ACKNOWLEDGMENTS

Sincerest gratitude is expressed to my advisor, Assistant Professor Thongchai Suwonsichon, and my co-advisor, Associate Professor Vichai Haruthaithanasan and Ms. Warunee Thanapase for their kind guidance and encouragement throughout the study. My deepest gratitude is expressed to Professor Yukihiro Ozaki for his support and guidance. Great thank is given to Dr. Sumaporn Kasemsumran, Ms. Naroo Kang, Dr. Bo-Yan Li, Ms. Yun Hu, and Assistant Professor Saowanee Lertworasirikul for their time and valuable suggestions about the chemometric technique analysis. I would like to thank Assistant Professor Sudsai Trevanich for serving as the Graduate School representative.

I would like to acknowledge the Ministry of University Affairs of Thailand and the Department of Science, Mahidol University, Thailand for funding throughout the study. Acknowledgements are extended to Kasetsart University Research and Development Institute (KURDI) as well as the Open Research Center project for private universities: matching fund subsidy from Ministry of Education, Culture, Science and Technology (MEXT), 2001-1005, Japan, for partial financial support of this research.

I am extremely thankful to the Department of Product Development, Kasetsart University, Thailand and Department of Chemistry and Research Center for Near-Infrared Spectroscopy, School of Science and Technology, Kwansei-Gakuin University, Japan for providing research facilities. I am also grateful to the Kasetsart Agricultural and Agro-Industrial Product Improvement Institute (KAPI), Thailand, for giving me the occasion of using an InfraAlyzer 500 spectrometer.

I would like to thank all my colleagues and friends at Kasetsart University, Thailand and Kwansei-Gakuin University, Japan, for their assistance and friendship. My special thanks go to all panellists who were taking their time and effort to participate in the sensory test.

My appreciation is devoted to my parents and my sisters whom always give me support and love.

Pitiporn Ritthiruangdej
December 2006