COMPARISON OF VEGETABLE OILS AND MONITORING OF RANCIDITY AND LARD ADULTERATION IN PALM OLEIN USING ELECTRONIC NOSE

By

GAN HOWE LIN

**Thesis Submitted to the School of Graduate Studies,
Universiti Putra Malaysia, in Fulfilment of the Requirements
for the Degree of Master of Science**

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ESPECIALLY DEDICATED TO MY BELOVED FAMILY

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Professor Yaakob bin Che Man, Ph.D.

Faculty: Food Science and Technology

Flavour analysis is typically performed by organoleptic panel, which is often expensive and less objective. A novel approach using a surface acoustic wave (SAW) sensing-based electronic nose (zNose^{TM}) for flavour analysis was explored in this study for determination of some parameters of edible oils and fats.

In the characterization of sixteen types of vegetable oils, the high resolution olfactory image, called VaporPrint^{TM}, was unique for each type of vegetable oil studied. The score plot from principal component analysis (PCA) indicated that 97% of the total variance in the zNose^{TM} measurement data was described by PC 1 and PC 2. The loading plot revealed five compounds (*m*, *k*, *n*, *s*, and *p*) that were important to differentiate the vegetable oils.

In determining oxidative stability of RBD palm olein, the results of zNose™ showed significant difference (P<0.05) between fresh oil and rancid oil. VaporPrint™ provided the operator with a visually recognised pattern for rapid identification of rancid off-flavour. By using Pearson correlation analysis, high correlation (r > 0.90) was observed between electronic nose responses and chemical test data; as well as between electronic nose responses and sensory evaluation scores.

The zNose™ technique was also employed to monitor the presence of lard as an adulterant in RBD palm olein. As the adulteration level increased from 1% to 20%, a few distinct peaks were found to gradually increase in size in the zNose™ chromatograms. These peaks dramatically increased in 3% lard, while the corresponding VaporPrint™ was obviously an exception to the normal RBD palm olein pattern. Qualitative identification of adulterated RBD palm olein samples was possible by the characteristic VaporPrint™. The most significant relationship occurred between percent lard and adulterant peak number 6 (R^2 = 0.906). An ideal correlation was also observed between the electronic nose response and chemical analyses (r > 0.90).

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENCIRIAN MINYAK SAYURAN SERTA PEMANTAUAN KETENGIKAN DAN PENGADUKAN MINYAK KELAPA SAWIT OLEIN DENGAN LEMAK KHINZIR MENGGUNAKAN HIDUNG ELEKTRONIK

Oleh

GAN HOWE LIN

October 2004

Pengerusi: Profesor Yaakob bin Che Man, Ph.D

Fakulti: Sains Makanan dan Teknologi

Pengujian citarasa biasanya dijalankan oleh panel ujideria yang selalunya mahal dan kurang objektif. Satu pendekatan baru menggunakan hidung elektronik (zNose^{TM}) yang berasaskan pengesanan "surface acoustic wave" (SAW) untuk menganalisa citarasa telah diterokai dalam kajian ini untuk menentukan beberapa parameter minyak dan lemak masakan.

Dalam pencirian enam belas jenis minyak sayuran yang berbeza, didapati imej resolusi tinggi yang dikenali sebagai VaporPrint^{TM} adalah unik untuk setiap jenis minyak masak yang dikaji. Lakaran skor dari "principal component analysis" (PCA) menunjukkan 97% daripada jumlah varian dapat dijelaskan oleh PC 1 dan PC 2. Lakaran loading pula

menunjukkan lima komponen (*m*, *k*, *n*, *s*, and *p*) yang penting dalam pembezaan minyak sayuran yang berlainan.

Dalam menentukan kestabilan pengoksidaan minyak kelapa sawit olein, keputusan zNose™ menunjukkan perbezaan yang bermakna ($P<0.05$) di antara minyak segar dengan minyak tengik. VaporPrint™ membolehkan pengguna mengenalpasti bau tengik dalam minyak dengan pantas. Dengan menggunakan korelasi Pearson, korelasi yang tinggi ($r > 0.90$) telah didapati di antara respons zNose™ dan data ujian kimia, serta diantara respons zNose™ dan skor ujideria.

Kaedah zNose™ juga digunakan untuk menguji kehadiran lemak khinzir dalam minyak kelapa sawit olein. Apabila lemak khinzir meningkat dari 1% ke 20%, saiz beberapa puncak didapati bertambah secara beransur-ansur. Puncak-puncak ini meningkat secara mendadak dalam 3% lemak khinzir sementara VaporPrint™ yang berkaitan adalah suatu pengecualian yang ketara kepada corak normal minyak kelapa sawit olein. Pengenalpastian kualitatif terhadap sampel RBD olein sawit yang tercemar dapat dilakukan dengan ciri-ciri VaporPrint™ yang tersendiri. Perhubungan yang paling ketara wujud antara peratus lemak khinzir tercemar dengan puncak ke-enam ($R^2 = 0.906$). Korelasi yang baik juga diperhatikan di antara respons zNose™ dan analisis kimia ($r > 0.90$).

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I certify that an Examination Committee met on 27 October 2004 to conduct the final examination of Gan Howe Lin on her Master of Science thesis entitled "Comparison of Vegetable Oils and Monitoring of Rancidity and Lard Adulteration in Palm Olein using Electronic Nose" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The committee recommended that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

AZIZAH HAMID, Ph.D.
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

SALMAH YUSOF, Ph.D.
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

LAI OI MING, Ph.D.
Lecturer
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

AMINAH ABDULLAH, Ph.D.
Professor
Faculty of Science and Technology
Universiti KebangsaanMalaysia
(Independent Examiner)

_____
GULAM RUSUL RAHMAT ALI, Ph.D.
Professor/ Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date :

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

YAAKOB BIN CHE MAN, Ph.D.
Professor
Faculty of Food Science and Biotechnology
Universiti Putra Malaysia
(Chairman)

NAZIMAH SHEIKH ABDUL HAMID, Ph.D.
Lecturer
Faculty of Food Science and Biotechnology
Universiti Putra Malaysia
(Member)

TAN CHIN PING, Ph.D.
Lecturer
Faculty of Food Science and Biotechnology
Universiti Putra Malaysia
(Member)

NOR AINI BINTI IDRIS, Ph.D.
Principal Research Officer
Malaysia Palm Oil Board (MPOB)
(Member)

_____
AINI IDERIS, Ph.D.
Professor/ Dean
School of Graduate Studies
Universiti Putra Malaysia

Date :

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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GAN HOWE LIN

Date:

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