APPLICATION OF NEAR-INFRARED RAMAN SPECTROSCOPY TO PORCINE FAT EVALUATION

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Key Words: porcine adipose tissue, Raman spectroscopy, unsaturated fatty acid, iodine value, *trans* fatty acid.

Introduction

The unsaturation degree of fatty acids is one of the critical characteristics of meat. It influences our palatability of meat via controlling the melting property of fat. For evaluating the unsaturation degree, the iodine value (I.V.) is regarded as one of the many useful parameters. Also, *trans* fatty acids contained in fat is currently considered harmful for human health. However, the measuring methods of I.V. and *trans* fatty acids are destructive to the sample and time consuming. For these reasons, vibrational spectroscopy has been applied to fat and oil analysis as a non-destructive method (van de Voort *et al*. 2001, Weng *et al*. 2003). Application of spectroscopy to meat studies usually accompanies two problems; the interference from water and the fluorescence emission disturbing spectroscopic measurements. It is well known that Raman spectroscopy is insensitive to water. We have demonstrated that near-infrared excitation is effective in reducing fluorescence from biological samples (Min *et al.* 2005). It is also known that the unsaturated carbon chain provides strong Raman signals. Therefore, near-infrared Raman spectroscopy is promising as a powerful method for obtaining chemical information on fat. The aim of this study is to assess the feasibility of near-infrared Raman spectroscopy for meat studies.

Materials and methods

Samples

Subcutaneous adipose tissues were harvested from belly of three-way cross (Duroc×(Large white×Landrace)) porc carcasses were prepared (n = 6). Their I.V. values were measured by the standard method (Wijs method). Lard; fat extracted from porcine adipose tissue, and shortening; solid fat made from vegetable oil, were purchased at a retail store.

Raman measurements

We measured the 1064 nm excited Raman spectra of the fresh cut surface of the adipose tissue, lard or shortening. Samples were placed on a slide glass and measured at room temperature. Considering the possibility of future application to the field experiment, we used an optical fiber probe. The laser beam (Q-switched Nd:YAG laser, X30-106QA, Spectra-Physics) was guided by one fiber to a sample. The back-scattered Raman light from the sample was collected and guided by the other fiber to a spectrometer (TRIAX320, Horiba Jobin-Yvon) and detected with a near-infrared multichannel detector (InP/InGaAsP, Hamamatsu photonics K.K.). The laser power at the sample was 92 mW, and the accumulation time was 45 sec.

Results and discussion

Raman spectrum of a porcine adipose tissue is shown in Fig. 1 together with those of lard and shortening samples. Clear Raman spectra were successfully obtained from the adipose tissue without any pretreatment. It is obvious that high water content (20%) in the porcine adipose tissue does not interfere the Raman measurements. The Raman bands related to fatty acids are observed at 1300 cm^{-1} ($\tau(CH_2)$), 1440 cm^{-1} ($\delta(CH_2)$), 1656 cm^{-1} ($\nu_{cis}(C=C)$) and 1748 cm^{-1} ($\nu(C=O)$). According to a previous report (Reitzenstein *et al*. 2007) that successfully

estimated the I.V. values of oils from a Raman band area ratio, we tried to calibrate the area ratio A_{1656}/A_{1748} to I.V., but only in vain. We were not able to make distinction between the two groups A and B of the studied porcine adipose tissue samples (Table 1).

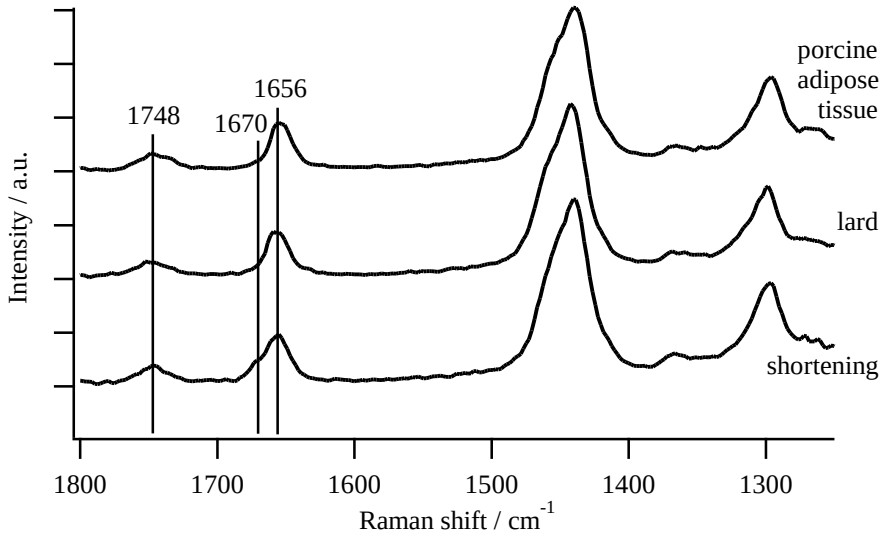

Fig. 1 Raman spectra of a porcine adipose tissue (representative), lard and shortening. Arrow indicates the band of *trans* C=C double bond.

Trans fatty acid is detected by the existence of the band at 1670 cm^{-1} (ν_{trans}(C=C)) in the spectrum of shortening (Fig. 1). Shortening becomes to contain *trans* C=C double bond in the process of hardening. On the other hand, porcine adipose tissue and lard do not seem to contain *trans* fatty acids from their spectra. Raman spectroscopy is capable of giving chemical information concerning animal fat quality, in particular safety.

Table 1 Sample grouping, their I.V. and the band area ratio A_{1656}/A_{1748}.

group	I.V.	s.d.	A_{1656}/A_{1748}	
			means	s.d.
A	54.0, 54.3, 54.5	0.25	1.29	0.10
B	62.3, 62.3, 62.7	0.23	1.33	0.13

s.d.=standard deviation

Conclusions

Raman spectroscopy is capable of providing chemical information of fatty acids in adipose tissues regardless of high water content. It has proved to be a simple and effective technique for porcine adipose tissue analysis since the measurement can be directly completed in a short period without any sample pretreatment. Near-infrared Raman spectroscopy has a high potential for meat quality evaluation and quality control.

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