INVESTIGACIÓN

FT-IR spectroscopy as a tool for the study of the quality of processed meat products.

By **M. Antonia Murcia***, **Clemente Cano** and **Jorge Bretón**
Departamento de Bromatología, Facultad de Veterinaria,
Universidad de Murcia, Apdo. 4021, E-30080 Murcia, Spain.

RESUMEN

Utilización de la espectroscopía de FT-IR para estudiar la calidad de productos cárnicos procesados.

Se ha utilizado la espectroscopía de infrarrojo de transformada de Fourier por reflectancia total atenuada para caracterizar productos cárnicos procesados. Las proteínas se valoraron a través de la banda amida I centrada a 1650 cm^{-1} y los lípidos por la banda de tensión del carbonilo a 1735 cm^{-1}.

Los valores de los cocientes proteína/lípido fueron calculados dividiendo el área bajo la banda a 1650 cm^{-1} por el área bajo la banda a 1735 cm^{-1}. Los cocientes proteína/lípido se correlacionan bien con aquellos obtenidos para las mismas muestras usando análisis químicos convencionales. La espectroscopía de infrarrojo de transformada de Fourier por reflectancia total atenuada es una técnica analítica rápida y con la ventaja sobre otros métodos de ser no destructiva, que puede ser usada para determinar la calidad de productos cárnicos procesados.

PALABRAS-CLAVE: Carne procesada—Espectroscopía de infrarrojo de transformada de Fourier—Lípido—Proteína—Reflectancia total atenuada.

SUMMARY

FT-IR spectroscopy as a tool for the study of the quality of processed meat products.

Attenuated total reflectance Fourier transform infrared spectroscopy has been used to characterize processed meat products. Proteins were estimated through the amide I band centered at 1650 cm^{-1} and lipids through the carbonyl stretching band at 1735 cm^{-1}.

Estimations of protein/lipid ratios were obtained by dividing the area under the 1650 cm^{-1} band by the area under the 1735 cm^{-1} band. These protein/lipid ratios correlated well with those obtained for the same samples using conventional chemical analysis. Attenuated total reflectance Fourier transform infrared spectroscopy is therefore a quick and analytical technique with the advantage over other procedures of being non destructive and which can be used to assess the quality of processed meat products.

KEY-WORDS: Attenuated total reflectance—Fourier transform infrared spectroscopy—Lipid—Processed meat—Protein.

1. INTRODUCTION

Spectroscopic methods such as FTIR (Fourier transform infrared spectroscopy) have an enormous potential for the non-destructive and rapid analysis of food products. This has been realized by a number of authors who have used recently near infrared spectroscopy for the analysis of protein or lipid in many different foodstuffs, as for example trout muscle (Rasco et al., 1991), bread (Osborne et al., 1984) or wheat and barley (Williams et al., 1985).

Less work has been done using the fundamental infrared region. For example, fat was determined in some foodstuffs by using infrared transmittance spectroscopy (Cronin and McKenzie, 1990). Also diffuse reflectance FTIR spectroscopy has been recently employed to study the biological and chemical treatment of barley straw (Stewart and Morrison, 1992) and attenuated total reflectance FTIR (ATR-FTIR) has been used to determine the degree of unsaturation of edible oils (Afran and Newbery, 1991).

Water is present in most foodstuffs and it represents a particular challenge in IR spectroscopy. Indeed, the domination in the field of food analysis by near-infrared and Raman spectroscopy is largely due to the low signal intensity of water compared to its high mid-infrared absorptivity. One solution to the intense water band problem is to use an overhead ATR sampling technique (Afran and Newbery, 1991) enabling also to obtain spectra with almost no sample preparation.

We will use in this paper ATR-FTIR which allows to analyze intact samples in a quick and easy way. The nutritional quality of the processed meat products will be assessed through their protein to lipid ratios, assuming that the best quality will correspond to the highest protein to lipid ratio. The importance of protein and lipid content is recognized, for example, by the Spanish legislation which classify processed meat products in different commercial qualities where minimum protein and maximum lipid contents are fixed (Boletín Oficial del Estado, 1981).

2. MATERIALS AND METHODS

2.1. Samples

The processed meat products analyzed were samples purchased from local shops corresponding to different industrial manufacturers and of the types called in Spanish 'chorizo' and 'salchichón' which are relatively similar to salami. Different commercial qualities were chosen. All of them were well ahead of the best before date. They were purchased and sliced by hand in the same shop. The slices were used directly for the spectroscopic measurements before 5 hours of the purchase. During this short period of storage the samples were protected from dehydration by keeping them wrapped in aluminium foil and always using a slice which was covered by at least two other slices.

2.2 FT-IR Spectroscopy

Infrared spectroscopy was taken in a Phillips PU3800 Fourier Transform infrared spectrometer, using a DTGS detector and a horizontal attenuated total reflectance accessory (ZnSe, 45°) from Spectra-Tech (Warrington, U.K.). Normally 100 scans were taken with and without samples, and they were averaged and apodized with a triangular function in order to obtain spectra of 2 cm^{-1} resolution. In order to improve the signal-to noise ratio of the spectra the sample was always in good contact with the ATR crystal thanks to a clamp provided with the accessory.

2.3. Chemical analysis

Protein was estimated by using the Kjeldahl method, N x 6.25, and the lipids using a Soxhlet extraction method using ethylic ether (ISO Standard 1444).

3. RESULTS AND DISCUSSION

In this communication a method is described to determine the quality of processed meat products by ATR-FTIR. Spectra of slices of processed meat were obtained using the ATR-FTIR technique and they were of high quality as revealed by Figure 1, which shows a few examples of meat samples of different commercial qualities. The ester carbonyl stretching vibration band, which is centered at approximately 1735 cm^{-1} (Casal and Mantsch, 1984) is a very convenient absorption mode to monitor lipid contents, since it is fairly specific for biomolecules bearing fatty acyl groups. Other alternatives like the methyl stretching groups present at 2800-2900 cm^{-1} are considerably less specific, since proteins for example may contribute appreciably to them. Proteins, on the other hand, can be very conveniently monitored trough the amide I band centered at approximately 1650 cm^{-1} (Bandekar, 1992) and which is mainly reflecting absorption of protein molecules.

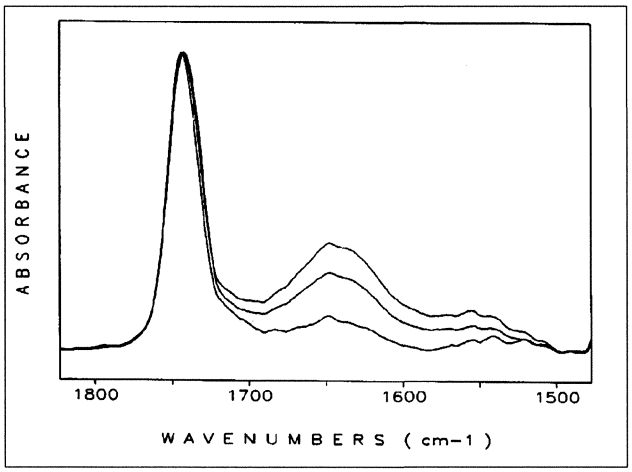

Figure 1
Normalized spectra of the 1800-1500 cm^{-1} region of different processed meat samples containing different protein/lipid ratios.

By measuring the areas under the amide I band (protein) and by the carbonyl stretching band (lipid), protein/lipid ratios were estimated. It should be remarked that the ratio values calculated in this way are only relative, since the molar extinction coefficients were not taken into account, and became the amide I band is arising from a carbonyl stretching implicated in a resonance. The protein and lipid contents were estimated in parallel and their weight ratios calculated as stated in the Experimental section.

Figure 2 shows a plot of the protein to lipid ratios estimated through ATR-FTIR versus the values calculated by using chemical analysis. A linear regression analysis was carried out and the correlation coefficient was 0.9, and the result is also shown in Figure 2. The good correlation obtained indicates that the method was reliable.

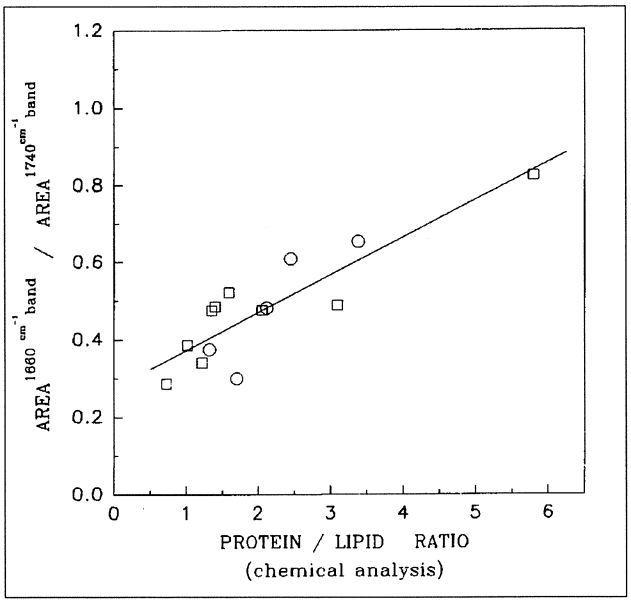

Figure 2
Plot of the ratio of the areas of the 1650 cm^{-1} (protein) and 1735 cm^{-1} (lipid) infrared bands versus the protein/lipid ratio obtained by chemical analysis for different types of sausage (spanish 'chorizo', ❑, and 'salchichón', ○). The regression straight line is also shown. Each point correspond to one of the samples analyzed.

Therefore, and using the values obtained through chemical analysis as calibration, real protein to lipid ratios can be estimated through the regression straight line, although that might not be necessary for many applications in which simply the relative index obtained by dividing the areas, could be enough.

It can be argued that additives or other substances present in the samples may also contribute to either amide I or the carbonyl band, therefore interfering with protein and lipid respectively. This is certainly a possibility, although the good correlation observed in Figure 2 between this method and a conventional one, indicate that the interference is not very important, at least in the samples used in this work.

Among the main advantages of this method, in comparison with other alternatives, it is necessary to mention that it is rapid simple, and non destructive. It is obvious that the same spectrum may supply information not only on lipid and protein which is what has been analyzed here, but also from other natural or added molecules, such as phosphate, polyphosphate or carbohydrates, and this could be an additional advantage which is being explored now in our laboratory, since there parameters are also important to characterize the quality of meat products.

REFERENCES

Afran, A. and Newbery, J.E. (1991).- "Analysis of the degree of unsaturation in edible oils by Fourier transform-infrared/attenuated total reflectance spectroscopy".- Spectroscopy **6**, 31-34.

Bandekar, J. (1992).- "Amide modes and protein conformation".- Biochim. Biophys. Acta **1120**, 123-143.

Boletín Oficial del Estado (Official Bulletin of the Kingdom of Spain) (1981).- "Normas de calidad para canales de porcino".- December-11, pp. 26398-26400.

Casal, H.L. and Mantsch, H.H. (1984).- "Polymorphic phase behavior of phospholipid membranes studied by infrared spectroscopy".- Biochim. Biophys. Acta **779**, 381-401.

Cronin, D.A. and McKenzie, K. (1990).- "A rapid method for the determination of fat in foodstuffs by infrared spectrometry".- Food Chem. **35**, 39-49.

ISO Standard 1444. (1973).- "Meat and meat products. Determination of free fat content".- 1973-04-15.

Osborne, B.G., Barrett, G.M., Cauvain, S.P. and Fearn, T. (1984). "The determination of protein, fat and moisture in bread by Near-Infrared reflectance spectroscopy".- J. Sci. Food Agric. **35**, 940-945.

Rasco, B.A., Miller, C.E. and King, T.L. (1991).- "Utilization of NIR spectroscopy to estimate the proximate composition of trout muscle with minimal sample pretreatment".- J. Agric. Food Chem. **39**, 67-72.

Stewart, D. and Morrison, I.M. (1992).- "FT-IR spectroscopy as a tool for the study of biological and chemical treatments of Barley straw".- J. Sci. Food Agric. **60**, 431-436.

(Recibido: Noviembre 1993)