Studies of lipids in "foie gras"

BEAUVALLET C., BONNET M. AND RENOU J.P.

Station de Recherches sur la Viande Unité RMN INRA Theix F63122 S^{t} Genès Champanelle

SUMMARY

The determination of lipids in "foie gras" was a basic experiment to characterize the type melting of foie gras. This is presently determined by tactile and visual test and means loss of fats by cooking. The feeding of animals and the processing of product (slaughter, plucking) play an important role on the quality of foie gras. NMR spectroscopy and micro-imaging allow to estimate lipids in liver cells by assessment of fatty globules size in different parts of the "foie gras" and characterization of unsatured and satured lipids by ^{13}C NMR. With the micro-imaging technique, the resolution is 10 μm and slices of less than a millimeter. Furthermore, the differential scanning calorimetry might enforced this attribution by pointing out the proportion of polyunsaturated fatty acids.

Introduction

The quality of "foie gras" was very studied in France during the last years. These studies were carried out to characterize the fats in liver cells and correlate the type melting of "foie gras". It means loss of fats by cooking and then decrease in the weight and quality of "foie gras". This is presently determined by tactile and visual test in industry by trained people. It appears very difficult to predict if a "foie gras" is capable of melting since the size is not a reliable criterion. Indeed, small "foie gras" can lost fats during cooking. This loss might be connected to the breaking of liver cells under the pressure of lipid amount and then be independent of liver size. It could also be related to the presence of collagen, a protein which contract under heating.

The genetic breeds of animals (geese, duck) is a variable factor of quality and the selection was correlated during many years to the size of "foie gras". Presently, the breed is more concerned with the melting type of liver.

We intend to apply NMR methods to assay lipids in "foie gras". Using micro-imaging with pulsed gradients, we obtain very good images with a resolution of pixels about fifteen microns with a slice thickness inferior to the millimeter. They showed a contrast of water and lipids appearing in white over black background. By selecting a specific peak (water or fats) using a selective pulse, we discriminate the coumpounds and get an image with only the chosen signal. This experiment must be carried out to select the best part of "foie gras" to get the maximum lipid signal to work on. Furthermore, this technique has good caracteristics and is applied to human illness studies (imaging). The environment of lipids in cells may be different in big or small "foie gras" and could be study by determination of relaxation times T_1 and T_2 correlated to molecular dynamics.

MATERIALS AND METHODS

The "foie gras" was purchased from the Maison Laffite (Montaut, St Sever) and was caracterized as good quality.

The experiments were carried on a Bruker AM 400 connected to a micro-imaging unit and using micro-imaging proton probe. The proton density and chemical shift images were obtained using Bruker programs installed on the calculator Aspect 3000. The sweep width was 45000 Hz and the resolution of pixels was 40 microns with a slice thickness of 0.55 millimeter.

The images of the whole "foie gras" were obtained with a horizontal magnet (2.35T, Ø 20cm) and a Bruker CXP console (INSERM U318 Grenoble). The spectral resolution was 37Hz, the spatial resolution 0.5 mm. The images were acquired in 2 minutes with a slice of 3 mm. To obtain the lipid images the selective presaturation of water signal was performed (Dante sequence: 3000 pulses of 8µs spaced of 300µs). The water image was the difference between the non selective image and the lipid image.

RESULTS AND DISCUSSION

Experiments were carried out in NMR imaging to determine first the spatial distribution of lipids inside the "foie gras". Different slices were obtained in the "foie gras" and it appeared an homogeneous distribution of lipids in the whole liver. The resolution was not sufficient to retrieve differences at the liver. No difference was observed at the different slice level in the small and the big lobe and we can postulate that the distribution of lipids in "foie gras" was regular at the supramolecular level. The melting criterion appeared difficult to be differenciate using imaging.

Secondly, we withdrew carots of "foie gras" in the two lobes and we observed in NMR spectroscopy two main peaks, water and lipids with a difference of chemical shift of 3.5 ppm. The peak of lipids appeared with almost the same intensity compared to the water signal. So, the quantities were quite similar and the images should reveal the same white intensity. The different carots showed the same intensity of the fat peak in the different parts of liver and so the distribution might be the same in the two lobes of "foie gras".

Effectively, we obtained non selective images with almost the same intensity over the background. One scan is enough to get a good observation of water and lipids over the protein texture. These images showed the distribution of these different protons in the liver and we observed clusters in the sharp extremity of the big lobe (see image 4). However, we did not retrieve these caracteristics in the other parts of liver (image 6) and we can suppose the breakdown of liver cells in the previous mentioned part. This could be correlated to the melting capacity of "foie gras".

Using selective pulse sequence, we obtained selective water and lipid images for the two lobes of "foie gras" and retrieved the caracteristics previously described. The repartition of lipids in the carots remained homogeneous in the protein texture except for the mentioned part.

The analysis of the fat from different parts of "foie gras" was performed using ^{13}C NMR spectroscopy (Figure 1) and differential scanning calorimetry in order to detect differences in composition.

These NMR techniques support the previous observations (Bonnet *et al.*1990) and develop new parameters for estimation of "foie gras" quality.

IMAGES

1) Whole "foie gras". Image of lipids and water

2) Whole "foie gras". Image of lipids

3) Whole "foie gras". Image of water

4) Sharp part of the big lobe. Non selective image: water + lipids protons

5) Sharp part of the big lobe. Selective image: Lipids protons

6) Sharp part of the small lobe. Non selective image: water + lipids protons

7) Sharp part of the small lobe. Selective image: Lipids protons

REFERENCES

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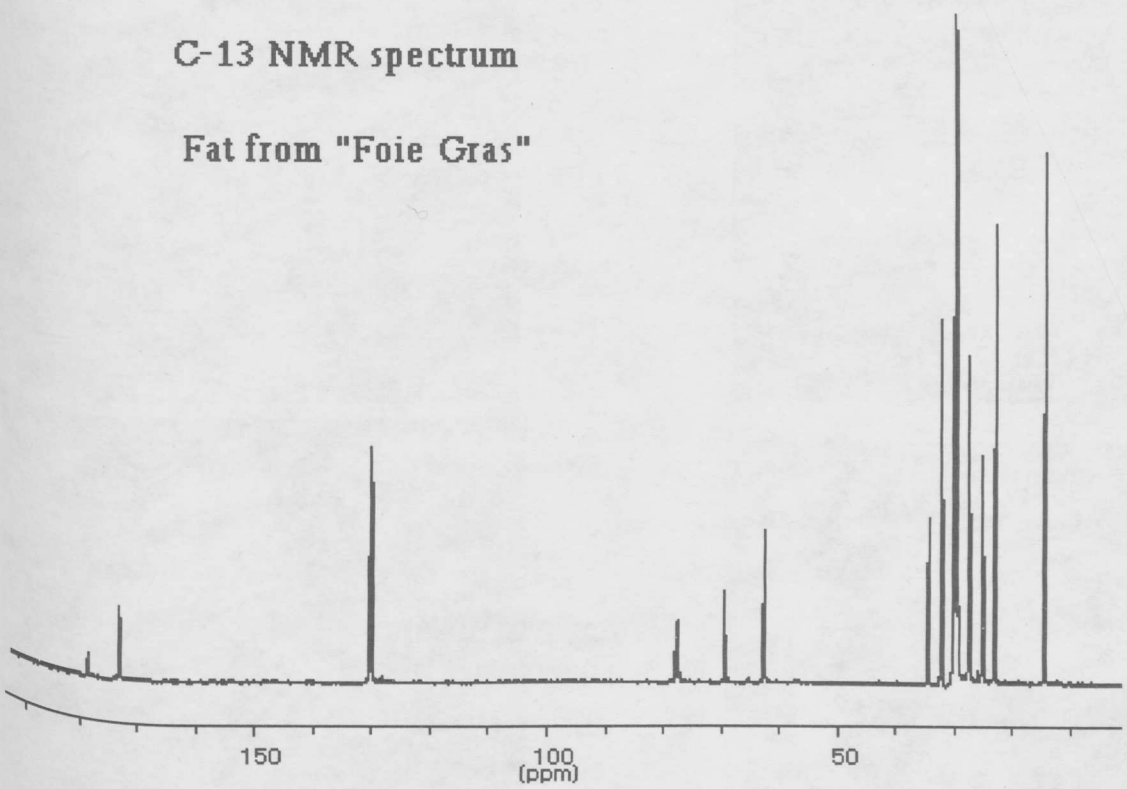

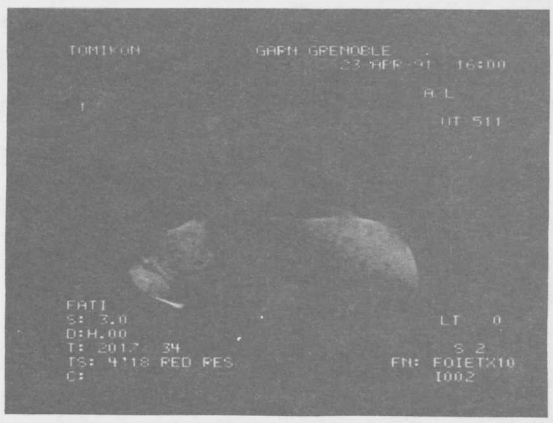
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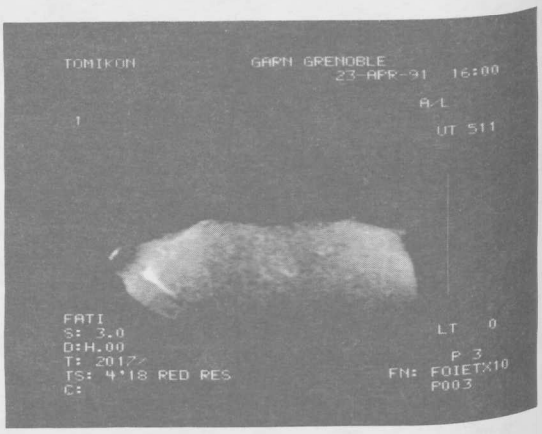
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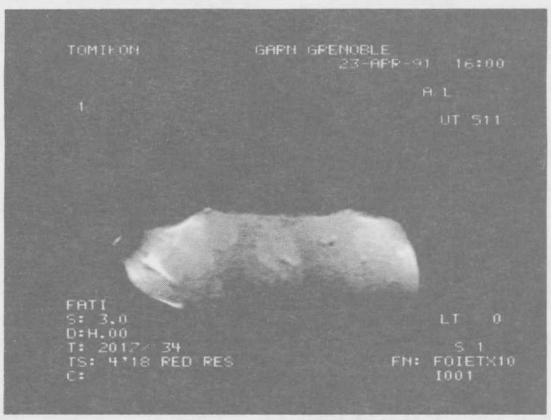
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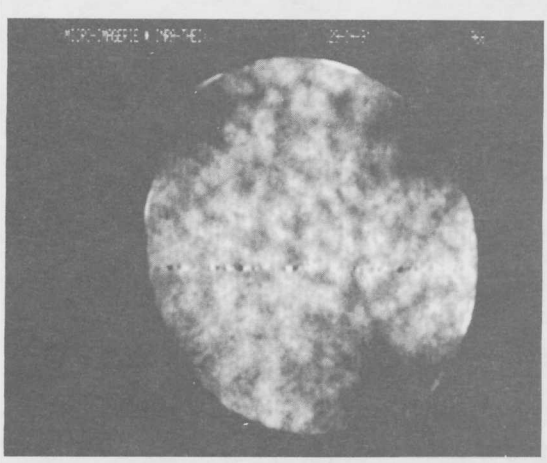

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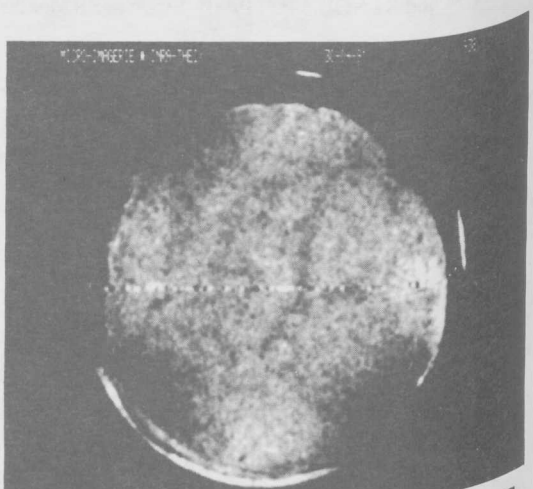

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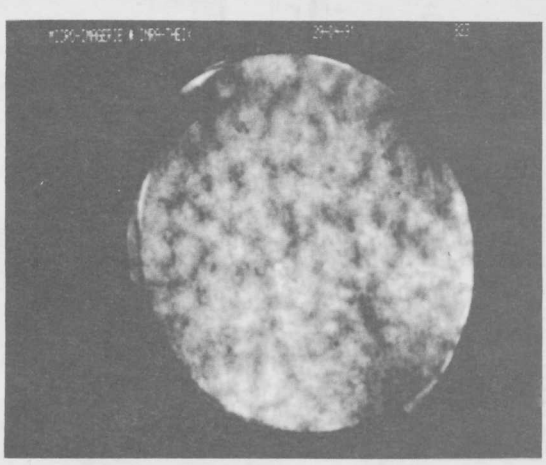

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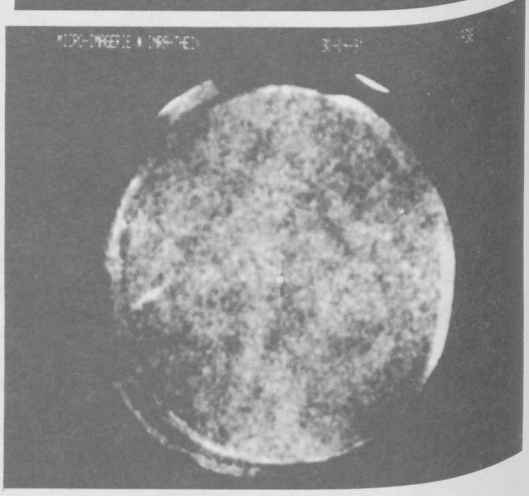

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