

Fat and oil content is an important measurement of nutritional value and product quality for many foodstuffs. In particular, this value is widely used to determine energy content and to calculate the proportion of other components in foods (e.g. carbohydrates). In addition, the fat and oil content may significantly affect the texture, perceived quality and flavour of products. Thus, accurate measurements of the fat and oil content enable the manufacturers to achieve higher standards in nutritional characterisation and quality control of foodstuffs.

Method

Solvent extraction techniques are commonly used for determination of fat content. However, they tend to be slow, cumbersome and inaccurate, and require highly skilled personnel. In addition, many of the often hazardous chemicals used are becoming increasingly unacceptable according to international environmental standards. Despite these issues, solvent extraction continues to be used as a reference measurement for quality control.

Instrumental methods are often referred to as secondary techniques since they are usually set up to match the results produced by solvent extraction. To provide a result equivalent to the traditional extraction techniques, secondary techniques require a correlation against the reference technique used. Although they are fast and easy to maintain, many secondary techniques need to be calibrated and maintained regularly. Also, maintenance and consumables add significantly to the cost of ownership. For example, although Supercritical Fluid Extraction (SFE) is reasonably fast, it requires high maintenance and the cost of compressed CO₂, used to extract oil is also significant. Near Infra-Red (NIR) is commonly used for on-line monitoring but is difficult to apply on opaque samples as it can only scan the surface. It is also complex to calibrate as measurements are sensitive to product granularity and additives such as seasoning, and it is therefore difficult to maintain accurate calibrations on a large variety of product types. For that primary reason, NIR has limited applicability for the quality control of fat (oil) content in many foods.

In contrast to the standard wet chemistry methods and various secondary techniques, low resolution Nuclear Magnetic Resonance (NMR) provides a fast, direct and user friendly method for determination of the fat and oil content in foodstuffs that can be operated by a non NMR expert user. This technique is based on measurement of the NMR response obtained from fat (oil) in the product, and quantification of the fat (oil) content by calibration.

Advantages of benchtop NMR

- It can be calibrated to cover a concentration range from 0 to 100% fat (oil)
- A primary calibration can be produced using a single sample of fat (oil)
- NMR is very stable over the long-term, therefore requires little recalibration
- The sample measurement time is short (typically 20 seconds)
- Minimal sample preparation is required¹
- It is virtually insensitive to sample matrix granularity and additives such as spices, flavours, colours and salt
- The NMR technique is non-destructive, so repeatability measurements can be made conveniently

Calibration and Results

A calibration can be generated using either one 100 % fat (oil) sample or a set of 3-6 samples of real products with predefined fat (oil) contents spanning the range of concentrations of interest. Figure 1 shows a calibration for foodstuffs with fat contents ranging from 2.1 to 40.2 % by mass. Samples of dried macaroni cheese, baked cheese, chicken powders, chicken sandwich fillers, milk powders, and meat pastes were used to generate the calibration in Figure 1. As seen in the figure, NMR gives an excellent linear correlation between the NMR response and the concentration of fats in the products.

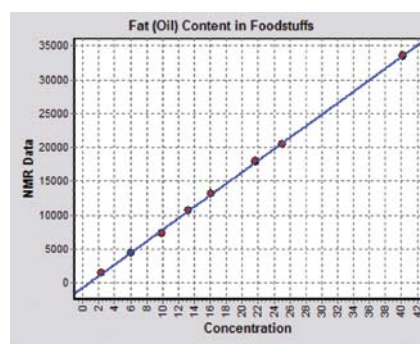


Figure 1: Calibration obtained for fat content in foodstuffs; standard deviation of the linear fit is 0.20 % by mass, correlation coefficient $R^2 = 1.00$. Measurements were made using an Oxford Instruments MQC-23 benchtop NMR analyser equipped with a 26 mm diameter probe.

¹For optimal precision, samples should be conditioned at 40°C for at least 20 minutes prior to the measurements.

Instrument repeatability was tested by measuring one sample ten times. After every test measurement, the sample was transferred from the instrument back to the conditioning block for 20 minutes to be conditioned at 40°C and then measured again. Table 1 shows the repeatability test results.

Given Fat Content %	Results (%) of Repeat NMR Measurements										Mean Value %	Standard Deviation %
16.1	15.79	15.80	15.80	15.81	15.82	15.81	15.82	15.82	15.83	15.81	15.81	0.01

Table 1: Results of instrument repeatability test

Recommended Instrument Configuration

The **MQC-23** with 0.55 Tesla magnet fitted with a 26 mm diameter (10 ml) sample probe is ideal for this application. The 'Fat Content in Foodstuffs' package comprises:

- The **MQC-23** which can be controlled using its own built-in computer using Microsoft Windows® or via a standalone PC
- **MultiQuant** software including **RI Calibration**, **RI Analysis**, and the **EasyCal** 'Fat Content in Foodstuffs' application software
- Test / tuning sample
- Three setting-up samples (SUS's) at nominally 10, 25 and 40 % fat content for calibration maintenance and quality control
- 23 mm diameter sample vials
- Polytetrafluoroethylene (PTFE) sample holders
- PTFE sample packing tool
- Installation Manual
- Method Sheet

In addition you may also wish to purchase:

- A dry block heater capable of maintaining samples at 40°C
- An aluminium block with holes for 23 mm diameter sample vials
- A precision balance

The instrument offers multiple advantages over other instruments on the market:

- High signal sensitivity
- Small benchtop footprint
- Specific 'Fat Content in Foodstuffs' Applications Software
- Low maintenance
- Minimal sample preparation



Oxford Instruments Magnetic Resonance

For more information please email:
magres@oxinst.com

UK

Tubney Woods, Abingdon
Oxon, OX13 5QX, UK
Tel.: +44 (0) 1865 393 200
Fax: +44 (0) 1865 393 333

China

Room 14-F, No. 1 Plaza
No. 800 Nanjing East Road
Shanghai 200001, China
Tel: +86 21 6132 9678
Fax: +86 21 6360 8535

USA

300 Baker Avenue, Suite 150
Concord, Mass 01742, USA
Tel: +1 978 369 9933
Fax: +1 978 369 8287

visit www.oxford-instruments.com for more information

www.oxford-instruments.com

This publication is the copyright of Oxford Instruments Molecular Biotoools Ltd. and provides outline information only, which (unless agreed by the company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or regarded as the representation relating to the products or services concerned. Oxford Instruments' policy is one of continued improvement. The company reserves the right to alter, without notice the specification, design or conditions of supply of any product or service. Oxford Instruments Molecular Biotoools Ltd. acknowledges all trademarks and registrations. Oxford Instruments Magnetic Resonance is a trading name of Oxford Instruments Molecular Biotoools Ltd. © Oxford Instruments Molecular Biotoools Ltd., 2010. All rights reserved. Part no: HIF-03-10



The Business of Science®

