Determination of Fat and Oil Content in Foodstuffs

Application Note 17

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 CO_2, 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 required[1]
- 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.

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

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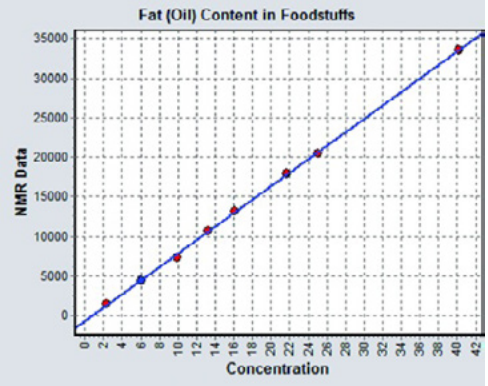

Figure 1: *Calibration obtained for fat content in foodstuffs; standard deviation of the linear fit is 0.20 % by mass, correlation coefficient r^2 = 1.00. Measurements were made using an Oxford Instruments* ***MQC+*** *benchtop NMR analyser equipped with a 26 mm diameter probe.*

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.

Table 1: *Results of instrument repeatability test*

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

Recommended Instrument Configuration

The **MQC+** 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+** with a built-in computer operating Microsoft® Windows® 10 (no separate PC is required).
- **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
- User Manuals
- 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

visit **www.oxford-instruments.com/mqc** for more information or email: **magres@oxinst.com**

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