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A RAPID METHOD FOR THE DETERMINATION OF FAT IN MEAT AND MEAT PRODUCTS

By Roy Nilsson and Kurt Kolar, Swedish Meat Research Institute, Kävlinge, Sweden

INTRODUCTION

The determination of the fat content in food is usually carried out by chemical methods in which the fat is extracted by organic solvents, as in the Soxhlet method, or in the method according to Schmidt-Bondzynsky-Ratzlaff. These methods are very accurate but time-consuming. Therefore, they are not suitable for production control or for other purposes where it is essential to obtain the answer rapidly or for serial analyses.

For such purposes one frequently uses modifications of chemical methods as the Gerber or Babcock methods, methods which are rapid but less accurate.

However, also physical methods are used for rapid determination of fat content, Nuclear Magnetic Resonance (NMR) has recently been used by Nilsson and Kolar for meat and meat products (1), and by Samuelsson (2) and by Moisio et al. (3) for milk and milk products.

The density has frequently been used for fat determination in meat, either without extraction or in an extract.

The Honeywell´s Digital Fat controller as described by Malanoski and Greenfield (4) determines the fat content without extraction but it is necessary to mince the sample. This is, however, not necessary with the apparatus developed by the Danish Meat Research Institute (5).

Methods in which the density of fat extracted and solve in organic solvents as trichlorethylene and heptan has been used by Grip et al. (6) by Ul-Hassan and Pearson (7) and by Bittenbender (8).

To render this type of methods more suitable for serial analyses an equipment has been developed by Foss Electric. This paper reports the results obtained by testing it for meat and meat products.

EQUIPMENT

The equipment "Foss-let" was supplied by A/S Foss Electric, Hilleröd, Denmark. It consists of the following units (Fig. 1).

1. Automatic byrett, 120 ml, type 15330, and a 10 l plastic bottle
2. Vibrator, type 15320
3. Cooler, type 15321
4. Measuring apparatus, type 15310
5. Filtering device
6. 2 extraction bottles of stainless steel. The bottles contain a cylinder with a central hole to facilitate the extraction.

It is advisable to place the extractor on a separate table.

METHOD

The main steps of the method are the following ones:

1. The sample is extracted with perchlorethylene in a vibrator.
2. The density of the solution is measured potentiometrically at a constant temperature in a measuring unit.
3. The fat percentage is obtained from a table supplied by the manufacturer or by using a calibration factor.

Procedure

The sample is grinded and mixed thoroughly. With a fat percentage of less than 60% in the sample 45.0 g is placed in an extraction bottle. If the fat content exceeds 60% only 22.5 g is used. To bind the water about 20 g dry sodium sulphate is added. The extraction bottle is closed, placed in the vibrator and vibrated for 2 minutes.

The extracted sample is filtered through a 70 mm filter paper.

The measuring cell in the measuring unit is rinsed twice with the fat perchlorethylene solution and then filled.

When the indicator lamp indicates that the temperature is correct in the measuring cell the reading is carried out.

Before measuring the fat content in unknown samples the measuring unit is adjusted by using a standard of mineral oil supplied by the manufacturer.

RESULTS

One requirement that has to be fulfilled if the method should have a practical use is that lard and tallow - the principal animal fats used - have the same density.

As shown by Table 1 this claim is fulfilled, anyhow, for practical purposes. The table also shows that it is necessary to keep the temperature rather constant to get reliable results.

The method was tested with a large amount of samples of meat, cured meat, sausages of different types and a broad variety of ready-made foods against a standard method. Some of the results are shown in Tables 2-6.

Table 2 shows the results obtained with beef. The fat content according to the Foss-let method are somewhat lower than those obtained by the official standard method (SBR). The difference was independent of the fat content. Therefore, the relative error was rather large at low fat contents, but quite tolerable from a practical point of view.

The agreement between the two methods was the same for pork as for beef.

Table 3 shows the comparison in fat content when the two methods were used for hot smoked sausages of Frankfurter and Bologna type, with a fat range between 14 and 28%. The agreement between the methods was generally good, as the relative error did not exceed 5%. The same type of results was obtained when analysing fermented and cold smoked sausages.

Cooked products as blood sausage and liver paste give generally a too low fat content when being analysed by rapid methods, but when the Foss-let method was used the agreement with the standard was reasonbly good as shown in Table 4. The values obtained by the Foss-let method were somewhat higher than when the standard method was used. But even if the absolute error in some cases was as high as 1.8% the relative error was not higher than about 5%.

For cured meat some typical results are shown in Table 5. The rapid methods gave practically the same fat content as the standard method.

A large variety of ready-made food, including meat and fish products, vegetables and cereals were analysed by the Foss-let method for the fat content. The results were good as shown by Table 6, with a low relative error with the exception for some of the samples with very low fat content.

It was interesting to see that the absolute error in fish and vegetables was not larger than the error in meat and meat products, as it implies that densities of these fats do not differ to any larger extent from those of lard and tallow.

The results from Tables 2-6 are summarized in Table 7 in the form of linear correlation coefficients and regression equations for the relation between the fat content obtained by the Foss-let method and an official standard method.

The correlation between the two methods was very good with values for the correlation coefficient over 0.99 for all tested product types.

DISCUSSION

There are certain advantages by using the Foss-let equipment as a rapid method for determining the fat content in food. The method gave reproducible results. The difference between duplicate samples was generally only 0.1% or less and exceeded 0.2% only in a few cases.

The accuracy of the method is sufficient. Even if the differences to the value obtained by an official method in same cases were more than 1% the relative error did not exceed 5% with a fat content between 10 and 60%. This error is too large for research use but for routine analyses in a production control or in determining the nutritive value of products this size of error can be tolerated.

The sample size, 45 g, is such that it is easy to obtain a representative sample compared with the official methods which generally use only a sample of a few grams.

The method can be used for a large variety of products as shown by the results in Tables 2-6. This is an advantage in relation to some other rapid methods mentioned in the introduction.

The method is easy to use and has a rather high capacity. One person can easily make 50-60 analyses per day.

One drawback of the method is that it is necessary to use perchlorethylene which is hazardous and therefore requires a hood with good ventilation. Furthermore, some persons are allergic to the substance.

Nevertheless, it seems to us as the method based on the Foss-let equipment could be recommended for rapid determination of the fat content in food.

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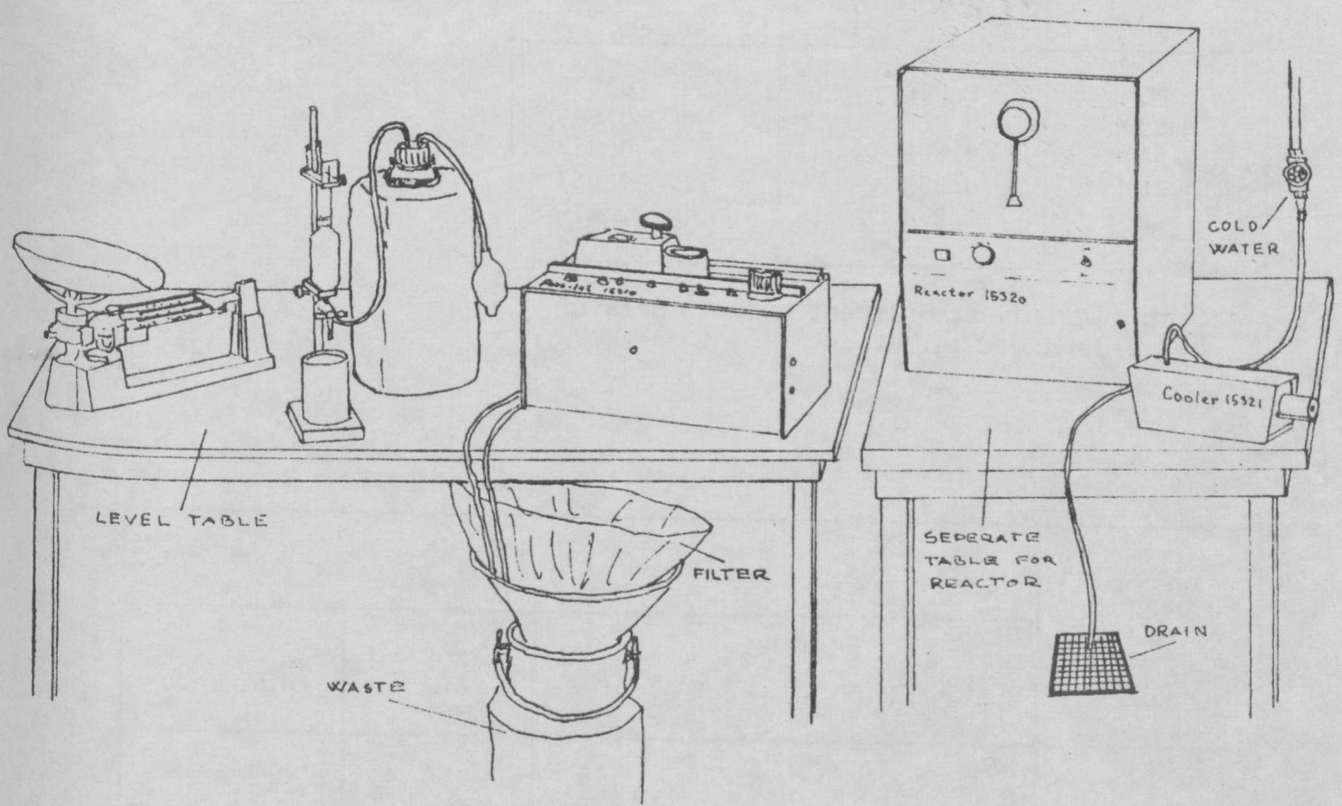

Figure 1. A schematic picture of the Foss-let equipment.

Temp. °C	Density	
	Tallow	Lard
40	0.900	0.900
50	0.888	0.890
60	0.881	0.882
70	0.865	0.867
80	0.874	0.876

Table 1. Density at different temperatures of lard and tallow.

Sample nr	Fat %				
	Foss-let			Standard MV	Difference
	1	2	MV		
1	1.15	1.20	1.2	1.7	-0.5
2	1.40	1.50	1.5	2.0	-0.5
3	1.95	1.95	2.0	2.2	-0.2
4	1.35	1.40	1.4	1.5	-0.1
5	1.70	1.75	1.7	1.7	0
6	1.50	1.60	1.6	2.0	-0.4
7	1.30	1.35	1.3	1.7	-0.4
8	1.55	1.50	1.5	2.0	-0.5
9	2.40	2.45	2.4	2.6	-0.2
10	4.35	4.40	4.4	4.4	0
11	12.00	12.05	12.0	12.5	-0.5
12	14.65	14.85	14.8	14.8	0

Table 2. Fat content in beef determined by the Foss-let method and by an official standard method (SBR). For the Foss-let method duplicate values and mean values are given.

Sample nr	Fat %				
	Foss-let			Standard	
	1	2	MV	MV	Difference
1	14.60	14.65	14.6	14.8	-0.2
2	15.15	15.15	15.2	15.5	-0.3
3	15.50	15.25	15.4	15.2	0.2
4	16.10	16.05	16.1	16.3	-0.2
5	17.10	17.35	17.2	17.1	0.1
6	20.10	20.10	20.1	19.9	0.2
7	20.95	20.70	20.8	20.3	0.5
8	21.20	21.30	21.3	21.0	0.3
9	20.25	20.15	20.2	20.1	0.1
10	22.20	22.20	22.2	22.4	-0.2
11	23.05	23.40	23.2	23.9	-0.7
12	24.85	24.70	24.8	24.6	0.2
13	25.05	25.10	25.1	24.0	1.1
14	26.05	26.15	26.1	26.4	-0.3
15	26.25	26.35	26.3	26.1	0.2
16	27.80	27.85	27.8	27.9	-0.1

Table 3. Fat content in hot-smoked sausages of Frankfurter and Bologna type determined by the Foss-let method and by an official standard method (SBR).

Product	Fat %		
	Foss-let	Standard	Difference
Blood sausage	19.8	20.0	-0.2
	22.1	22.2	-0.1
Pork sausage	24.2	24.3	-0.1
Liver sausage	27.7	27.0	0.7
	26.6	26.5	0.1
	42.2	41.3	0.9
Liver paste	27.4	26.3	1.1
	27.3	27.0	0.3
	32.2	30.8	1.8
	28.5	27.3	1.2
	31.8	31.2	0.6

Table 4. Fat content in cooked products determined by the Foss-let method and by an official standard method (SBR).

Product	Fat %		
	Foss-let	Standard	Difference
Smoked ham	3.0	2.5	0.5
	8.2	7.8	0.4
	7.2	7.4	-0.1
	4.0	4.0	0
Cooked ham	4.0	4.0	0
	4.5	4.7	-0.2
	13.2	13.6	-0.4
	14.8	14.9	-0.1
	17.1	17.4	-0.4
Kasseler	5.0	5.2	-0.2
	8.7	9.0	-0.3
	11.2	10.6	0.6
Bacon	50.3	50.1	0.1
	49.3	48.6	0.7
	40.1	40.1	0

Table 5. The fat content in cured meat determined by the Foss-let method and by an official standard method (SBR).

Product	Fat %		
	Foss-let	Standard	Difference
Meat and comminuted meat	7.9	8.4	-0.5
	15.6	15.2	0.4
	9.5	10.3	-0.8
	18.2	18.5	-0.3
Meat and vegetables	6.3	6.1	0.2
	6.4	6.5	-0.1
	10.7	10.1	0.6
	9.4	9.6	-0.2
	8.5	8.1	0.4
Fish	3.9	3.5	0.4
	3.8	3.4	0.4
	5.2	4.6	0.6
	5.6	5.5	0.1
Vegetables	0.5	0.7	-0.2
	0.4	0.7	-0.3
	0.2	0.7	-0.5
	0.3	1.0	-0.7
Cereals	4.6	4.3	0.3
	6.1	6.1	0
	11.0	11.5	-0.5

Table 6. The fat content in different types of ready made food determined by the Foss-let method and by an official standard method (SBR).

Product type	Regression equation	Corr. coef.
Beef and pork	y = 1.007x - 0.303	0.998
Hot smoked sausages	y = 0.996x - 0.010	0.991
Cooked sausages	y = 1.024x - 0.304	0.997
Cold smoked sausages	y = 1.076x - 3.109	0.995
Cured meat	y = 1.008x - 0.120	0.999
Ready made food	y = 1.012x - 0.142	0.997

Table 7. Regression equation and linear correlation coefficients for the fat content determined by the Foss-let method (y) and an official standard method (x).

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By Roy Nilsson and Kurt Kolar, Swedish Meat Research Centre, Kävlinge, Sweden

SUMMARY

An equipment developed by Foss Electric, Hilleröd, Denmark, has been used for a rapid and accurate determination of fat in meat and meat products.

The method is based on a rapid extraction of the fat from a minced sample into perchlorethylene by a vibrator. The density of the solution is then determined potentiometrically at a constant temperature and the fat content read from a calibration curve.

The method gives reliable results with meat, sausages, cured meat and ready made food, even such products that contain vegetables, cereals and fish.

The difference between duplicate samples is generally about 0.1%. The correlation between the method and an official standard method is good with correlation coefficients between 0.991 and 0.999 for the different products.

EINE SCHNELLMETHODE FÜR DIE BESTIMMUNG VON FETTE IN FLEISCH UND FLEISCHWAREN

von Roy Nilsson und Kurt Kolar, Schwedisches Fleischforschungsinstitut, Kävlinge, Schweden

ZUSAMMENFASSUNG

Ein Gerät, das von Foss Electric, Hilleröd, Dänemark, entwickelt ist, ist zur Bestimmung von Fett in Fleisch und Fleischwaren geprüft. Die Methode ist schnell und genau.

Prinzip: Das Fett ist aus der verkleinerten Probe mit Perchlorethylen extrahiert. Die Dichte der Fettlösung ist bei konstanter Temperatur elektrisch gemessen und der Fettgehalt aus einer Eichkurve erfasst.

Die Methode gibt zuverlässige Ergebnisse bei Untersuchung von frischem Fleisch, gepökeltem Fleisch, Wurstwaren und Fertiggerichten. Die Methode eignet sich auch für Waren, die Gemüse, Getreide und Fisch enthalten.

Die Differenz zwischen Duplikaten betrug im Allgemein etwa 0,1%.
Die untersuchte Methode gab eine signifikant Uebereinstimmung mit einer offiziellen Standardmethode. Der Korrelationskoeffizient schwankte zwischen 0,991 und 0,999 und war von der Art der Ware abhängig.

ЭКСПРЕССМЕТОД ОПРЕДЕЛЕНИЯ ЖИРА В МЯСЕ И МЯСНЫХ ПРОДУКТАХ

Рой Нильссон и Курт Колар, Шведский институт по исследованию мяса, Чевлинге, Швеция

РЕЗЮМЕ

Для скорого и точного определения жира в мясе и мясных продуктах была использована аппаратура, развитая фирмой Фосс Электрик, Хиллерёд, Дания.

Метод основывается на скором экстрагировании жира, с помощью вибратора, из пробы рубленного мяса в сосуд, содержащий тетрахлорэтилен. Плотность раствора затем определяется потенциометрическим способом при постоянной температуре. Содержание жира прочитывается на градуировочной кривой.

Этот метод дает надёжные результаты как в отношении мяса, колбас, консервированного мяса и приготовленной пищи, так и в отношении продуктов, содержащих овощи, кашу или рыбу.

Разница между двойными пробами составляет обыкновенно около 0,1 %. Корреляция между экспрессметодом и официальным стандартным методом является хорошей; корреляционные коэффициенты для различных продуктов находятся между 0,991 и 0,999.

MÉTHODE RAPID POUR LA DÉTERMINATION DE LA MATIÈRE GRASSE DANS LA VIANDE ET LES PRODUITS DE VIANDE

Roy Nilsson et Kurt Kolar, Institut de Recherche sur la viande, Kävlinge, Suède

RESUMÉ

Un instrument développé par Foss Electric, Hilleröd, Danmark, a été utilisé pour déterminer la matière grasse dans la viande et les produits à base de viande d'une manière rapide et exacte.

La méthode est basée sur une extraction rapide de la matière grasse d'un échantillon de viande hachée. L'extraction se fait à l'aide de perchlorure d'éthylène et d'un vibrateur. La densité de la solution est ensuite déterminée avec un potentiomètre à une tempèrature constante. La teneur de matière grasse est calculée à l'aide d'une courbe de calibration.

La méthode donne des résultat corrects avec des échantillons de viande, de saucisses, de viande salée et de repas préparés même si les produits contiennent des légumes, des céréales et du poisson.

La différence entre deux échantillons est généralement environ 0.1%. La corrélation entre cette méthode et une méthode standard officielle est entre 0.991 et 0.999 pour les différents produits.