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Comparison of methods for the determination the fat content of meat

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Abstract

For the efficiency of the animal breeding, and also in the food science, the accurate determination of the components, including fat content of the meat is very important. The objective of this study was to compare different chemical and physical methods as well, which are widely used to determinate the fat content of the different tissues of the animals. In total 23 pigs and 19 cattle were included in the investigations. Different cuts of the carcasses like longissimus muscle (MLD), head, belly and breast, feet, ham, neck, loin, tenderloin and subcutaneous fats were used this comparison. During the investigation the following 3 chemical [Soxhlet method, automatic fat extraction (ANKOM XT 15 Extractor), automatic fat extraction following hydrolyzing (ANKOM HCL Hydrolysis System, ANKOM XT 15 Extractor)] and 2 physical methods (Infratec1255 Food and Feed Analyzer, Tecator AB; FoodScan™ Lab, FOSS) were compared. For the accurate statistical analysis the different cuts were ordered into 3 groups. Data were analysed by the GLM procedure of SAS (1985), using the Least-Square-Method. The repeatability (θ) of the chemical methods for all samples was also calculated, it ranged between 0,9925-0,9977.

Introduction

The total fat content could be determined with different chemical and physical methods. Soxhlet is a widespread method, but nowadays efforts are made to lower the solvent use, and minimise the time of analysis. Several automatic equipments are available on the market, which advantages are low solvent need, and less labour and time requisite. The physical methods as NIT (Near Infrared Transmission) techniques are running without chemicals, and the duration of the analysis is few minutes. During the studies the issue is raising, if the results of the different methods are comparable, or some tendencies could be detected.

The objective of this study was to compare different chemical and physical methods as well, which are widely used to determinate the fat content of the different tissues of the animals.

Materials and Methods

The total fat content of 80 beef and pork cuts and tissues (Table 1.) were analysed with different chemical and physical methods. To simplify the statistical analysis the cuts were

ordered in groups: group 1: MLD, group 2: tenderloin, ham, chuck, blade steak, roastbeef, loin, breast; group 3: belly and breast, head, hock. In the first group (group 1) 43, in the second (group 2) 25, in the third (group 3) 12 samples were analysed.

Three subcutaneous fat samples were analysed only with the chemical methods, as the NIT technique is calibrated for samples less than 56% fat content. So these samples were not taken into the statistical analysis, and also not shown in the tables.

In this investigation the total fat content of different cuts was determined with several methods as follows: (1) extraction with soxhlet method, (2) extraction with automatic extraction system (AnkomXT 15 extractor, Ankom technology), (3) extraction with automatic extraction system, following hydrolysis (AnkomHCL Hydrolysis System and, AnkomXT 15 Extraktor, Ankom technology), (4) analysis with NIT method with Infratec equipment (Infratec1255 Food and Feed Analyzer, Tecator AB), (5) analysis with NIT method, with Foss equipment (FoodScan™ Lab, FOSS NIR Systems, Inc.).

Table 1.: Overview of the studied tissues

Tissues		N	Group
MLD beef	beef	20	1
MLD pork	pork	23	1
tenderloin	beef	3	2
tenderloin	pork	2	2
ham	beef	3	2
ham	pork	2	2
chuck	beef	3	2
blade steak	pork	2	2
roastbeef	beef	3	2
loin	pork	2	2
breast	beef	5	2
Belly and breast	pork	5	3
head	pork	5	3
hock	pork	2	3
Total		80	

For the examination ca. 250 g muscle and subcutaneous samples were taken, minced in a food processor (Multiboy, Ilmenau, Germany) and stored frozen (-20°C) till analysis. For the studies the samples were thawed at 4°C for 24 h. The chemical methods were carried out in 3-times repetition, the results of the NIT method are the average of 10, and the results of the Foss method are the average of 16 measures of one sample.

Soxhlet method

With the soxhlet method the moisture and the fat content were determined. A well defined and weighed amount (5-8 grams) of the minced and well mixed samples was taken into an aluminium vessel, mixed with see sand and with some ethanol. The samples were dried for 4 h

on 105°C in a drying oven. The extraction was performed with petroleum ether, for 6 h, on 60°C. After the distillation, the flasks with the fat were dried for 1 h on 100°C, and cooled on room temperature in exsiccator. The extracted lipids of muscle were weighed to determine the intramuscular fat content.

Fat content analysis with automatic extraction system (Ankom XT 15 Extraktor)

This method determines crude fat by extracting with petroleum ether. A well defined and weighed amount (ca. 2 grams) of the minced and well mixed samples were taken, and placed a pre weighted filter bag, then encapsulated. The samples were then dried in drying oven for 3 h on 102°C. Automatic extraction was carried out for 60 min on 60 °C, with petroleum ether as extraction solvent. After the extraction the samples were dried for 30 min on 105°C, cooled in desiccant pouch on room temperature and weighted. The fat content was calculated as follows:

100 x (pre dried sample weight– sample weight after extraction)/ wet sample weight = fat %

Fat content analysis with hydrolysis and automatic extraction system (Ankom HCL Hydrolysis System, Ankom XT 15 Extraktor)

Prior to the extraction detailed above, hydrolysis procedure is also done by this method. A well defined and weighed amount (1-1,5 grams) of the minced and well mixed samples, and also a defined amount of diatomaceous earth (0,5-1 g) were taken, and placed a pre weighted filter bag, then encapsulated.. The samples were hydrolysed in 3N HCL for 80 min on 90 °C, and then rinsed for 4-6 times depending on the fat content. The samples were then dried in drying oven for 3 h on 102°C. Then the automatic extraction was carried out as described above, the fat content calculation was also the same.

Fat content analysis with Infratec 1255 FFA-Analysator

The NIT principle is based on the fact that the measured sample, for example, raw meat, absorbs the Near Infrared light at different wavelengths according to different characteristics such as fat or protein content. It is an indirect method, which is based on a calibration on the classical chemical methods.

The Infratec 1255 FFA is a NIT-analysis equipment. By this method 50g of the minced and well mixed samples is distributed in 5 cuvettes, the equipment measures 2 times each cuvettes, it means, the results are the average of 10 measures. The equipment is calibrated on soxhlet method.

Fat content analysis with Foss FoodScan Lab

The Foss FoodScan is also a NIT-analysis equipment. By this method 200-250g of the minced and well mixed samples is extended in the analysis plate, the equipment measures 16 times, it means, the results are the average of 16 measures. The equipment is calibrated on soxhlet method.

Statistical Analyses

The statistical analysis was carried out with the GLM process of Program-Packets SAS (Statistical Analysis System, 1985) by using Least-Square-Method. Factors as method and fat content were considered in the variant analysis. The mean comparison and the repeatability vas analysed with LSD method. As significance border, $P < 0,05$ was taken.

Results

The results of the statistical analysis show that the repeatability (θ) of all the chemical methods was high (Table 2.). In the group 1 and group 2 the soxhlet, in the third group the Ankom method reached the highest repeatability. Anyway, there are minimal differences among the repeatability results of the methods. For the NIT methods no repeatability could be calculated, because there were no single data available, only averages of the measurements.

Table. 2: Repeatability of the different methods and groups

	Ankom	Ankom with Hydrolysis	Soxhlet
Group 1			
N	46	46	46
θ	0,98	0,99	1,00
Group 2			
N	25	25	25
θ	0,94	0,93	0,99
Group 3			
N	12	12	12
θ	0,98	0,89	0,95

Table 3. shows the LSM and standard errors of the fat content (%) of the three groups (group 1-3), determined with five different methods. In the group 1 the Ankom method resulted in the highest and the Ankom with hydrolysis method the lowest averages. By the group 2 and group 3 the soxhlet and infratec methods showed the highest results.

Table 3.: LSM of the fat content (%) of different groups, determined with different methods

	Ankom	Ankom with Hydrolysis	Soxhlet	FOSS	Infratec
Group 1					
N	46	46	46	46	46
LSM (%)	2, 42	2,02	2,41	2,27	2,24
SE	0,33	0,33	0,33	0,34	0,34
Group 2					
N	25	25	25	25	25
LSM (%)	12,42	12,06	12,75	12,63	11,75
SE	0,72	0,72	0,72	0,74	0,74
Group 3					
N	12	12	12	12	12
LSM (%)	43,16	43,02	43,30	42,23	44,77
SE	2,23	2,23	2,23	2,30	2,30

The methods were also compared with difference analysis (Table 4). For better interpretation, the table contains only the significant differences ($P < 0,05$) of the methods, in the different groups. In the table the methods are indicated, and the groups are marked as follows: Group 1=G1, group 2=G2, group 3=G3. The table shows, between the results of certain methods in which groups are the differences significant.

There were no statistical differences to see between the results of the soxhlet, and the Ankom method, but both methods of them had statistical variance comparing to the Ankom with hydrolysis. The Foss method had mostly similar results as of other chemical and physical methods. There is no statistical alteration between the results of the Foss and soxhlet in any groups, but between the infratec and soxhlet in group 2. There are no significant differences between the two NIT techniques.

Methods	Ankom	Ankom with hydrolysis	Foss	Infratec	Soxhlett
Ankom		G1		G2	
Ankom with Hydrolysis					G1, G2
Foss					
Infratec					G2

Conclusion

Current study was conducted to compare the results of the different fat content determining methods. Methods were carried out on samples with a wide range of fat content. All methods were performed parallel. The results show, that all methods had high repeatability (θ =0,89-1,00). The Ankom with hydrolysis showed the lowest repeatability (θ =0,89), it could be due to the biological variance. It should be considered, that a smaller amount of sample was taken by this method (1-1,5 g), in contrast to the soxhlet method (5-8 g), and Ankom method (2g). Nevertheless the repeatability of the Ankom seems to be high also.

There was no statistical difference between the soxhlet and Ankom method, as it was expected. Both of the methods based on the same principle of extraction, and were performed with the same solvent. If the hydrolysis anticipates the extraction with petroleum ether, the results are significantly lower ($P < 0,05$) in group 1 (compared to soxhlet and Ankom method) and group 2 (compared to the soxhlet method). These differences could be ascribed to the hydrolysis.

There is no significant difference between the results of the Foss and soxlet methods, as it was anticipated, because the NIT techniques are based on the calibration on the soxhlet method. Despite of this comment there was significant difference to see between the results of the infratec and soxhlet method in the group 2. To brighten the cause of it, further studies are required.