A Quick Combined Microwave/NMR-Method for Routine Analysis of Fat and Water Content in Meat Products

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Summary

As supplementation of common standard techniques such as the Soxhlet-extraction [1], we present an approach combining microwave and NMR technique for the fast analysis of moisture and fat content in meat products.

In Analyticum-Food Laboratory several kinds of sausages and meat products were analyzed using the SmartTrac® analysis instrument. Optimizations concerning sample quantity and drying temperature were performed to meet the requirements of reliable analysis data.

Results were compared to established methods with respect to correctness, precision and variance. Validation of analysis results was performed according to the quality standard ISO/IEC 17025 using the excel macro "Validata". The method showed notably good correlation with the established methods and has proved superior concerning analysis time and precision.

Introduction

A routine method is presented for the fast determination of water and fat content in meat products by microwave drying and nuclear magnetic resonance (NMR) analysis respectively. In the first step of the two-stage process, the sample is dried by microwave heating. The sample temperature is constantly controlled using a temperature feedback system and weight loss is monitored to determine weight constance.

NMR is based on the fact that certain nuclei absorb and re-emit RF energy over a narrow band of frequencies when placed in a static magnetic field. This phenomenon is caused by the interaction between the nuclear magnetic dipole of a nucleus and the magnetic field it experiences. In meat products that have undergone microwave drying the main constituents containing significant amounts of protons are fat, protein and carbohydrates. By application of a magnetic field such as that introduced by the SmartTrac® system (CEM-Company, D-Kamp – Lintford, Germany) the transverse relaxation times for fat are considerably longer than the transverse relaxation times for protein and carbohydrate.[2]

In our laboratory we investigated different products by using this method. The samples included various types of meat (pork, beef, turkey) and products (sausages, ready meals).

Material and Methods

Microwave moisture/solids analyzer — Sensitivity of 0.2mg water; moisture range of 0.01 - 99.99% in liquids, solids and slurries; 0.01% resolution. Includes automatic electronic balance (0.1mg readability), microwave drying system with temperature feedback and microprocessor computer control (CEM Corp.)

NMR-RF pulse generator.— Pulse power, 250W nominal; pulse times, variable in 100ns increments, transmit and receive phases, selectable 0°, 90°, 180° and 270°; nominal 90° pulse times, 4µs (18mm probe)

Magnet — permanent, thermally stabilized, 0.47T (20MHz) and homogeneity better than 10ppm

Signal detection — dual-channel (quadrature) detection with programmable low-pass filtering, programmable data acquisition rate up to 4MHz per pair of points
Glass fiber pads — (CEM Corp.)
Trac film — (CEM Corp.)

Sample preparation and water determination — Two square formed glass fiber pads are introduced into the Smart system for recording the tare weight. The homogenized samples are then inserted between the pads forming a sandwich.

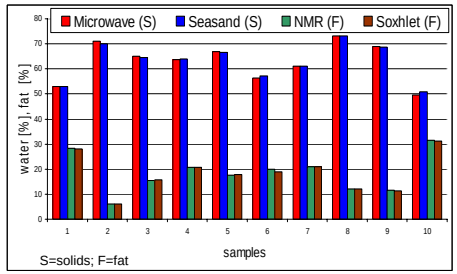
The appropriate method is then started and the sample is heated by microwave radiation until weight constance.

Fat determination — The glass fiber pads are coiled up.(6) The sample is then compressed in the plastic sleeve by using the compression tool and introduced into the NMR chamber for analysis.

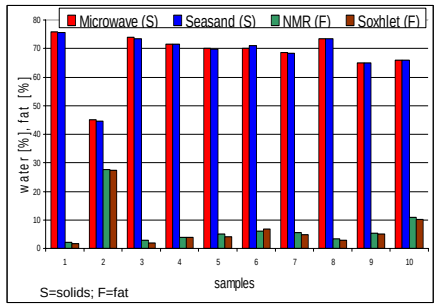
Optimization of Parameters

For the three different matrices (boiled, cooked and raw sausages) optimizations of sample amount and temperature were performed.

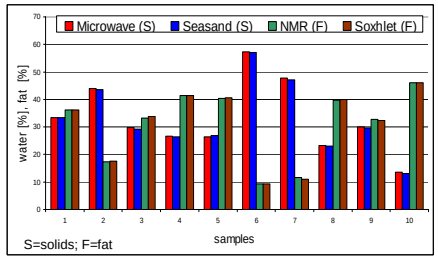
Temperatures ranging from 90-130°C were investigated with and without weight compensation turned on. These optimizations needed to be investigated in order to maximize the yield of sample dehydration which is crucial for the exact determination of fat content as remaining water interferes with NMR determination. Furthermore it could be shown that weight compensation was essential for exact analysis results in all cases.



Boiled sausages — Optimization was performed for three different sorts of boiled sausages. Optimal drying was found for a sample amount of about 3g, a constant drying temperature of 120°C and the parameter of weight compensation on. By using these parameters 10 different samples were analyzed and compared to the standard techniques. As shown in Table 1 the results obtained by the SmartTrac system showed good correlation with the reference methods. With the exception of sample 6 an average difference of 1% could be registered. An explanation for this difference may be found in the composition of the sausage. As the sausage contains cheese, the fat content obtained by the Soxhlet method is known to be inaccurate (Soxhlet effect).



Cooked sausages — Optimal drying conditions were found for 4g of sample, a temperature of 120°C and the parameter of weight composition turned on. As shown in Table 2 the samples showed good correlation with standard methods except for sample 7. In this case the whole caraways and the existing inhomogeneities (connective tissue, cartilage) could be a cause of the difference. All other samples differ around 0.5% and are in the range of the standard deviation.



Raw sausages — Optimal results were obtained for a sample weight of 2g and a temperature of 110°C with weight compensation turned on. In addition to that, two different kinds of homogenizers were tested. The Grindomix (Grindomix GM 200, Retch GmbH & Co KG, Haan, Germany) led to substantially more exact results than the Buechimix (Büchi Labor Technik, Flawil, Switzerland). Table 3 shows the analysis data obtained for samples homogenized by the Grindomix. Comparing those results with the standard methods a deviation of maximally a half percent was found.

Conclusion

As a result of this study comparing reference methods with the Smart Trac–methods one can conclude that the methods lead to comparable results with respect to correctness, precision and variance. Validation of analysis results was successfully performed.The Smart Trac Methode is much quicker and easier to perform routine analysis.

Literature

[1] Cartwright et al. 2005.Rapid Determination of Moisture/Solids and Fat in Dairy Products by Microwave and Nuclear Magnetic Resonance Analysis. Journal of AOAC International VOL: 88.

[2] Official Methods of Analysis.2000. Journal of AOAC International. MD, pp. 17.01–17.10.

[3] Büchi a o. Journal. Retch.2002.