RAPID SIMULTANEOUS DETERMINATION OF FAT, MOISTURE, PROTEIN AND COLOUR IN BEEF BY NIT-ANALYSIS

P. FREUDENREICH

Federal Centre for Meat Research, 8650 Kulmbach, Germany

SUMMARY

This publication reports on the possible application of near-infrared-transmission spectroscopy (NIT) for the quick and simultaneous determination of various meat quality characteristics, including meat colour. The NIT analyses were carried out on an Infratec 1255 (Perstorp, Sweden). During NIT analysis an infrared light beam is passed through a 15 mm thick sample, and using the principle that different functional molecule groups (eg. fat, moisture, protein, ect.) absorb the infrared light at different wavelengths, the absoption scan between 850 and 1050 nm of a sample is determined. The aim of this work was the development of calibration curves for various meat quality characteristics of beef, and testing the correlation between the NIT determinations and the reference values from the same samples using conventional proximate analysis techniques.

The samples used were collected from carcasses on the open market (young bulls n=68; heifers n=60). The determinations were carried out on the M. longissimus dorsi, M. psoas major and M. biceps femoris, as well as from the wing rib (three rib cut). Three calibration curves were constructed, one with an average intramuscular fat content of 3,8%, one with an average fat content of 12,7%, as well as a calibration curve for the estimation of meat colour.

INTRODUCTION

A quick and comprehensive analysis of chemical and physical meat quality characteristics is gaining importance from a production as well as a consumer point of view. Conventional methods for the determination of meat quality parameters are time consuming, personnel and chemical intensive. Efforts were therefore aimed at simplifying the determinations, especially towards automatisation and a simultaneous reduction in analysis time. Results of developments towards satisfying this aim during the past few decades have been of variable success. Methods for the quick determination of fat, moisture and protein in meat have been developed and consequently evaluated (HAUSER and WEBER; 1978; McNEAL, 1987; BERG and KOLAR, 1991). Using near-infrared-spectroscopy, BECK et al. (1991) have also predicted the colour of beef.

MATERIALS AND METHODS

Samples of the M. longissimus dorsi, M. psoas major and M. biceps femoris, as well as of the wing rib (three rib cut) were taken one day post mortem from young bull (n=68) and heifer (n=60) carcasses. All samples were frozen at -30 °C until analysis.

For the NIT analyses the Infratec 1255 Food and Feed Analyser (Perstorp, Sweden) was used. The Infratec is a desktop instrument of relative modest dimensions. By means of a drawer system defined volumes of homogenised samples of predetermined thickness are introduced for analysis. The course of events are shown in Figure 1. During transmission measurements the near-infrared beam is transmitted through the sample. Up to 30 repetitive measurements may be taken. For the present work only 10 repetitive measurements were taken. Under these conditions a NIT scan and consequent prediction of the variables took 50 sec. The near-infrared spectroscopy is based on the principle that molecule groups such as fat, moisture (water) and protein absorp infrared light

at specific wavelengths. During a measurement, a scan of the near-infrared absorption between 850 and 1050 nm is taken every 2 nm. As a result of the relatively small differences between the different absorption values, no typical absorption peaks are found between the different components (Fig. 2). The resultant absoption spectra can be used to quantify the various components only if the corresponding calibration curves are available from which the various quality characteristics could be calculated according to regression functions. To determine the various regression functions the NIT measurements and results of the conventional proximate analyses of the same samples are needed. Therefore, parallel to the NIT measurements the fat, moisture and protein contents of the lean meat samples (excluding all subcutaneous and intermuscular fat) were determined. The colour (L* value = lightness; a* value = red tone; b* value = yellow tone) of the meat samples were determined with a Minolta Chroma 200b Meter. Results of the determination of the calibration curves and its verification using an independent data set are described. The precision of the prediction was determined using multiple correlation coefficents (R) and the standard error of calibration (SEC) and standard error of prediction (SEP). SEC and SEP are measures of the variation between the values predicted by the NIT measurement and those from conventional proximate analysis methods.

RESULTS AND DISCUSSION

The chemically determined fat content of the samples used for the construction of the calibration curves were in the range 0,7% to 8,4%, the protein content 21% to 24%, and the moisture content in the range 70% to 75% (Table 1). The average SEP values were 0,26, 0,29 and 0,27 for fat, moisture and protein respectively. In practice this means that 95% of the NIT measurements were within one error unit, which is double the SEP value, from the chemically determined reference value.
In a second calibration curve complex (Table 2) in which the chemically determined fat contents were in the range 0,7 to 31%, the SEP values were substantially higher than those from Table 1. This indicates the possible limits for an accurate prediction. Therefore, a narrow prediction range should preferably be used although cognizance of the aim of the analysis should be taken.

Aside from predicting the quality parameters fat, moisture and protein contents, meat colour can also be predicted (Table 3). In analysing the lightness L* value of homogenised samples (14 days post mortem), a SEP of 0,69 (Fig. 3) was found between the NIT values and reference values, and a SEP of 2,51 for intact meat samples (not homogenised).

CONCLUSIONS

The NIT-spectroscopy has been introduced for the quick and environmentally friendly prediction of value determining parameters of beef quality. An evaluation of the prediction accuracy using an independent sample indicated that the SEP for fat, moisture and protein content respectively were comparable to that of the conventional methods. However, NIT-spectroscopy, which is a very interesting technology, shows promise not only in predicting fat, moisture and protein contents in meat, but also in predicting various other meat quality characteristics, which are currently under investigation.

REFERENCES

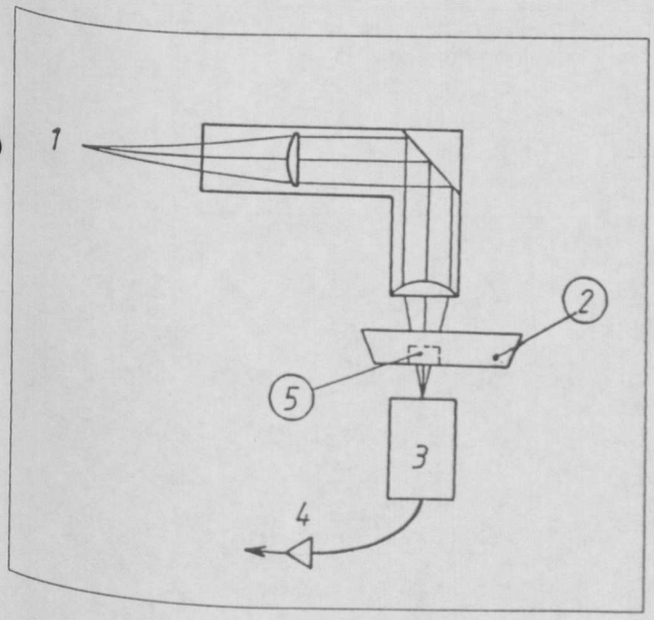
BECK G., DÜRR R., EICHINGER H., 1991. Reflectance measurments in the visible and near infrared range for the determination of different beef meat qualities. Proceedings of the 37rd intern. congress of meat science and technology, vol. 1,Kulmbach 1 - 6 Sept. 1991. pp. 44-47.

BERG H., KOLAR K., 1991. Evaluation of rapid moisture, fat, protein and hydroxyproline determination in beef and pork using the Infratec Food and Feed Analyzer. Fleischwirtschaft 71 (7), 787-789.

HAUSER E., WEBER U.,1978. The use of infra-red reflection analysis in the quick determination of the value-determining portions of meat and meat products. Fleischwirtschaft (3),452-459.

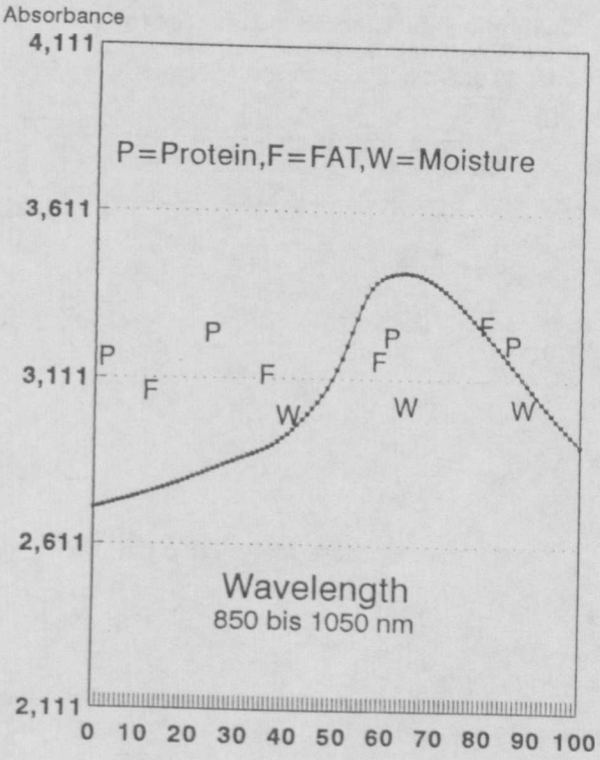
McNEAL J.E., 1987. Rapid methods for determination of meat composition. J. Assoc. Off. Anal. Chem. 70, 95.

Fig. 1: Principle of Infratec measurements



1. Monochromatic radiation
2. Sample cup
3. Detector
4. Preamplifier
5. Sample collar

Fig. 2: Absorbance spectra of homogenized samples beef (M. long. dorsi)



Tab. 1: **Calibration and prediction statistics for the NIT estimation of beef quality criteria** (M.long.dorsi)

Parameter	Calibration set R[1)]	Prediction set SEC[2)]	SEP[3)]
	n=53	n=53	n=15
Fat	0,99	0,13	0,26
Moisture	0,99	0,21	0,29
Protein	0,95	0,20	0,27
Beffe	0,94	0,22	0,29
Chemical analyses of meat samples			
	Mean	Range	
Fat %	3,84	0,74	8,40
Moisture %	73,34	69,80	75,44
Protein %	22,39	20,97	23,60
Beffe %	21,65	20,13	22,88

1) Multiple correlation coefficient
2) Standard error of calibration
3) Standard error of prediction

Tab. 2: **Calibration and prediction statistics for the NIT estimation of beef quality criteria** (M.long.dorsi, 3 rib cut)

Parameter	Calibration set R	Prediction set SEC	SEP
	n=67	n=67	n=40
Fat	0,99	0,59	1,18
Moisture	0,99	0,58	1,03
Protein	0,98	0,42	0,56
Ash	0,94	0,04	0,06
Chemical analyses of meat samples			
	Mean	Range	
Fat %	12,65	0,67	30,54
Moisture %	66,34	52,82	76,81
Protein %	20,57	16,04	24,34
Ash %	0,98	0,62	1,23

Tab. 3: **Calibration and prediction statistics for the NIT estimation of color criteria** (M.long.dorsi, M.psoas major, M.biceps femoris)

Parameter	Calibration set R	Prediction set SEC	SEP
	n=66	n=66	n=30
L*-values (homog.)	0,99	0,42	0,69
L*-values	0,97	0,60	2,51
a*-values	0,93	1,04	2,18
b*-values	0,80	1,24	1,86
Meat color Chroma-Meter (14 d p.m.)			
	Mean	Range	
L*-values (homog.)	40,3	32,0	45,0
L*-values	40,6	36,2	48,0
a*-values	19,7	9,0	24,6
b*-values	12,4	6,0	16,0

Fig. 3: **Plot of NIT and meat color (L*-value) beef** (M.long.dorsi)