PREDICTABILITY OF SENSORIC PROPERTIES IN BEEF BY PHYSICOCHEMICAL MEASUREMENTS

G.A. BECK, ROSWITHA DUERR and H.M. EICHINGER
Versuchsstation Thalhausen, Techn. Univ. Muenchen, W-8051 Kranzberg, Germany

SUMMARY

Standardization of beef meat quality is a major problem in the European beef market. It was the aim of this study to examine a variety of easy to perform physicochemical measurements for the prediction of the sensoric beef meat quality. Meat samples (musculus longissimus thoracis) of 37 young bulls and 38 heifers were used for the physicochemical measurements and the sensoric evaluations. Electronic measurements of pH and conductivity, as well as reflexion spectroskopic measurements of intramuscular fat (IMF) in the near infrared region, and of meat color in the visible region of the spectrum were performed 1 day post mortem. Sensoric evaluation of tenderness, juiciness, aroma and overall palatability was performed after aging of the meat samples for 2 weeks. Tenderness of cooked samples was also measured objectively by the use of the Warner-Bratzler-Shearpress. For the prediction of the sensoric properties and shear force values multiple regression models including conductivity, pH, meat color and IMF content were used. Linear and curvilinear relations between the dependent and the independent variables were considered in the regression models. The multiple coefficients of correlation (R) between the predicted and the real evaluated sensoric properties were between 0.62 and 0.75 and highly significant. The prediction models used only IMF and color, whereas pH and conductivity did not increase the coefficients of determination in our material. Relations between the sensoric properties and IMF or color measurements were curvilinear, and for acceptable beef meat quality, a lower limit of 2.5% for IMF and 34 for L* value was derived from the calculated curves.

INTRODUCTION

Several surveys of attitudes to and perceptions of meat (EICHINGER, 1985) indicate an increasing interest of beef producers and consumers to standardize beef meat quality. Several German and European beef packers already offer special beef brands, which claim superior quality and certainly have higher prices. However, the available information on important sensoric meat quality criteria is still very limitted.

It was the aim of this study, to examine the combined value of now available high-tech measurements for the prediction of sensoric beef meat quality parameters.

MATERIAL AND METHODS

One day after slaughtering, samples from the musculus longissimus thoracis from 37 young bulls and 38 heifers were removed for further measurements and sensoric evaluation. The carcasses were selected to give a high variation in IMF for each of the two categories. At 1 day post mortem, pH-values were measured electronically in triplicate (pH-Star, Fa. Matthaeus, Poettmes, Germany). Conductivity was measured at 3 different locations between the 6th and 9th rib (LF 191, Fa. WTW, Weilheim, Germany). At the freshly cut muscle surface, meat color (L* value) was repetively measured at 8 locations (Chromameter CR 200, Minolta, Japan). Intramuscular fat content (IMF) was directly measured by NIR reflexion spectroskopy on homogenized samples (NIR Systems Analyzer, Modell 6500, Silver Spring, ML, USA).

Muscle samples for sensoric tests and shear force measurements were further stored for 2 weeks at +2°C. For the sensoric evaluation the samples were heated until a core temperature of 78°C was reached. A trained taste panel (11 members) scored tenderness, juiciness, aroma and general palatability.

Shear force values were measured on cooked samples (core temperature: 80°C) after cooling. From each sample 10 cylinders

(12,5 mm diameter) were removed and each cylinder was sheared three times by a Warner-Bratzler-Shearpress. The mean values of these 30 measurements were calculated for further statistical analysis.

Multiple regressions were used to predict sensoric properties and shear values by direct measurements including pH, conductivity, color, and intramuscular fat content. Non linear correlations were also considered in the regression models by mathematicaly transformation of IMF and color values (1/IMF and $1/[L^*_{value}-30]$, resp.). Regression analysis were computed using the REG procedure of the SAS statistical package (SAS, 1987). Only such variables were included in the models, which significantly improved the coefficient of determination ($p < 0,05$).

RESULTS AND DISCUSSION

Carcasses were selected to give a high variation in marbling, therefore, the IMF values ranged from 1.2 to 11.1%, the mean value being 4.31% with a standard deviation of 2.26% (Tab. 1). Coefficient of variation of conductivity was below 30%. Standard deviation of meat color (L*) was 2.27. PH values showed nearly no variation, no DFD meat was detected.

Multiple regression analysis revealed already the maximal coefficient of determination for the prediction of sensoric evaluation and shear force, when models used IMF and meat color as predictive criteria. Neither pH values nor conductivity values were included in the regression models, as they did not further improve the coefficients of determination for the prediction of sensoric quality and shear force tenderness.

Overall palatability and shear force values were correlated with IMF and meat color in a curvilinear manner (1/IMF and $1/[L^*_{value}-30]$, Tab. 2). Therefore samples with very low IMF content and/or low L* values were considered to be very tough and were scored very low in palatability. Juiciness and aroma were predominatly influenced by IMF, also in a non linear way (1/IMF, Tab. 2). When using the optimized regression models, the sensoric overall impression could be determined with a coefficient of determination (R^2) being 56% (Tab. 2).

The curvilinear correlations between the sensoric overall acceptability and the IMF (Fig. 1) suggest, that with increasing IMF until about 2.5%, the improvements of sensoric qualities are very pronounced, whereas the improvements beyond a IMF of 2.5% are only marginally. This is in accordance with findings from other authors (BOCCARD, 1985; WOOD, 1990; DIKEMAN, 1991) suggesting minimum IMF values for good beef quality being between 2 an 3%.

In addition, meat color also shows a curvilinear relationship (Fig. 2) which suggests a value of $L^* = 34$ as lower limit for good sensoric quality. There is strong evidence, that the darker meat stands for a higher age of the animal (LAWRIE, 1961), and it is well known, that the older animals normally provide less tender meat.

If the whole number of samples in this experiment were split according to the afore mentioned limits ($IMF > 2.5\%$, $L^* > 34$) the resulting two quality groups strongly differ in their sensoric and shear force values (Tab. 3). The quality group I has remarkebly better means and a reduced variability compared to the lower quality group II.

We conclude, that meat from young bulls as well as from heifers can be considered as sensorically satisfying, if at least 2.5% IMF and a color value higher than $L^* = 34$ can be measured, provided proper handling and processing of the meat.

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Tab. 1: Ranges, means ($\bar{x}$) and standard deviations (s) of physicochemical criteria and sensoric properties (n = 75)

	Range	$\bar{x}$	s
Conductivity [mS/cm]	1.87 - 5.67	3.31	0.94
pH-value	5.33 - 5.84	5.49	0.08
L*-value	32.0 - 44.4	37.5	2.27
intramuscular fat [%]	1.2 - 11.1	4.31	2.26
Shear force [N]	16.1 - 59.0	34.0	7.33
Tenderness* [scores]	1.44 - 6.00	4.04	0.89
Juiciness* [scores]	2.21 - 5.64	4.02	0.63
Flavor* [scores]	2.20 - 5.45	4.05	0.60
overall palatability* [scores]	1.60- 5.73	3.93	0.73

* 6 = extremly desirable, ... , 1 = extremly undesirable

Tab. 2: Multiple correlations (R), coefficients of determination (R^2) and residual standard deviations (SE) of regression equations predicting sensoric properties and shear force values by physicochemical measurements (n = 75)

Dependent variable	Independent variable	R	R^2	SE
Tenderness* [scores]	1/IMF 1/(L*-30)	0.73	0.53	0.62
Juiciness* [scores]	1/IMF	0.73	0.54	0.43
Flavor* [scores]	1/IMF	0.62	0.38	0.48
overall palatability* [s.]	1/IMF 1/(L*-30)	0.75	0.56	0.49
Shear force [N]	1/IMF 1/(L*-30)	0.76	0.58	4.8

* 6 = extremly desirable,..., 1 = extremly undesirable

Tab. 3: Means ($\bar{x}$) and standard deviations for two quality classes of beef meat according to IMF and color minimum requirements

Criteria	Quality group I n = 58 (L* > 34 and IMF > 2.5)		Quality group II n = 17 (L* < 34 or IMF < 2.5)	
	$\bar{x}$	s	$\bar{x}$	s
Tenderness* [scores]	4.30	0.66	3.16	1.02
Juiciness* [scores]	4.20	0.54	3.42	0.56
Flavor* [scores]	4.20	0.54	3.55	0.56
Overall palatability* [s.]	4.15	0.56	3.19	0.77
Shear force [N]	31.9	4.93	41.1	9.64

* 6 = extremly desirable,..., 1 = extremly undesirable

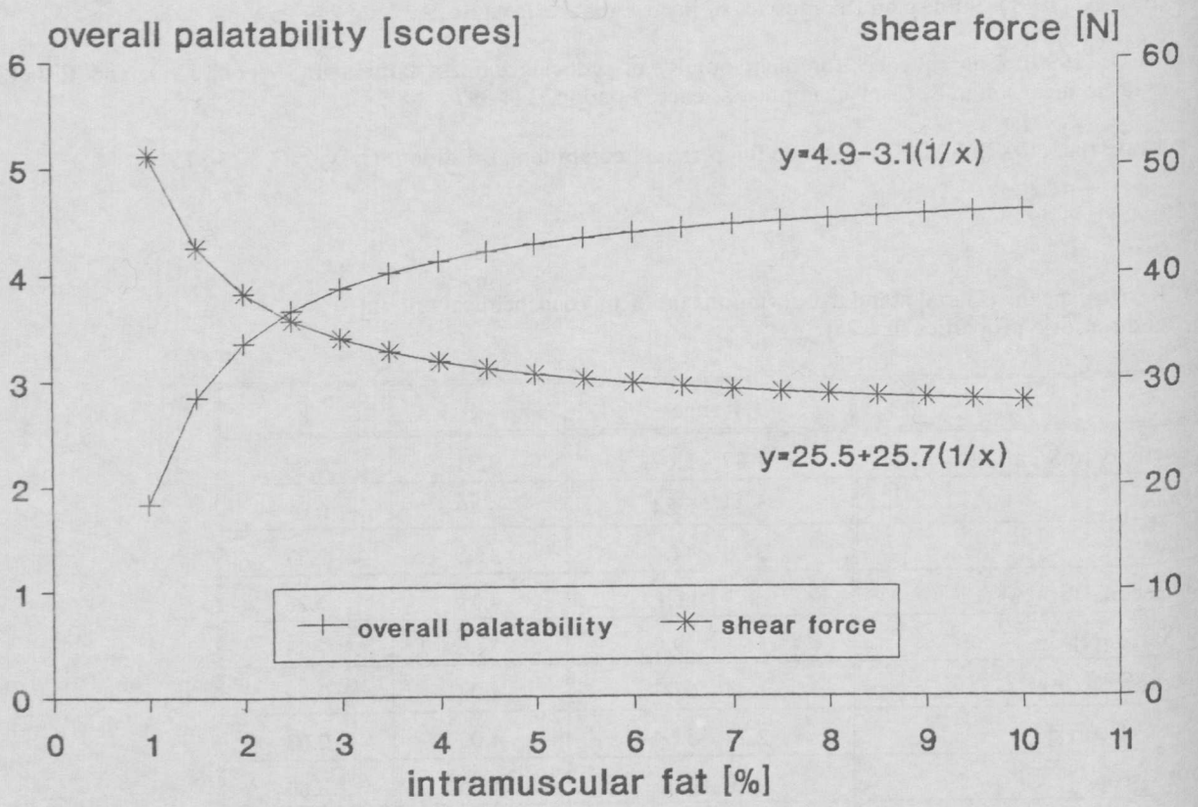

Fig. 1: The influence of intramuscular fat on sensoric overall palatability and shear force values

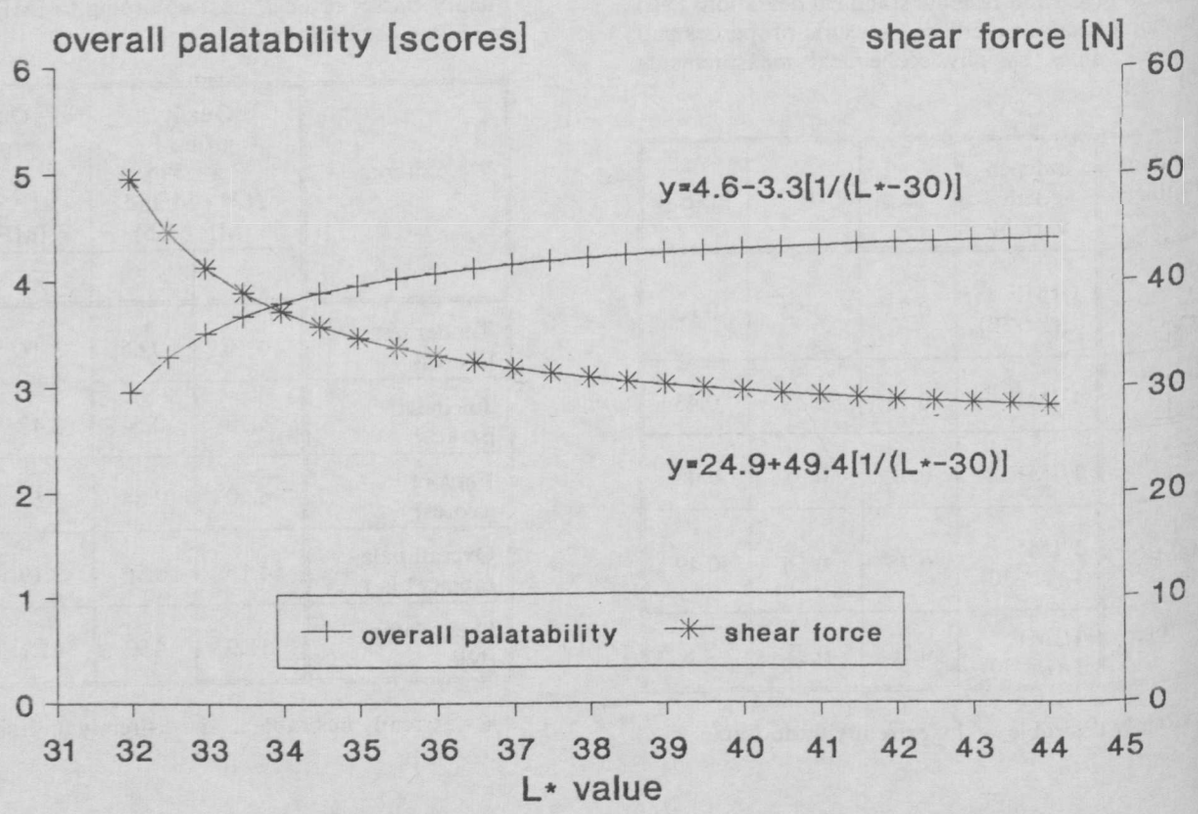

Fig. 2: The influence of color (L* value) on sensoric palatability and shear force value