62nd Annual Meeting EAAP 2011, Stavanger, Norway, August 29th – September 2nd
Session 44 Milk and meat product quality abstract no. 28

Prediction of Warner-Bratzler tenderness in cattle and genetic parameters of beef quality traits- preliminary results

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Introduction

Tenderness variability is the major cause of consumer dissatisfaction with beef worldwide. Approx. 25-30 % of the variation in beef tenderness is due to genetics. Inclusion of meat quality traits in the breeding programmes will provide a permanent improvement of these traits in cattle populations, and contribute to fortify the beef market share. Additionally, on-line prediction of beef quality gives the industry opportunities for meat quality grading and sorting of carcasses.

Objectives

Main objective: To include beef product quality traits in the dairy and beef cattle breeding programmes in Norway through:

- Development of methods for on-line measurements of meat quality traits related to beef tenderness for breeding and industrial purposes
- Increased knowledge of genetic relationships between biochemical factors in muscles that affect beef tenderness

Material and methods

Animals: This study (2008-2012) will finally include data from approx. 600 NRF (Norwegian Red; a dual purpose breed) bulls, sired by 25 NRF A.I. bull sires. Present data include 525 bulls from six commercial beef producers, slaughtered in batches at a commercial abattoir. Average daily carcass gain (ADCG) are recorded in addition to carcass grading (EUROP) for carcass conformation (EURC) and fatness (EURF).

Muscle analyses: Muscle tissue samples for μ- (μCALP) and m-calpain (mCALP) enzyme activity analyses are collected 1 h *p.m.* together with a hot-boned, conditioned sample of *m.l.dorsi* (LD) muscle from the left carcass side (9^{th} to 13^{th} thoracic vertebrae) . A 3 cm slice is subjected to pH measurements 1, 6, 10 and 48 h *p.m.* The rest of the of *m.l.dorsi* muscle sample is aged for 7 days prior to Warner-Bratzler shear force (WBSF) analyses and VIS-NIR (350-1025 nm; QualitySpec®BT) measurements in the lab, L*a*b colour and analyses of intramuscular fat % (IMF), water % (WT) hydroxyproline % (HP), iron % (FE) and calcium % (CA) content. The right carcass sides are subjected to a commercial cooling procedure *p.m.* Approx. 24 h *p.m.*, the QualitySpec®BT is applied on-line on the *m.l.dorsi* surface at the 11^{th} thoracic vertebrae, in addition to L*a*b and pH (pH24h) measurements.

Statistical methods: ANOVA; Animal models; Multivariate analyses (SAS, SAS Inst., Cary, USA; DMU-AI, Madsen and Jensen 2008; The Unscrambler X, Camo, Norway). A USMARC developed VIS-NIR prediction model for slice shear force within the QualitySpec®BT is tested as indicator for NIR prediction of tenderness (NIR-SSF).

Preliminary results

Overall means, standard deviations, min., max. and preliminary estimated heritabilities for a part of the the traits included is presented in Table 1.

Table 1. Overall means, std.dev, min., max. and heritabilities for the traits included.

Trait	n	Mean	Std.dev.	Min.	Max.	h^2
Carcass:						
ADCG (g/d)	525	549	61	360	716	0.40
EURC (1-15)	525	5.3	0.8	3	8	0.05
EURF (1-15)	525	6.1	1.1	1	9	0.21
Cold carcass 1d *p.m.*:						
NIR-SSF (kg/cm^2)	484	25.6	5.0	11.0	39.0	0.16
L-lightness	415	36.8	2.6	28.6	47.0	0.64
a-redness	415	22.1	2.8	13.6	30.2	0.14
b-yellowness	415	11.1	2.7	1.0	15.8	0.12
pH 24h	478	5.60	0.21	5.23	7.06	0.00
Hot boned muscle 7d *p.m.*:						
WBSF (N)	525	74	20	36	161	0.25
pH1h	507	6.51	0.27	5.80	7.47	0.12
pH6h	508	5.84	0.27	5.36	6.98	0.16
pH10h	507	5.62	0.22	5.17	7.07	0.09
pH48h	508	5.54	0.19	5.03	6.87	0.00
IMF (%)	488	1.5	0.8	0.2	7.0	0.25
WT (%)	488	74.3	0.9	70.1	76.4	0.00
FE (%)	488	1.57	0.36	0.45	2.60	0.52
CA (%)	488	3.45	0.64	2.00	5.70	0.35
μCALP (units/g)	271	0.99	0.21	0.32	1.72	n.a.
mCALP (units/g)	271	1.05	0.33	0.22	2.10	n.a.

Genetic variation:

Preliminary h^2 for NIR-SSF were of moderate magnitude (0.16), while the heritabilities for WBSF, IMF%, Fe%, Ca% and L*-lightness were higher (0.25, 0.25, 0.52, 0.35 and 0.64 respectively). Muscle traits associated with meat quality such as muscle fiber type, colour and

enzyme activity are thus highly heritable. The h^2 for pH demonstrate a genetic influence on glycolytic potential in muscle early *p.m.* which is not noticeable on ultimate pH.

NIR-prediction:

Raw NIR-spectra are collected 1) on-line 24h and 7d *p.m.* in the lab; bloomed (2), not bloomed surface (3); through (4) and removed (5) vacuum plastic bag. Preliminary results from 1) and 2) based on PLS analyses indicate clear relationships between WBSF and VIS-NIR spectral waves within approx. ranges 450-485, 550-590, 630-650 and 855-930 nm, and with r_P in the range 0.35 to 0.59 between VIS-NIR predicted and measured WBSF.

Further research will focus on refinement and development of current and new prediction models based on the final data set, in addition to AM-estimation of genetic parameters for all meat quality traits studied.

Acknowledgements

The study is a research collaboration between University of Life Sciences and Nofima, and is financed by the industrial partners Geno, TYR, Nortura BA and Animalia - and The Research Council of Norway (Agricultural foundations).