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Allele effects of genetic markers on meat quality traits in Swiss beef breeds

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Introduction

Meat performance:

Fattening performance	**X**
Carcass quality	**X**
Meat quality	

X: Considered in the Swiss breeding programme for beef cattle

Introduction

- of great interest to consumers:
  - Tenderness
  - Flavour
  - Juiciness
  - Marbling (intramuscular fat content and its distribution)
  - Meat colour

  → important factors of beef purchase decision (Velik, 2008)

Aim of this study

- To generate basic information necessary to implement meat quality in Swiss beef cattle breeding.
- To analyse the degree of differentiation possible with effects of commercially available genetic markers on meat quality traits in meat samples collected in various trials investigating meat quality in Swiss beef cattle.

Pictures: www.mutterkuh.ch

Material*

	All trials	Trial 1	Trial 2	Trial 3
Angus	36	28	-	8
Blonde d'Aquitaine	26	26	-	-
Charolais	28	28	-	-
Eringer	8	-	-	8
Limousin x Swiss Fleckvieh	81	-	73	8
Limousin	36	28	-	8
Piedmontese	27	27	-	-
Simmental	28	28	-	-
Total	270	165	73	32

* Studies by P.-A. Dufey, research station ALP

Methods

- 18 meat quality traits (Dufey and Chambaz, 2006)

- Meat samples were genotyped:
  - GeneSTAR Tenderness 4 test
    - Marker T1 in the Calpastatin gene
    - Marker T2, T3 and T4 in the Calpain gene
  - Laboratory Progenus, Belgium

Methods

- Associations were analysed using a linear model with fixed effects of treatment series (Chambaz et al., 2001) and number of favourable alleles evaluated separately and combined over all four investigated markers.
- SAS (SAS Inst. Inc., Cary, NC, USA) :
  - Procedure GLM
  - Procedure MEANS
  - Procedure FREQ

Results

Picture:
www.ars.usda.gov/SP2UserFiles/Place/54380530/protocols/WBSProtocol.pdf

Means and standard deviations over all 270 animals:

Warner Bratzler shear force 14 d aged (kg)	2.88 ± 0.61
Sensory tenderness (points)	5.01 ± 0.95
Sensory juiciness (points)	4.73 ± 0.82
Sensory flavour (points)	4.58 ± 0.51

Results – allele frequencies of marker T1

	unfavourable	favourable
Angus	0.069	0.931
Blonde d' Aquitaine	0.212	0.788
Charolais	0.093	0.907
Eringer	0.125	0.875
LimousinxSwissFleckvieh	0.181	0.819
Limousin	0.153	0.847
Piedmontese	0.327	0.673
Simmental	0.074	0.926
Total	0.158	0.842

Results – allele frequencies of marker T2

	unfavourable	favourable
Angus	0.597	0.403
Blonde d' Aquitaine	0.900	0.100
Charolais	0.852	0.148
Eringer	1.000	0.000
LimousinxSwissFleckvieh	0.781	0.219
Limousin	0.778	0.222
Piedmontese	0.923	0.077
Simmental	0.963	0.037
Total	0.813	0.187

Results – allele frequencies of marker T3

	unfavourable	favourable
Angus	0.319	0.681
Blonde d' Aquitaine	0.500	0.500
Charolais	0.352	0.648
Eringer	0.500	0.500
LimousinxSwissFleckvieh	0.456	0.544
Limousin	0.569	0.431
Piemonteser	0.596	0.404
Simmental	0.667	0.333
Total	0.483	0.517

Results – allele frequencies of marker T4

	unfavourable	favourable
Angus	0.056	0.944
Blonde d' Aquitaine	0.038	0.962
Charolais	0.000	1.000
Eringer	0.000	1.000
LimousinxSwissFleckvieh	0.019	0.981
Limousin	0.028	0.972
Piemonteser	0.019	0.981
Simmental	0.037	0.963
Total	0.026	0.974

Results – effects on tenderness traits

Significance level, least square means and standard deviations for the effects of markers T1 and T3 on tenderness traits over all animals

Number of favourable alleles in T1	Sensory tenderness (points)	Warner Bratzler shear force (kg)	Number of favourable alleles in T3	Sensory tenderness (points)
0	3.86 ± 0.42	3.23 ± 0.27	0	4.71 ± 0.12
1	5.00 ± 0.11	2.72 ± 0.07	1	5.07 ± 0.08
2	5.01 ± 0.07	2.91 ± 0.05	2	5.09 ± 0.11
Significance level	p=0.028	p=0.035	Significance level	p=0.027

Results – effects on tenderness traits

Significance level, least square means and standard deviations for the combination of the four markers and their effect on tenderness over all animals

Number of favourable alleles	Sensory tenderness (points)
2	3.39 ± 0.93
3	4.60 ± 0.17
4	4.98 ± 0.12
5	4.89 ± 0.10
6	5.21 ± 0.13
7	5.16 ± 0.18
8	5.48 ± 0.38
Significance level	p=0.025

Results – effects on flavour and juiciness

- Trial 1 ($p < 0.05$):

Juiciness score	Points	Genotype
Highest	4.62	Homozygous unfavourable
Lowest	4.05	Homozygous favourable

- In trial 2 the association between marker T2 and juiciness was numerically contrary, but not significant ($p > 0.05$).
- Trial 2 ($p < 0.05$):

Flavour score	Points	Genotype
Highest	4.91	Heterozygous
Lowest	4.24	Homozygous unfavourable

Discussion

- In most studies, the favourable homozygous genotype of T1, T2 and T3 was associated with the lowest shear force and the highest sensory tenderness (e.g. Page et al. 2004, White et al. 2005, Casas et al. 2006 and Corva et al. 2007).
- In the present study, no effects of marker T2 on tenderness were detected. Because the frequency of the unfavourable allele was high, marker T2 does not seem to be very informative in this investigation. Allais et al. (2007) came to the same conclusion with Limousin and Blonde d'Aquitaine breeds.

Discussion

- The effect of marker T1 on WBSF was different from most results described in literature, as the heterozygous genotype was associated with the lowest WBSF and the mean level of tenderness observed in the meat samples used in this study was not comparable.
- The associations of markers T1 and T3 with sensory tenderness were similar to those reported in literature.
- An effect of marker T1 on flavour was also described in Casas et al. (2006), but it was different from that found in this study, i.e., homozygous favourable genotype was associated with the highest and the homozygous unfavourable genotype with lowest flavour value.

Conclusion

- Before these markers can be recommended for use in Marker Assisted Selection for beef quality traits in Swiss beef cattle breeding, more analyses are needed, and additional markers should be evaluated.
- Phenotypic data on a pedigreed population are necessary, e.g. to estimate variance components to be used in MAS, or to estimate chromosome segment effects to be applied in genomic selection.

Thank you