Impact of feeding strategy on meat quality of beef in low input production systems

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Introduction

In most European countries, beef carcasses are priced according to slaughter weight, slaughter age, fat and conformation score. Meat quality, describing parameters such as tenderness, colour or nutritive composition, is not taken into account when setting the price. Several studies have examined carcass and meat quality of beef produced in intensive feeding systems, however, few studies have been undertaken on low input and organic feeding systems.

Animals, materials, and methods

(1) In one experimental trial, heifers were fattened either indoor with grass silage, maize silage, and moderate concentrate amounts or on pasture with an indoor finishing period (same ration as indoor group). Twenty Simmental x Charolais heifers were bought in spring with approximately 300 kg live weight, divided into two groups and fattened up to 550 kg live weight. Heifers were slaughtered – due to different live weights at the beginning of the trial – between September 2008 and April 2009. Two pasture heifers reached slaughter weight during pasture period.

(2) A second study compared differences in meat quality of the following Austrian beef origins: (a) steers, which are kept on alpine pastures during summer (STEERk), (b) suckler calves, which are kept with their mothers until a slaughter age of 10-12 months (JR), (c) organically fattened steers (STEERo), (d) organically fattened heifers (HEIFo), (e) conventionally fattened heifers (HEIFk), and (f) conventionally fattened bulls (BULL). From each origin, meat samples of 11 animals were collected at cutting companies. Farmers were called by phone and asked for feeding rations and genetics.

Meat analyses of both experiments were carried out at *M. longissimus dorsi* (roastbeef). Statistical analyses were done with SAS (2004) and the procedures GLM or MIXED.

Results and discussion

Tab. 1: Carcass and meat quality of heifers *(Experiment 1)*

Item	Stable	Pasture	s_e
Slaughter age, months	16.4	17.0	1.32
Slaughter weight, kg	309	308	10.5
Daily net gain, g	620	600	44.5
Shear force			0.543
7 $days_{ageing,}$ kg	4.13[a]	4.58[a]	
14 days	2.94[b]	3.17[b]	
Fat colour			
b* $(yellowness)_{14days}$	7.6[b]	9.8[a]	0.80
Nutritive composition			
Intramuscular fat, %	3.4	2.5	1.75
SFA[i], % of total FA	48.8	49.8	1.97
PUFA[ii]	5.2	6.6	2.01
CLA[iii]	0.53	0.65	0.143
Ω-6 / Ω-3	2.5	2.0	0.43

[i]saturated fatty acids, [ii]poly unsaturated acids, [iii]conjugated linoleic acid
[a,b] different upper indices show significant differences between feeding groups

Feeding system had no effect on fattening performance. Heifers on pasture showed in both pasture and indoor feeding period at 1,050 g high average daily gains. Carcass quality was

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not significantly different between feeding groups, however, from a subjective point of view, pasture heifers seemed to have less carcass fat.
Shear force, an objective measurement for beef tenderness, did not differ between feeding groups, however, ageing time had a marked effect on tenderness. Prolonging meat ageing from 7 to 14 days significantly increased beef tenderness. Meat aged for 21 days was not statistically more tender compared to 14 days aged meat.
Meat colour was not affected neither by feeding regime nor by aging period (data not shown). However, fat colour from pasture heifers was more yellow compared to fat colour from indoor heifers. Intramuscular fat content was numerically lower in pasture group. Proportion of Ω-6 to Ω-3 tended to be lower in pasture group.

Tab. 2: Carcass and meat quality of Austrian beef origins *(Experiment 2)*

Item	BULL	STEER	STEERo	HEIF	HEIFo	JR	s_e
Slaughter age, months	21.6^{b}	27.7^{a}	25.2^{a}	17.9^{b}	20.3^{b}	11.1^{c}	93.16
Slaughter weight, kg	377^{a}	388^{a}	351^{a}	286^{bc}	297^{b}	232^{c}	37.7
Daily net gain[iv], g	587^{b}	465^{c}	466^{c}	526^{bc}	489^{bc}	688^{a}	79.0
Meat quality							
Shear force							
7 $days_{ageing}$, kg	4.70^{a}	4.18^{ab}	3.28^{b}	3.36^{b}	3.90^{ab}	3.95^{ab}	1.026
14 days, kg	3.51	3.40	2.82	2.91	3.59	3.00	0.693
Fat colour							
b* $(yellowness)_{14days}$	11.1	10.4	11.2	10.3	10.0	9.4	1.55
Nutritive composition							
Intramuscular fat, %	4.9^{a}	2.9^{ab}	2.2^{b}	4.2^{ab}	3.0^{ab}	1.7^{b}	1.78
SFA[i], % of total FA	49.7	51.6	50.4	48.3	50.6	48.2	2.70
PUFA[ii]	6.4	6.6	7.7	5.5	7.1	8.7	2.49
CLA[iii]	0.32^{c}	0.48^{bc}	0.37^{bc}	0.45^{bc}	0.53^{b}	0.77^{a}	0.152
Ω-6 / Ω-3	2.9^{ab}	2.2a^{bc}	1.9^{bc}	1.9^{bc}	1.5^{c}	3.4^{a}	1.12
Mineral content							
Iron, mg/kg DM	51.5	57.6	56.3	48.2	56.4	50.5	8.52
Zinc, mg/kg DM	201^{a}	169^{b}	169^{b}	170^{b}	168^{b}	159^{b}	24.5

[i]saturated fatty acids, [ii]poly unsaturated acids, [iii]conjugated linoleic acid, [iv]slaughter weight / slaughter age in days
[a,b] different upper indices show significant differences between beef origins

Beef from all origins (also bulls) was produced in rather extensive, grassland based production systems (pasture, hay, grass silage, no or only moderate concentrate amounts). According to production guidelines, slaughter age and slaughter weight markedly differed between beef origins. Daily net gains were highest in suckler beef and lowest in steers. Regarding shear force, meat from bulls was significantly tougher compared to the other beef origins. Prolonging ageing from 7 to 14 days improved beef tenderness in all origins. Fat colour was not different between beef origins. Intramuscular fat content was highest in bulls (explanation is still missing) and, as expected, lowest in suckler beef and organic steers. In line with experiment 1, SFA and PUFA were not significantly different between beef origins. Notable was the high CLA content of suckler beef. Proportion of Ω-6 to Ω-3 was highest in suckler beef and lowest in organic heifers. Nevertheless Ω-6 to Ω-3 ratio was in all beef origins within the optimal range of < 5:1. Slight differences between beef origins were found for mineral contents.

Conclusion

When fattening beef cattle in rather extensive, grassland-based production system, convincing meat quality can be obtained. Particularly fatty acid composition of beef from grassland-based production is more valuable in terms of nutritional physiology compared to beef from intensive fattening systems. In future, farmers, retail, marketing, and research organisations should collaborate to start paying farmers not only for carcass quality but also for product quality and process quality.

Appendices

Literature review on meat quality in extensive (low input, grassland-based) beef production systems) as compared to intensive systems

Autor	Shear force	Taste panel	Water loss	L* meat	a* meat	b* fat	IMF
Dufey 2008	" ↑		~			~	~
Blanco et al. 2008	~			* ↑	~	~	~
Razminowicz et al. 2006	* ↓		~	~	~		~
Dannenberger et al. 2006	* ↑			* ↓			* ↓
Nürnberg et al. 2005	* ↑	~		* ↓			* ↓
Sami et al. 2004	~	~		~	~		* ↓
Realini et al. 2004	" ↓			* ↓	~	* ↑	
Vestergaard et al. 2000				" ↓	~		
Keane and Allen 1998	~	~	~	* ↓	* ↓		* ↓
Schwarz et al. 1998	~	* ↓		* ↓		* ↑	" ↓
Dufranse et al. 1995	~		"↑	" ↓	~		

~ no effect of feeding regimen; *↓, *↑ significantly higher/lower in extensive system; “↓, “↑ tendentially higher/lower in extensive systems

Autor	SFA	MUFA	PUFA	Omega-3	Omega-6	CLA
Blanco et al. 2008	~	~	~			
Dannenberger et al. 2006	* ↓		* ↓	* ↑	* ↓	~
Nürnberg et al. 2005	~		* ↑	* ↑	~	* ↑
Noci et al. 2005	" ↓	~	" ↑	* ↑	~	
Sami et al. 2004	~	" ↓	" ↑	" ↑	" ↑	
Realini et al. 2004	~	* ↓	* ↑	* ↑	* ↑	* ↑
Poulson et al. 2004						* ↑
Engle and Spears 2004	~	~	* ↑			* ↑
Steen et al. 2003	~	~	" ↑	* ↑	* ↓	
Reichardt et al. 2002	* ↓	" ↑	" ↑			
French et al. 2000	* ↓	~	* ↑	* ↑	~	* ↑

~ no effect of feeding regimen; *↓, *↑ significantly higher/lower in extensive system; “↓, “↑ tendentially higher/lower in extensive systems