S4.15

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55th Annual Meeting of European Association for Animal Production
Bled, Slovenia – 5.-9. September 2004.

Commission on Sheep and Goat Production

Comparison of meat quality between five lamb hybrids

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ABSTRACT

Electro-conductivity, pH, contents of proteins, fat, ash, hydroxyproline, amino acids and subjective assessments of colour, fibrosity, texture, juiceness, odour, and taste of lamb meat (*musculus longissimus lumborum et thoracis)* were investigated. Ram lambs (n=98), hybrids between Merino ewes and Oxford Down, Texel, Charollais, Suffolk and Merinolandschaf rams were slaughtered at the average age of 119.2 days. Average carcass weight was 16.3 kg. The data was evaluated by the analysis of variance using the last square method. The average pH of meat decreased continuously from 6.57 (1 hour after slaughter) to 5.64 (48 hours after slaughter) and was not affected by hybrid combination. On the contrary the electro-conductivity increased. The highest electro-conductivity of lean meat was detected in the progeny of Oxford Down sires. The average contents of proteins, fat, ash and hydroxyproline were 19.94%, 1.70%, 1.02% and 0.065% resp.. The content of fat in meat was affected mainly by the age of lambs. Highly significant effects of the sire breed on the content of the majority amino-acids in the lamb meat proteins were found. The higher total content of the essential amino acids was detected in the muscles of the progeny of Merinolandschaf sires. The subjective assessments of meat colour, fibrosity, texture, juiceness, odour, and taste were not affected by the breed of sire.

MATERIAL AND METHODS

Experiment was provided on carcasses of ram lambs, crosses between Merino ewes incrossed by Merinolandschaf {(M, MxML, (MxML)xML} and Oxford Down (OD), Texel (T), Charollais (CH), Suffolk (SF) and Merinolandschaf (ML) rams. Lambs were fattened indoor together with their dams in the same flock, and they were fed by alfalfa hey (*ad libitum*) and concentrate. Animals (n=100) were slaughtered at the average age of 119.2 days and in the average live-weight 34.7 kg. Average cold carcass weight was 16.3 kg. Electro-conductivity and pH of *m. longissimus lumborum et thoracis* were measured 1, 3, 5, 7, 24 and 48 hours after slaughter. The samples of muscles (50-100g) were harvested 24 hours *post mortem* from the back muscles (*m. longissimus lumborum et thoracis*) at the level of 1st-3rd lumbar vertebras. The contents of total dry mass, total proteins, fat, ash and hydroxyproline were detected. The samples of the lean meat for degustation analysis were stored in frozen state until degustation, which were provided in specialized laboratory for sensoric analysis in Institute of Food Technology of Mendel University of Agriculture and Forestry in Brno. Assessments were provided in 4 tours by 6 experienced assessors (3 men and 3 women). Non-structured graphic scales (100mm) were used for description of individual characteristics (descriptors). 5 descriptors were described between marginal values (0-100 mm): meat colour (pale – dark); fibrosity (fine fibres– rough fibres) odour (weak-

expressive with other smell), consistency (soft and very tender- tough), juiceness (very juicy, exudative-dry) taste (appropriate without strange taste – atypical with strange taste).
The samples of meat for animo-acids analysis were treated by oxidative acid hydrolysis HCl (c= 6 mol.l^{-1}). For the detection of Trp content the alcaline hydrolysis LiOH (c = 4.2 mol.l^{-1}) (Kráčmar, Liška, 2002) was used. The chromatographic analysis of hydrolysate samples was performed using Na-citrate buffers and ninhydrine detection.

The procedure PROC GLM from the SAS program package (SAS Institute Inc., 1989) was used for the data analysis. Following statistical model was used:

Y=SB+DA+BS+age+lw+e

where: Y - observed trait
SB - slaughter date (fixed effect – 4 levels)
DA - age and breed group of dam (fixed effect – 3 levels)
BS - breed of the sire (fixed effect – 5 levels)
age - age at slaughter (fixed linear regression)
lw - live-weight at slaughter (fixed linear regression)
e - residual error

For aminoacids contents analysis the litter size was also included into the model equation.

RESULTS AND DISCUSSION

The basic characteristics of analysed dataset are presented in table 1.

Table1: Basic characteristics of analysed dataset

Trait	unit	n	aritm. mean	stand. deviation	Minimum	maximum
Age of lambs at slaughter	Dny	98	119.5	9.7	93	153
Live weight	kg	98	34.72	5.70	22.5	47.1
% of dry matter in muscle	%	98	23.51	0.73	20.83	25.37
% of proteins in muscle	%	98	19.94	0.65	16.85	21.42
% of fat in muscle	%	98	1.70	0.51	0.864	3.47
% of proteins in dry matter of muscle	%	98	84.85	2.26	79.63	89.94
% of fat in dry matter of muscle	%	98	7.19	2.02	3.81	14.03
% of ash in muscle	%	98	1.02	0.03	0.9	1.08
% of hydroxyproline in muscle	%	98	0.065	0.011	0.043	0.100
Weight of carcass	kg	77	16.27	2.96	10.6	22.8
pH – 1 h after slaughter		77	6.57	0.21	6.01	6.91
pH – 3 h after slaughter		77	6.39	0.23	5.8	6.81
pH – 5 h after slaughter		77	6.24	0.23	5.68	6.58
pH – 7 h after slaughter		77	6.06	0.20	5.63	6.44
pH – 12 h after slaughter		77	5.73	0.12	5.51	5.98
pH – 48 h after slaughter		77	5.64	0.11	5.42	5.9
El.vodivost – 1 h after slaughter		77	2.65	0.35	2.18	4.17
EL.conductivity – 3 h after slaughter		77	2.62	0.23	2.17	3.23
EL.conductivity – 5 h after slaughter		77	2.74	0.24	2.25	3.45
EL.conductivity – 7 h after slaughter		77	2.92	0.32	2.28	3.65
EL.conductivity – 12 h after slaughter		77	3.30	0.45	2.15	4.13
EL.conductivity – 24 h after slaughter		77	5.52	2.02	2.15	11.75
Description of meat colour	mm	56	46.70	11.38	23	68
Description of meat fibrosity	mm	56	51.41	10.27	29	70
Description of meat odour	mm	78	31.64	8.09	11	57
Description of meat consistency	mm	78	49.08	17.38	18	87
Description of meat juiceness	mm	78	52.72	13.61	25	80
Description of meat flavour	mm	78	34.08	7.34	13	59

Table 2: Analysis of variance - effects of systematic factors on quality and technological characteristics of lamb meat (F-values).

	Slaughter date	Dam age	Breed of sire	Age	Carcass weight	R^2	Res. S.D.
% of dry matter in muscle	0.64	1.90	0.78	3.98*	5.14*	0.266	0.667
% of proteins in muscle	4.02*	0.26	0.45	0.02	2.60	0.309	0.572
% of fat in muscle	7.53***	2.59	1.05	17.12***	2.36	0.506	0.382
% of proteins in dry matter of muscle	14.09***	2.02	0.73	7.33**	0.36	0.542	1.626
% of fat in dry matter of muscle	8.54***	2.50	1.02	16.85***	1.66	0.504	1.516
% of ash in muscle	1.28	0.19	0.35	1.29	0.35	0.066	0.031
% of hydroxyproline in muscle	3.97*	0.56	0.75	0.27	2.41	0.150	0.011
pH – 1 h after slaughter	10.10***	0.28	0.74	2.32	0.00	0.337	0.184
pH – 3 h after slaughter	6.48**	0.41	0.74	1.92	0.08	0.246	0.213
pH – 5 h after slaughter	6.90**	0.64	0.98	0.82	0.01	0.247	0.218
pH – 7 h after slaughter	6.09**	0.62	0.88	0.62	0.25	0.206	0.195
pH – 12 h after slaughter	5.01**	0.65	0.82	0.78	2.47	0.305	0.105
pH – 48 h after slaughter	24.38***	0.97	0.76	0.87	5.01*	0.543	0.078
El.vodivost – 1 h after slaughter	0.49	3.97*	1.40	1.38	0.24	0.278	0.318
EL.conductivity – 3 h after slaughter	0.13	2.93	1.30	0.65	0.63	0.164	0.222
EL.conductivity – 5 h after slaughter	0.13	0.24	3.75**	1.17	3.44	0.232	0.222
EL.conductivity – 7 h after slaughter	0.29	0.43	3.93**	0.19	0.04	0.267	0.292
EL.conductivity – 12 h after slaughter	0.24	0.45	2.46	1.32	0.01	0.213	0.430
EL.conductivity – 24 h after slaughter	12.10***	1.08	0.85	0.01	0.15	0.422	1.647
Description of meat colour	5.10*	1.17	4.63**	0.61	0.46	0.304	10.38
Description of meat fibrosity	4.24*	0.82	0.34	0.56	1.38	0.185	10.14
Description of meat odour	4.12**	2.77	0.16	0.13	0.80	0.213	7.75
Description of meat consistency	2.27	0.51	1.18	4.14*	1.82	0.267	16.07
Description of meat juiceness	3.14*	0.02	0.32	2.45	2.41	0.306	12.25
Description of meat flavour	0.78	1.21	0.73	3.24	0.36	0.150	7.31

Table 3: Differences between groups of crossbred lambs sired by rams of different breeds - meat composition

Breed of sire		Dry matter	Proteins	Fat	Ash	Hydoxyproline.
		%	%	%	%	%
Charollais	LSM	23.46	19.99	1.67	1.014	0.064
	St.Err.	0.23	0.20	0.13	0.011	0.004
Merinolandschaf	LSM	23.49	20.06	1.55	1.028	0.066
	St.Err.	0.16	0.14	0.09	0.007	0.003
Oxford Down	LSM	23.35	19.97	1.56	1.026	0.069
	St.Err.	0.15	0.13	0.09	0.007	0.002
Suffolk	LSM	23.30	19.82	1.62	1.025	0.063
	St.Err.	0.19	0.16	0.11	0.009	0.003
Texel	LSM	23.64	20.01	1.77	1.025	0.064
	St.Err.	0.16	0.14	0.09	0.007	0.003

Tabulka 4: Differences between groups of crossbred lambs sired by rams of different breeds - pH of meat 1,3, 5, 7, 24 and 48 hours after slaughter

Breče of sire		pH1	pH3	pH5	pH7	pH24	pH48
Charollais	LSM	6.61	6.42	6.22	6.08	5.74	5.65
	St.Err.	0.06	0.07	0.07	0.07	0.04	0.03
Merinolandschaf	LSM	6.57	6.36	6.25	6.07	5.72	5.65
	St.Err.	0.05	0.06	0.06	0.05	0.03	0.02
Oxford Down	LSM	6.56	6.41	6.30	6.09	5.76	5.67
	St.Err.	0.04	0.05	0.05	0.05	0.02	0.02
Suffolk	LSM	6.62	6.50	6.41	6.21	5.70	5.64
	St.Err.	0.07	0.09	0.09	0.08	0.04	0.03
Texel	LSM	6.67	6.45	6.24	6.07	5.69	5.62
	St.Err.	0.06	0.06	0.07	6.06	0.03	0.02

Tabulka 5: Differences between groups of crossbred lambs sired by rams of different breeds - electroconductivity of meat 1,3, 5, 7, 24 and 48 hours after slaughter

Plemeno otce		EC1	EC3	EC5	EC7	EC24	EC48
Charollais	LSM	2.69	2.62	2.79	3.02	3.44	5.67
	St.Err.	0.11	0.08	0.07	0.10	0.14	0.56
Merinolandschaf	LSM	2.56	2.49	2.61A	2.73A	3.10A	5.44
	St.Err.	0.08	0.06	0.06	0.08	0.11	0.43
Oxford Down	LSM	2.68	2.64	2.88Ba	3.10Ba	3.53B	5.84
	St.Err.	0.07	0.05	0.05	0.07	0.10	0.38
Suffolk	LSM	2.85	2.63	2.69	2.81b	3.23	5.40
	St.Err.	0.13	0.09	0.09	0.12	0.17	0.66
Texel	LSM	2.73	2.56	2.66b	2.86b	3.27	6.48
	St.Err.	0.10	0.07	0.07	0.09	0.13	0.50

Tabulka 6: Differences between groups of crossbred lambs sired by rams of different breeds in sensoric assessment of lamb meat

Breede of sire		Colour	Fibrosity	Odour	Consistancy	Juicenes s	Taste
Chrollis	LSM			30.52	44.47	49.23	37.90
	St.Err.			4.52	9.38	7.15	4.27
Merinolndschf	LSM	44.79	53.64	33.94	41.96	51.35	35.72
	St.Err.	3.32	3.23	2.13	4.41	3.37	2.01
Oxford Down	LSM	64.77	56.17	32.71	45.66	52.54	33.06
	St.Err.	4.97	4.86	2.44	5.06	3.86	2.30
Suffolk	LSM	42.14	50.63	33.37	51.58	53.94	36.59
	St.Err.	3.12	3.04	2.44	5.05	3.85	2.30
Texel	LSM	45.10	53.43	32.67	54.23	55.82	33.52
	St.Err.	2.96	2.90	1.98	4.10	3.13	1.87

The F-values for effects of systematic factors included into model equation on quality and technological characteristics of lamb meat are presented in table 2.Fat contents in the back muscles of lambs were statistically highly influenced mainly by the effect of lamb age at slaughter. That fact caused also influence of lamb age on content of dry matter. Protein contents were influenced mainly by the slaughter date. Hydroxyproline contents depends significantly on the date of slaughter and carcass weight. It were not detected significant influences of studied systematic effects on ash content in lamb. Variability of ash content in dataset was very low (variation coefficient was 2.9%) and the used model equation allows to explain only 6.6% of variability. The pH of meat especially 48 hours after slaughter were influenced mainly by the slaughter date. It can be assumed that this trait depends significantly on the conditions during the meat maturing. The meat electro-conductivities 5 and 7 hours after slaughter were significantly influenced mainly by the breed of sire. Meat consistency was influenced mainly by the age of lambs.

In tables 3-6 the LSMs of individual lamb hybrids according to breed of sire are presented. The highest content of dry matter (23.64%) and fat (1.77%) were detected in the progeny of Texel rams, while the highest content of proteins (20.06%) was in the progeny of Merinolandschaf. Nevertheless differences between hybrids were not statistically significant.

Electro-conductivities of meat 5, 7 and 24 hours after slaughter in lambs sired by Oxford Down were significantly higher than in meat of Merinolandschaf progeny.

During the meat degustation and sensoric assessment the odour and the taste of lamb meat of all hybrids were evaluated as very good. The effects of systematic factors of slaughter date, liveweight at slaughter, litter size, sire breed, age and breed of dam on amino-acids (AA) contents in lamb meat are presented in Table 7. There were not detected significant influence of slaughter date, slaughter age and live weight of lambs, litter size, age and breed group of dam for the majority of examined amino acids. On the contrary the sire breed showed the highly significant effects on contents of Asp, Met, Thr, Glu, Pro, Gly, Ala, Val, Ile, Leu, Tyr, Phe, Lys and Trp.

Lower contents of nonessential amino acids (NEAA) than essential and semi-essential amino acids (EAA) in muscle *m. longissimus lumborum et thoracis* were detected for all examined hybrid combinations of lambs (Table 8). Swartvagherová *et al.* (1996) and Mikulík *et al.* (1984) refere about the opposite situation. Šubrt et al. (2002) detected lower content of essential AA (30.16 -34.5 %) and semi-essential AA (9.17-11.62 %) in the sirloin muscle of

bulls of milked and beef commercial types in comparison with the lambs examined in this study.

In the group of NEAA the highest contents were detected for Glu (11.67-12.74 %) and Asp (7.61-8.10 %). Lower contents were observed for Ala (5.21 –5.48 %) and Tyr (4.79-5.38 %). Contents of Gly, Ser and Pro ranged between 3.03–3.71 %. Also Jelínek (1998), Gajdošík *et al*. (1998) a Swartvagherová *et al*. (1996) found out the highest contents of Glu and Asp of all NEAA.

Lys (7.74-8.33%), Arg (7.23–7.44%) and Leu (6.23–6.70%) had the highest contents of all EAA. The low contents, usually less than 2%, were detected for Met, Trp and Cys. Also Jelínek (1988), Swartvagherová *et al*. (1996) a Kuchtík *et al*. (1998) proved the highest content of EAA Lysine, Arginine and Leucine. Relations between contents of NEAA and EAA for individual hybrids are shown in Table 8. By the comparison of EAA contents between individual hybrids we obtained following results: Hybrid MxOD had the highest content of Lysine and the lowest contents of Methionine, Cysteine , Threonine, Valine and Histidine of all examined hybrids. Progeny of Texel sires had the highest content of Methionine, Arginine, Leucine and Histidine but the lowest contents of Lysine and Tryptophan. In muscles of ChxM hybrids the highest contents of Cysteine, Threonine and the lowest contents of Arginine, Leucine, Phenylalanine and Isoleucine were detected. The highest contents of Valine and Phenylalanine showed the progeny of Merinolandschaf sires. The last examined hybrid SfxM had the highest content of Tryptophan and Isoleucine and the lowest content of Arginine. In the muscle tissue of the progeny of Merinolandschaf sires the highest overall content of all EAA (47.29%) was detected. The overall EAA contents of hybrids between Merino ewes and rams of meat breeds ranged from 46.72 to 47.00%.

CONCLUSIONS

The goal of this study was to compare qualitative and technological characteristics of lamb meat of five different hybrids. The highly significant effects of sire breed were found for majority of analysed amino acids contents. Odour and the taste of lamb meat of all hybrids were evaluated as very good during the lamb meat degustation.

Supported by Ministry of Agriculture of the Czech Republic, peroject NAZV QC 1231.

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