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The effect of sex category on the eating quality of lamb loin chops.

Report

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Summary
The ninety lambs in this trial came from six different farms with different feeding and housing strategies. Each farm produced female lambs plus either male lambs or castrated lambs.
The major differences are related to different degrees of tenderness. The majority of grilled lamb loin chops were considered tender. Five of the six groups of panels were very consistent in rating lamb from female animals as being more tender than either males or castrates. Four of the groups of panels rated lamb from males as less tender, 1 group of males from farm 4 were rated as more tender than other lambs.
The pooled data for tenderness showed that female lambs were more tender than castrates which in turn were more tender than males, however all the mean values were within 2 categories of tenderness.
Only one group of lambs from farm 1 were considered more juicy than castrates and males. The pooled data did not reveal differences in juiciness between sex types.
There were few differences in the odour of the fat, only in one group of lambs were there significant differences and this favoured the castrates which had less abnormal odour than either females or males although the absolute values were in the categories "very weak to moderately weak"
Surprisingly, in view of the different diets used, there were no differences in lamb flavour across the groups although in two groups abnormal flavour was significantly different where male and castrate lambs from farms 3 & 6 respectively had higher abnormal flavour than female lambs from farm 3. Similarly abnormal flavour was higher in castrates from farm 5 whilst males and females from farm 4 did not differ significantly. The overall level of abnormal flavour was in the category range of "very weak to slightly weak".

The hedonic data for flavour liking and overall liking showed that meat from female lambs was preferred over that of male and castrate lambs. There was no significant difference between male and castrate lambs in flavour liking or overall liking.
The hedonic data should be treated with caution as it derived from a small group of assessors and may not be representative of consumer acceptability; it merely serves as an indication of trends in flavour and overall liking.

Objective

Compare the eating quality of male, castrate and female lambs and compare either castrate or male lambs against female lambs within farms.

Materials & Methods

Farms

Frozen vacuum packed paired lamb loins were received at The Division of Farm Animal Science, Sensory Group.
On arrival, all samples were checked for the integrity of the vacuum pack and all found to be intact.
The lamb loin samples came from six different farms (coded 1 to 6) each of which were asked to supply 15 lambs comprising five females and either ten castrates or male lambs. Two farms did not follow the protocol exactly, farm 5 supplied 4 females and 11 castrates and farm 6 supplied six females and 9 castrates. This resulted in a change within some individual panels to accommodate this variation, but over the six farms the totals of males, castrates and females were balanced.
Individual farm details are given in Appendix 1.

Sensory analysis

The day before assessment loins, were removed from the –20^{o} C room and initially thawed at room temperature and then stored overnight in a refrigerator set at +1 ^{o} C.

The allocation of lambs was based on ensuring that at each panel three samples were present, comprising male, castrate and female lambs, where two of the lamb samples were supplied from the same farm. As far as possible, lambs within a panel had similar carcass grades. The panel allocations are shown in Appendix 2, which identifies individual lambs and farms.
On the morning of sensory analysis, loin samples were de-boned and cut into ten 2 cm steaks. Loin samples were cooked (turning every 3 minutes) under a grill, until the internal temperature of each sample reached 75 ^{o} C as measured by a thermocouple. The samples were then removed from the grill and placed in an incubator prior to sampling for the panel. Samples were prepared such that the fat and connective tissue were removed and fat and lean were served separately. Samples were then wrapped in pre-coded aluminium foil and placed in hot blocks in each sensory booth.

Ten assessors, who had been screened according to British Standards Institute methods and who had also received special training in the assessment of meat took part in the tests. All assessments were completed under red light.

Assessors were asked to rate 8 point category scales for: lamb odour of the fat, abnormal odour of the fat and assessment of the lean meat for texture, juiciness, lamb flavour intensity, abnormal lamb flavour intensity and also two hedonic scales for flavour liking and overall liking. (Appendix 3) A total of 30 panels were convened and were attended by the same assessors throughout.

Statistical analysis.
Analysis of variance using sex and assessors as factors were used for each block of 5 panels where either males versus females or castrates versus females were compared within farm. To make up the triad for each panel a third sample came from another farm. A pooled analysis comparing the three sex types were completed across all farms. Individual mean values for each lamb are given Appendix 4.

Results.

Within farm sex comparisons
Farm 1, males versus females, Table 1.
There were no significant differences in lamb odour of the fat or abnormal odour of the fat. On eating meat from females lambs was significantly ($p<0.001$) were more tender and significantly ($p<0.01$) more juicy than males. There were no significant differences in lamb flavour or abnormal flavours. The hedonic terms of flavour liking and overall liking did not reveal differences between meat from female or male lambs.

Table 1. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Farm 1	**Type**					
	Male	Female	vr	Probability	sig	lsd
Attributes						
Fat						
Lamb odour	4.92	5.04	0.31	0.5806	ns	!
Abnormal odour	1.92	1.86	0.07	0.7908	ns	!
Lean						
Texture	5.18	6.16	16.28	0.0001***		0.48
Juiciness	5.12	5.60	9.52	0.0028 **		0.31
Lamb Flavour	4.32	4.56	1.25	0.2675	ns	!
Abnormal Flavour	3.44	3.46	0	0.9440	ns	!
Hedonic						
Flavour liking	4.24	4.58	1.63	0.2056	ns	!
Overall liking	4.24	4.70	2.68	0.1056	ns	!

vr, variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Farm 2, Female versus castrate, Table 2.

There was no significant difference in lamb odour of the fat, however, abnormal odour of the fat was significantly higher ($p<0.01$) in the fat from female lambs.

Meat from female lambs was significantly ($p<0.05$) more tender than meat from castrated lamb. There were no significant differences in juiciness, lamb flavour, or abnormal flavour. Neither were there differences in flavour liking or overall liking.

Table 2. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Farm 2	Type					
	Female	Castrate	vr	Probability	sig	lsd
Attributes						
Fat						
Lamb odour	4.66	4.66	0	>0.9999	ns	!
Abnormal odour	2.36	1.80	7.61	0.0072	**	0.40
Lean						
Texture	5.62	5.04	4.08	0.0467	*	0.57
Juiciness	4.98	5.00	0.01	0.9177	ns	!
Lamb Flavour	4.48	4.58	0.18	0.6721	ns	!
Abnormal Flavour	3.54	3.66	0.16	0.6912	ns	!
Hedonic						
Flavour liking	4.44	4.42	0.01	0.9417	ns	!
Overall liking	4.44	4.24	0.53	0.4697	ns	!

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Farm 3, male versus female, Table 3.

There were no significant differences in the odour of fat from either male or female lambs. Female lambs were significantly ($p<0.001$) more tender than meat from male lambs but did not differ in juiciness or lamb flavour. Abnormal flavour was significantly ($p<0.001$) higher in meat from male lambs. Flavour liking and overall liking of lamb from females was significantly higher at $p<0.01$ and $p<0.001$ respectively when compared with meat from male lambs.

Table 3. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Farm 3	Type					
	Male	Female	vr	Probability	sig	lsd
Attributes						
Fat						
Lamb odour	4.16	4.54	2.69	0.1047	ns	!
Abnormal odour	2.40	2.16	1.05	0.3083	ns	!
Lean						
Texture	4.84	6.16	34.57	<0.0001	***	0.45
Juiciness	4.76	5.06	2.05	0.1566	ns	!
Lamb Flavour	4.30	4.72	3.59	0.0619	ns	!
Abnormal Flavour	3.36	2.48	11.99	0.0009	***	0.51
Hedonic						
Flavour liking	4.40	5.24	11.20	0.0012	**	0.50
Overall liking	4.34	5.32	13.92	0.0004	***	0.52

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Farm 4, male versus female, Table 4.

There were no significant differences in lamb odour or abnormal odour of the fat. Meat from female lambs was significantly ($p<0.01$) more tender than meat from male lambs although both meats were rated as tender.
There were no significant differences in juiciness, lamb flavour, abnormal flavour or in flavour liking and overall liking between meat from male or female lambs.

Table 4. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Farm 4	**Type**					
	Male	Female	vr	Probability	sig	lsd
Attributes						
Fat						
Lamb odour	4.30	4.38	0.17	0.6769	ns	!
Abnormal odour	1.96	1.98	0.01	0.9306	ns	!
Lean						
Texture	5.06	5.68	8.18	0.0054	**	0.43
Juiciness	5.22	5.04	1.51	0.2221	ns	!
Lamb Flavour	4.78	4.68	0.18	0.6743	ns	!
Abnormal Flavour	2.96	3.10	0.34	0.5633	ns	!
Hedonic						
Flavour liking	4.70	4.88	0.50	0.4829	ns	!
Overall liking	4.62	4.88	0.94	0.3362	ns	!

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Farm 5, female versus castrate, Table 5.

Four female lambs were supplied from this farm so consequently comparisons with castrates are based on four comparisons.

There were no significant differences in lamb odour or abnormal odour of the fat. On eating the lean, meat from female lambs was significantly ($p<0.01$) more tender than meat from castrates. There were no significant differences in juiciness, lamb flavour, abnormal flavour or the hedonic terms of flavour liking and overall liking.

Table 5. Influence of type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 4 replications.

8 point category scale used

Farm 5	**Type**					
	Female	Castrate	vr	Probability	sig	lsd
Attributes						
Fat						
Lamb odour	4.67	4.70	0.02	0.8869	ns	!
Abnormal odour	1.85	1.70	0.69	0.4087	ns	!
Lean						
Texture	5.83	4.97	8.10	0.0060	**	0.60
Juiciness	4.92	4.63	1.44	0.2349	ns	!
Lamb Flavour	4.38	3.95	3.04	0.0863	ns	!
Abnormal Flavour	3.52	3.77	0.42	0.5193	ns	!
Hedonic						
Flavour liking	4.47	4.05	1.95	0.1679	ns	!
Overall liking	4.45	3.95	2.62	0.1108	ns	!

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Farm 6, female versus castrate, Table 6.

There were no significant differences in lamb odour or abnormal odour of the fat from female or castrate lambs.
Texture, juiciness, lamb flavour and abnormal flavour had similar mean values and did not differ significantly.
There were no significant differences in flavour liking or overall liking in this group of lambs.

Table 6. Influence of type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Farm 6	**Type**					
	Female	Castrate	vr	Probability	sig	lsd
Attributes						
Fat						
Lamb odour	4.12	4.34	0.87	0.3545	ns	!
Abnormal odour	2.10	1.84	1.50	0.2239	ns	!
Lean						
Texture	4.26	4.30	0.02	0.8899	ns	!
Juiciness	4.80	4.84	0.07	0.7977	ns	!
Lamb Flavour	4.38	4.36	0.01	0.9294	ns	!
Abnormal Flavour	3.02	3.16	0.27	0.6072	ns	!
Hedonic						
Flavour liking	4.36	4.28	0.11	0.7371	ns	!
Overall liking	4.04	4.16	0.24	0.6244	ns	!

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Across farms sex type comparisons.

Farm 1 male and female plus farm 2 castrates. Table 7.

Five panels compared the 3 sex types using loins from farms 1 & 2.

There were no significant differences in lamb odour or abnormal odour of the fat.

Meat from female lambs was significantly ($p<0.001$) more tender than meat from male or castrate lamb. There were no significant differences between male and castrate lamb. Meat from female lambs was significantly ($p<0.01$) more juicy than either male or castrate lamb. There were no significant differences in juiciness between male and castrate lamb.

There were no significant differences in lamb flavour, abnormal lamb flavour or the hedonic terms flavour liking and overall liking.

Table 7. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Panels 1 to 5	**Type**						
	Male Farm1	Female Farm 1	Castrate Farm 2	vr	Probability	sig	lsd
Attributes							
Fat							
Lamb odour	4.92	5.04	4.92	0.22	0.8027	ns	!
Abnormal odour	1.92	1.86	1.92	0.05	0.9525	ns	!
Lean							
Texture	5.18[b]	6.16[a]	5.56[b]	7.81	0.0006	***	0.50
Juiciness	5.12[b]	5.60[a]	5.18[b]	5.40	0.0057	**	0.32
Lamb Flavour	4.32	4.56	4.74	1.94	0.1488	ns	!
Abnormal Flavour	3.44	3.46	3.50	0.02	0.9783	ns	!
Hedonic							
Flavour liking	4.24	4.58	4.52	0.91	0.4047	ns	!
Overall liking	4.24	4.70	4.48	1.38	0.2547	ns	!

vr variance ratio, * significant at 5 %, ** significant at 1 %, *** significant at 0.1 %
! least significance test post hoc not computed
Figures with the same superscript do not differ significantly

Farm 1 male plus farm 2 female and castrates. Table 8.

There was no significant difference in lamb odour of the fat between the three sex types, however, there were significant differences in abnormal odour where the abnormal odour of fat from female lambs and male lambs was significantly ($p<0.05$) higher than from castrate lambs, although the values were within the "very weak to moderately weak" categories. Meat from female lambs were significantly ($p<0.001$) more tender than meat from castrates or male lambs and castrates were significantly more tender than meat from male lambs. There were no significant differences between the sex types for the remaining sensory attributes, neither were there differences in flavour liking or overall liking.

Table 8. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Panels 6 to 10	**Type**						
	Male Farm1	Female Farm 2	Castrate Farm 2	vr	Probability	sig	lsd
Attributes							
Fat							
Lamb odour	4.26	4.66	4.66	2.31	0.1034	ns	!
Abnormal odour	2.42[a]	2.36[a]	1.80[b]	3.90	0.0229	*	0.48
Lean							
Texture	4.32[c]	5.62[a]	5.04[b]	10.73	<0.0001	***	0.56
Juiciness	4.86	4.98	5.00	0.27	0.7635	ns	!
Lamb Flavour	4.62	4.48	4.58	0.21	0.8120	ns	!
Abnormal Flavour	3.36	3.54	3.66	0.59	0.5533	ns	!
Hedonic							
Flavour liking	4.16	4.44	4.42	0.79	0.4567	ns	!
Overall liking	3.92	4.44	4.24	2.09	0.1278	ns	!

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Figures with the same superscript do not differ significantly

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Farm 5 female and castrate plus farm 3 male. Table 9.

These comparisons were based on four panels since there were only four females supplied from Farm 5. Therefore panel 15 is not included since it contained two castrate samples. There were no significant differences observed for lamb odour or abnormal odour of the fat. Meat from female lambs were significantly ($p<0.001$) more tender than meat from castrates or male lambs and castrates were significantly more tender than meat from male lambs. There were no significant differences between the sex types for the remaining sensory attributes, neither were there differences in flavour liking or overall liking.

Table 9. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 4 replications.

8 point category scale used

Panels 11 to 14	**Type**						
	Male Farm3	Female Farm 5	Castrate Farm 5	vr	Probability	sig	lsd
Attributes							
Fat							
Lamb odour	4.85	4.67	4.70	0.47	0.6250	ns	!
Abnormal odour	1.93	1.85	1.70	0.76	0.4711	ns	!
Lean							
Texture	4.28[c]	5.83[a]	4.97[b]	13.33	<0.0001	***	0.60
Juiciness	4.75	4.92	4.63	0.90	0.4109	ns	!
Lamb Flavour	4.05	4.38	3.95	2.06	0.1333	ns	!
Abnormal Flavour	3.58	3.52	3.77	0.29	0.7495	ns	!
Hedonic							
Flavour liking	4.05	4.47	4.05	1.53	0.2211	ns	!
Overall liking	3.83	4.45	3.95	2.59	0.0809	ns	!

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed

Figures with the same superscript do not differ significantly

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Farm 3 male and female plus farm 6 castrate. Table 10.

These comparisons were based on four panels since there were only 9 castrates supplied from Farm 6. Five were required for the female versus castrate comparison within farm 6 panels described later and therefore only four were available for these sex type comparisons. Panel twenty, which contained two female samples is not included in this group of panels.

There were no significant differences in lamb odour or abnormal odour of the fat.

The tenderness of meat from female lambs did not differ significantly from castrate lambs although both of these differed significantly ($p<0.01$) from male lambs. There were no significant differences in juiciness or lamb flavour between the sex types. However, male and castrate lamb meat was significantly ($p<0.01$) higher in abnormal flavour than meat from females.

This was reflected in the hedonic terms flavour liking and overall liking where meat from female lambs were significantly ($p<0.01$) preferred over male and castrate meat.

Table10. Influence of type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 4 replications.

8 point category scale used

Panels 16 to 19	**Type**						
	Male Farm3	Female Farm 3	Castrate Farm 6	vr	Probability	sig	lsd
Attributes							
Fat							
Lamb odour	4.30	4.50	4.35	0.36	0.6979	ns	!
Abnormal odour	2.38	2.27	2.20	0.21	0.8075	ns	!
Lean							
Texture	4.88[b]	5.97[a]	5.58[a]	7.40	0.0011	**	0.58
Juiciness	4.83	5.03	4.88	0.46	0.6326	ns	!
Lamb Flavour	4.15	4.70	4.22	3.00	0.0548	ns	!
Abnormal Flavour	3.55[a]	2.50[b]	3.52[a]	7.29	0.0012	**	0.62
Hedonic							
Flavour liking	4.33[b]	5.17[a]	4.25[b]	6.49	0.0023	**	0.57
Overall liking	4.28[b]	5.20[a]	4.22[b]	6.96	0.0016	**	0.58

vr variance ratio, * significant at 5 %, ** significant at 1 %, *** significant at 0.1 %
! least significance test post hoc not computed.
Figures with the same superscript do not differ significantly

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Farm 4 male and female plus farm 5 castrate. Table 11.

There were no significant differences observed for lamb odour or abnormal odour of the fat.

Meat from female lambs were significantly ($p<0.05$) more tender than meat from male lambs, but did not differ significantly from castrate lambs. There were no significant differences in juiciness or lamb flavour, but abnormal flavour was significantly ($p<0.001$) higher in castrates than in female or male lambs which did not differ significantly.
In terms of flavour liking, meat from male and female lambs was significantly ($p<0.001$) preferred over meat from castrates and this was reflected in overall liking.

Table 11. Influence of sex type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Panels 21 to 25	**Type**						
	Male Farm4	Female Farm 4	Castrate Farm 5	vr	Probability	sig	lsd
Attributes							
Fat							
Lamb odour	4.30	4.38	4.28	0.15	0.8631	ns	!
Abnormal odour	1.96	1.98	1.82	0.32	0.7253	ns	!
Lean							
Texture	5.06[b]	5.68[a]	5.56[a]	4.21	0.0170	*	0.45
Juiciness	5.22	5.04	4.94	1.84	0.1630	ns	!
Lamb Flavour	4.78	4.68	4.32	2.37	0.0982	ns	!
Abnormal Flavour	2.96[b]	3.10[b]	4.06[a]	10.20	<0.0001	***	0.52
Hedonic							
Flavour liking	4.70[a]	4.88[a]	3.80[b]	10.78	<0.0001	***	0.49
Overall liking	4.62[a]	4.88[a]	3.84[b]	8.88	0.0003	***	0.51

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed
Figures with the same superscript do not differ significantly

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Farm 4 male, farm 6 female and castrate. Table 12.

There were no significant differences in lamb odour or abnormal odour of the fat.

Meat from male lambs were significantly ($p<0.05$) more tender than meat from either female or castrates which did not differ significantly.
There were no significant differences in juiciness, lamb flavour, abnormal flavour or the two hedonic terms flavour liking and overall liking.

Table 12. Influence of type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 5 replications.

8 point category scale used

Panels 26 to 30	**Type**						
	Male Farm4	Female Farm 6	Castrate Farm 6	vr	Probability	sig	lsd
Attributes							
Fat							
Lamb odour	4.26	4.12	4.34	0.44	0.6446	ns	!
Abnormal odour	2.22	2.10	1.84	1.44	0.2401	ns	!
Lean							
Texture	4.88[a]	4.26[b]	4.30[b]	3.19	0.0447	*	0.54
Juiciness	5.08	4.80	4.84	1.92	0.1508	ns	!
Lamb Flavour	4.74	4.38	4.36	1.77	0.1743	ns	!
Abnormal Flavour	2.98	3.02	3.16	0.25	0.7799	ns	!
Hedonic							
Flavour liking	4.58	4.36	4.28	0.88	0.4171	ns	!
Overall liking	4.40	4.04	4.16	1.16	0.3166	ns	!

vr variance ratio
* significant at 5 %
** significant at 1 %
*** significant at 0.1 %
! least significance test post hoc not computed
Figures with the same superscript do not differ significantly

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Pooled data, Table 13.
An orthogonal set of twenty-eight panels (84 samples) were pooled across farms to compare males, females and castrates. Means for the non-orthogonal panels (6 samples) have been included in the individual values data set.

There were no significant differences in lamb odour of the fat with values falling within the "slightly weak "category. There were significant differences observed in abnormal odour of the fat where males and castrates had significantly ($p<0.05$) higher abnormal odour in the fat. However, the mean values all fall within the "very weak" categories.

In terms of tenderness, meat from female lambs was significantly ($p<0.001$) more tender than meat from castrates which in turn were significantly more tender than meat from male lambs. There were no significant differences in juiciness or lamb flavour, although abnormal lamb flavour was significantly higher ($p<0.01$) in castrates than either male or female lambs, which did not differ significantly.

In terms of flavour liking and overall liking, meat from female lambs was significantly ($p<0.001$) preferred over male and castrate meat, which did not differ significantly.

Table 13. Influence of type on the eating quality of grilled lamb loin.
Values are the means derived from analysis of variance with Type and Assessor as factors with 28 replications.

8 point category scale used

All Farms	**Type**						
	Male	Female	Castrate	vr	Probability	sig	lsd
Attributes							
Fat							
Lamb odour	4.47	4.56	4.54	0.44	0.6431	ns	!
Abnormal odour	2.14[a]	2.07[a]	1.88[b]	3.89	0.0207	*	0.19
Lean							
Texture	4.78[c]	5.56[a]	5.16[b]	23.17	<0.0001	***	0.23
Juiciness	4.99	5.07	4.92	1.71	0.1808	ns	!
Lamb Flavour	4.47	4.53	4.38	1.22	0.2967	ns	!
Abnormal Flavour	3.29[b]	3.20[b]	3.61[a]	6.08	0.0024	**	0.24
Hedonic							
Flavour liking	4.35[b]	4.64[a]	4.22[b]	7.81	0.0004	***	0.21
Overall liking	4.22[b]	4.60[a]	4.15[b]	9.68	<0.0001	***	0.22

vr variance ratio, * significant at 5 %, ** significant at 1 %, *** significant at 0.1 %
! least significance test post hoc not computed
Figures with the same superscript do not differ significantly

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Comparison of females, across farms, Table 14.

All farms supplied female lambs and using the balanced panels it was possible to compare lambs across farms. Farm 5 results are based on 4 female lambs.

There was no significant difference in lamb odour or abnormal odour of the fat. Lambs from farm 6 were significantly ($p<0.001$) less tender than lambs produced on other farms. There were no significant difference in tenderness for lambs reared on farms 1, 2, 3, 4, and 5.

In terms of juiciness farm1 lambs were significantly ($p<0.05$) juicer than lambs from other farms.

There were no significant differences in lamb flavour or abnormal flavour.

There were no significant differences in flavour liking between farms.

Lambs from farm 3 were significantly ($p<0.05$) preferred over farms 2, 5 & 6 but did not differ from farms 1 and 4. The least liked was from farm 6 but lambs from this farm were not significantly different from lambs reared on farms 1, 2, & 5.

Table 14. Comparison of the eating quality of grilled lamb loin from female lambs across farms

Values are the means derived from analysis of variance with Farm and Assessor as factors with 5 replications.

8 point category scale used

	FARM 1	FARM 2	FARM 3	FARM 4	FARM 5	FARM 6	vr	Probability	sig	lsd
Attributes										
Fat										
Lamb odour	5.04	4.66	4.54	4.38	4.68	4.12	2.36	0.073	ns	!
Abnormal odour	1.86	2.36	2.16	1.98	1.85	2.10	2.40	0.068	ns	!
Lean										
Texture	6.16[a]	5.62[a]	6.16[a]	5.68[a]	5.83[a]	4.26[b]	6.15	<.001	***	0.89
Juiciness	5.60[a]	4.98[b]	5.06[b]	5.04[b]	4.93[b]	4.80[b]	3.47	0.018	*	0.47
Lamb Flavour	4.56	4.48	4.72	4.68	4.38	4.38	0.95	0.470	ns	!
Abnormal Flavour	3.46	3.54	2.48	3.10	3.53	3.02	2.41	0.067	ns	!
Hedonic										
Flavour liking	4.58	4.44	5.24	4.88	4.48	4.36	2.59	0.053	ns	!
Overall liking	4.70[abc]	4.44[bc]	5.32[a]	4.88[ab]	4.45[bc]	4.04[c]	3.76	0.012	*	0.71

vr variance ratio

* significant at 5 %

** significant at 1 %

*** significant at 0.1 %

! least significance test post hoc not computed

Figures with the same superscript do not differ significantly

Conclusion

In these trials the major differences are related to different degrees of tenderness. The majority of grilled lamb loin chops were considered tender. Five of the six groups of panels were very consistent in rating lamb from female animals as being more tender than either males or castrates. Four of the groups of panels rated lamb from males as less tender, 1 group of males from farm 4 were rated as more tender than other lambs. The pooled data for tenderness showed that female lambs were more tender than castrates which in turn were more tender than males, however all the mean values were within 2 categories of tenderness.

Only one group of lambs from farm 1 were considered more juicy than castrates and males. The pooled data did not reveal differences in juiciness between sex types

There were few differences in the odour of the fat, only in one group of lambs were there significant differences and this favoured the castrates which had less abnormal odour than either females or males although the absolute values were in the categories "very weak to moderately weak"

There were no differences in lamb flavour across the groups although in two groups abnormal flavour where lambs male and castrate lambs from farms 3 & 6 respectively had higher abnormal flavour than female lambs from farm 3. Similarly abnormal flavour was higher castrates from farm 5 whilst males and females from farm 4 did not differ significantly.

The hedonic data for flavour liking and overall liking showed that meat from female lambs was preferred over that of male and castrate lambs. There was no significant difference between male and castrate lambs in flavour liking or overall liking.

Appendix 1. The effect of sex category on the eating quality of lamb loin chops

Farm & lamb details

Lamb mix	**Lambing period**	**Feeding regime during finishing**	**When castrated**	**Male & females together or separate**	**Farm Code Allocated by Bristol.**
10 male & 5 female	mid March – mid April	Finished inside on a super intensive lamb concentrate and silage bedded on straw	N/A	Housed in separate pens	**Farm 1**.
10 castrated & 5 female	End of March – early April	Outside grazing supplemented with Wynnstay's lambmaster creep feed	Early August	Castrates & females together	**Farm 2.**
10 male & 5 female	End of April/ early May	Outside grazing, supplemented with HJ Lea Oakes 'Bwyd y Buarth' concentrate	N/A	Grazing separate fields	**Farm 3**
10 male & 5 female	20th March – 15th April	Finished outside on pasture only	N/A	Grazing separate fields	**Farm 4**
10 castrated & 5 female	Early – mid April	Finished inside on a rolled wheat & beet pulp mix and bedded on straw	Early August	Castrated & females housed together	**Farm 5**
9 castrated & 5 female	March	Finished indoors and fed Wynnstay lambmaster and hay.	Castrated with rubber ring at less than 7 days old	Castrated & females housed together	**Farm 6**

Appendix 2. Taste-panel allocation of lamb samples.

Farm	F	Ram	Castrates	Farmer
1	5	10		D Jones
2	5		10	Jukes
3	5	10		Williams
4	5	10		O Jones
5	4		11	Price
6	6		9	Breese

Panel structure

Panels	Males	Females	Castrates	Panels	Males	Females	Castrates
1	F1M R3L 12508	F1F R3L 12502	F2C R3L 12551	16	F3M O2 12521	F3F O3H 12518	F6C O2 12582
2	F1M R3H 12506	F1F R3H 12503	F2C R3L 12552	17	F3M O2 12524	F3F R3L 12516	F6C R3L 12590
3	F1M R3H 12509	F1F R3H 12505	F2C R3L 12553	18	F3M R3L 12523	F3F R3L 12517	F6C R3H 12588
4	F1M R3H 12511	F1F R4L 12501	F2C R4L 12555	19	F3M R3L 12528	F3F R3H 12519	F6C R4L 12584
5	F1M R3L 12512	F1F R4H 12504	F2C R4L 12560	20	***F3M R3H 12522***	***F3F R4H 12520***	***F6F R3H 12580***
6	F1M U3L 12507	F2F U3H 12546	F2C R2 12558	21	F4M 02 12536	F4F 02 12533	F5C O2 12566
7	F1M O3L 12513	F2F U3H 12547	F2C R3L 12556	22	F4M 02 12541	F4F 02 12534	F5C R2 12564
8	F1M R3L 12510	F2F U3H 12548	F2C R3L 12559	23	F4M 03L 12537	F4F 03L 12532	F5C R3L 12567
9	F1M R3L 12514	F2F U3H 12549	F2C R3H 12557	24	F4M 03L 12543	F4F 03L 12535	F5C R3L 12568
10	F1M R3L 12515	F2F U3H 12550	F2C U4H 12554	25	F4M 03L 12542	F4F R3L 12531	F5C R3H 12570
11	F3M O2 12525	F5F R3H 12561	F5C R3H 12569	26	F4M P+1 12538	F6F R2 12576	F6C R3L 12583
12	F3M O2 12526	F5F R3L 12563	F5C R3L 12571	27	F4M P+2 12539	F6F R2 12578	F6C R3L 12585
13	F3M 02 12527	F5F R2 12565	F5C R2 12572	28	F4M P+2 12540	F6F R3L 12577	F6C R3L 12586
14	F3M O2 12529	F5F U2 12574	F5C R2 12575	29	F4M P+2 12545	F6F R3L 12579	F6C R3L 12587
15	***F3M O2 12530***	***F5C R3H 12573***	***F5C U3L 12562***	30	F4M O3L 12544	F6F R3L 12581	F6C R3L 12589

Key:- F followed by number = Farm, last digit, M, F or C =sex type

Panels 15 and 20 contained just 2 sex types

Appendix 3. Eight point category scales used in the assessment of lamb. Numerical values are added subsequently.

Lamb Odour of fat / Abnormal odour intensity

8. Extremely strong
7 Very strong
6 Moderately strong
5 Slightly strong
4 Slightly weak
3 Moderately weak
2 Very weak
1 Extremely weak

Texture / Juiciness	**Lamb flavour intensity / Abnormal flavour intensity**
8 Extremely tender/juicy	Extremely strong
7 Very tender/juicy	Very strong
6 Moderately tender/juicy	Moderately strong
5 Slightly tender/ juicy	Slightly strong
4 Slight tough/ dry	Slightly weak
3 Moderately tough/ dry	Moderately weak
2 Very tough/dry	Very weak
1 Extremely tough/dry	Extremely weak

Hedonic
Flavour/ Overall liking
8 Like extremely
7 Like very much
6 Like moderately
5 Like slightly
4 Dislike slightly
3 Dislike moderately
2 Dislike very much
1 Dislike extremely

Appendix 4. Individual panel means for each lamb for each sensory attribute

Rep	Farm	Sex	Number	Lamb odour fat	Abnormal odour fat	Texture lean	Juiciness	Lamb flavour	Abnormal flavour	Flavour liking	Overall liking
1	1	Male	12508	4.9	2.9	6.5	5.6	4.7	3.9	4.2	4.3
2	1	Male	12506	5.3	1.7	4.4	4.8	4.5	3.1	4.5	4.2
3	1	Male	12509	5.2	1.5	4.1	5.2	4.0	3.4	3.8	3.8
4	1	Male	12511	4.5	1.8	5.5	4.7	4.4	3.0	4.9	5.0
5	1	Male	12512	4.7	1.7	5.4	5.3	4.0	3.8	3.8	3.9
6	1	Male	12507	4.5	3.0	3.8	4.0	4.5	3.8	3.4	3.3
7	1	Male	12513	4.3	2.2	4.0	4.8	4.1	3.2	3.7	3.4
8	1	Male	12510	3.5	2.9	3.6	4.5	4.9	3.7	4.2	3.6
9	1	Male	12514	4.6	2.1	4.2	5.4	4.7	2.5	4.9	4.5
10	1	Male	12515	4.4	1.9	6.0	5.6	4.9	3.6	4.6	4.8
11	3	Male	12525	4.8	2.1	4.0	4.5	4.1	3.3	4.2	3.9
12	3	Male	12526	4.3	2.2	5.1	4.9	4.1	4.0	4.2	4.2
13	3	Male	12527	5.1	1.8	3.6	4.8	3.7	3.9	3.4	3.1
14	3	Male	12529	5.2	1.6	4.4	4.8	4.3	3.1	4.4	4.1
15	3	Male	12530	4.5	2.3	5.5	5.1	4.0	2.6	4.1	4.4
16	3	Male	12521	4.6	2.5	5.6	4.3	4.1	2.6	4.8	4.8
17	3	Male	12524	4.0	2.5	5.7	4.9	4.2	3.4	4.4	4.7
18	3	Male	12523	4.4	2.2	4.2	5.2	4.4	3.5	4.4	4.2
19	3	Male	12528	4.2	2.3	4.0	4.9	3.9	4.7	3.7	3.4
20	3	Male	12522	3.6	2.5	4.7	4.5	4.9	2.6	4.7	4.6
21	4	Male	12536	4.4	2.3	5.2	5.1	5.0	2.7	4.7	4.8
22	4	Male	12541	4.7	1.5	5.9	5.8	4.8	3.1	5.3	5.3
23	4	Male	12537	4.5	1.7	5.6	5.1	4.9	2.7	5.0	4.9
24	4	Male	12543	4.0	2.6	5.0	5.3	4.5	3.0	4.4	4.4
25	4	Male	12542	3.9	1.7	3.6	4.8	4.7	3.3	4.1	3.7
26	4	Male	12538	4.5	1.8	4.2	4.6	4.9	2.5	4.7	4.3
27	4	Male	12539	3.9	2.4	5.9	5.5	4.5	3.3	4.7	4.8
28	4	Male	12540	4.3	2.4	4.4	4.9	4.8	2.9	4.3	4.1
29	4	Male	12545	4.2	2.2	4.9	5.0	5.0	2.7	5.0	4.7
30	4	Male	12544	4.4	2.3	5.0	5.4	4.5	3.5	4.2	4.1
1	1	Female	12502	5.6	1.5	6.6	4.9	4.7	3.0	5.1	5.4
2	1	Female	12503	5.1	2.3	5.5	5.5	4.9	3.3	4.6	4.6
3	1	Female	12505	4.5	1.7	6.5	5.8	4.1	4.0	4.3	4.5
4	1	Female	12501	4.8	2.1	5.5	5.8	4.6	3.1	4.9	4.7
5	1	Female	12504	5.2	1.7	6.7	6.0	4.5	3.9	4.0	4.3
6	2	Female	12546	5.3	2.1	5.1	4.7	4.6	3.4	4.7	4.6
7	2	Female	12547	3.9	2.7	5.4	5.0	4.8	2.7	4.6	4.7

8	2	Female	12548	4.8	2.6	6.1	5.5	4.9	3.2	4.9	4.9
9	2	Female	12549	4.8	2.3	5.6	4.5	4.4	3.4	4.6	4.5
10	2	Female	12550	4.5	2.1	5.9	5.2	3.7	5.0	3.4	3.5
11	5	Female	12561	4.6	2.0	6.8	5.1	4.6	2.9	4.9	5.1
12	5	Female	12563	4.9	1.8	5.3	4.8	4.5	3.0	4.7	4.6
13	5	Female	12565	4.4	1.6	5.2	4.8	4.0	4.1	4.1	3.9
14	5	Female	12574	4.8	2.0	6.0	5.0	4.4	4.1	4.2	4.2
15	5	Castrate	12573	4.6	2.0	5.8	5.4	4.8	3.6	4.3	4.3
16	3	Female	12518	4.5	2.2	6.1	5.0	5.1	2.2	5.7	5.6
17	3	Female	12516	5.5	2.0	5.9	5.7	5.0	2.1	5.8	5.9
18	3	Female	12517	3.9	2.3	5.8	4.6	4.6	2.7	4.4	4.4
19	3	Female	12519	4.1	2.6	6.1	4.8	4.1	3.0	4.8	4.9
20	3	Female	12520	4.7	1.7	6.9	5.2	4.8	2.4	5.5	5.8
21	4	Female	12533	4.5	1.9	5.3	5.2	4.9	2.6	5.2	4.9
22	4	Female	12534	4.7	1.5	6.5	5.0	4.7	3.4	4.8	5.0
23	4	Female	12532	4.2	2.1	5.1	5.3	4.2	3.6	4.9	4.9
24	4	Female	12535	4.3	2.1	6.1	4.9	4.8	3.0	4.8	4.9
25	4	Female	12531	4.2	2.3	5.4	4.8	4.8	2.9	4.7	4.7
26	6	Female	12576	4.0	2.2	4.7	5.1	4.3	2.7	4.7	4.4
27	6	Female	12578	3.4	1.9	3.0	4.8	4.2	2.9	4.3	3.5
28	6	Female	12577	4.7	2.2	3.6	4.7	4.5	2.8	4.2	3.6
29	6	Female	12579	4.5	2.2	5.1	4.5	4.6	2.6	4.8	4.9
30	6	Female	12581	4.0	2.0	4.9	4.9	4.3	4.1	3.8	3.8
1	2	Castrate	12551	5.4	1.8	5.3	5.1	4.8	4.0	4.3	4.2
2	2	Castrate	12552	4.5	2.1	4.6	5.3	5.0	3.1	4.6	4.6
3	2	Castrate	12553	5.5	1.6	6.4	5.1	5.1	3.5	5.1	5.0
4	2	Castrate	12555	4.6	2.3	5.6	5.0	4.5	4.0	3.9	3.9
5	2	Castrate	12560	4.6	1.8	5.9	5.4	4.3	2.9	4.7	4.7
6	2	Castrate	12558	4.7	1.5	4.4	4.8	4.9	3.3	4.6	4.2
7	2	Castrate	12556	4.5	2.1	6.3	5.1	4.3	4.8	3.5	3.6
8	2	Castrate	12559	4.7	1.5	3.6	4.8	4.2	4.1	3.7	3.4
9	2	Castrate	12557	4.3	2.5	5.6	5.3	4.6	2.7	5.5	5.5
10	2	Castrate	12554	5.1	1.4	5.3	5.0	4.9	3.4	4.8	4.5
11	5	Castrate	12569	4.9	1.7	6.3	5.3	4.2	3.8	4.3	4.4
12	5	Castrate	12571	4.6	1.7	4.9	4.5	3.2	4.6	3.9	3.8
13	5	Castrate	12572	4.7	1.8	3.6	4.4	4.2	2.8	4.0	3.5
14	5	Castrate	12575	4.6	1.6	5.1	4.3	4.2	3.9	4.0	4.1
15	5	Castrate	12562	4.4	2.7	6.5	5.4	4.5	4.0	4.2	4.3
16	6	Castrate	12582	4.5	2.3	5.1	4.8	3.8	3.4	4.1	4.0
17	6	Castrate	12590	4.5	1.8	6.8	5.1	4.5	2.6	4.9	5.1

18	6	Castrate	12588	4.3	2.4	6.2	4.5	4.7	3.5	4.6	4.6
19	6	Castrate	12584	4.1	2.3	4.2	5.1	3.9	4.6	3.4	3.2
20	6	Female	12580	3.7	2.7	6.3	5.5	4.5	2.8	5.2	5.2
21	5	Castrate	12566	4.8	1.6	5.4	4.8	4.7	3.5	4.4	4.3
22	5	Castrate	12564	4.4	1.7	4.4	4.6	3.8	5.0	2.8	2.9
23	5	Castrate	12567	3.7	2.0	6.5	5.0	4.0	4.6	3.8	3.9
24	5	Castrate	12568	4.5	1.5	5.2	5.0	4.5	2.7	4.4	4.4
25	5	Castrate	12570	4.0	2.3	6.3	5.3	4.6	4.5	3.6	3.7
26	6	Castrate	12583	5.0	1.6	4.9	4.9	4.6	2.7	4.8	4.8
27	6	Castrate	12585	3.7	2.2	4.4	5.2	3.8	4.0	3.7	3.7
28	6	Castrate	12586	4.6	2.4	2.9	4.3	4.0	3.1	3.5	3.3
29	6	Castrate	12587	4.0	1.5	4.8	5.1	4.8	2.5	4.9	4.6
30	6	Castrate	12589	4.4	1.5	4.5	4.7	4.6	3.5	4.5	4.4