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The Effects of Terminal Sire Breed on Carcass Quality and Sensory Traits of Lamb

A final report to the Alberta Sheep and Wool Commission

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Canada

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INTRODUCTION

This experiment was conducted to compare the carcass and eating quality of crossbred lambs from Charollais, Suffolk, Texel, Canadian Arcott, and Ile de France sires bred to cross bred ewes, slaughtered at current market weights produced under Western Canadian conditions.

The efficiency of meat production is maximized by the use of terminal sire breeds to complement characteristics of crossbred ewes. To compete effectively, the industry needs to produce uniform, nutritious, lean lamb that satisfies the eating preferences of Canadian consumers. A major influence on carcass lean content is the sire breed that is used and there is a wide range of breeds in Canada, as well as an increasing number of new breeds imported from Europe.

Suffolk sheep are widely used in the Canadian sheep industry and have been included in many breed evaluations in the United Kingdom and United States. The other common terminal sire breeds in Canada include the Charollais, Canadian Arcott and Texel. The Ile de France sheep breed has recently been introduced into Canada from Europe and consequently, very little research has been gathered on this breed in North America.

Canada has a large number of sheep breeds, making it difficult for producers to know which ones will help them to produce lamb most profitably. This diversity also causes problems when lambs for a single market are sourced from flocks with widely varying growth rates and finishing characteristics. Most breeds of lambs in western Canada are properly finished at 50-52 kg (110-115 lb.) live weight (Agric. 2005). However, very large-framed lambs may not have enough fat cover at that weight, while small-framed lambs may be over finished at this same weight which may affect the consistency of quality lamb cuts.

Different terminal sire breeds may be suited to different production systems. To produce lamb carcasses to fixed level of fat cover, the larger breeds (eg. Suffolk and Ile de France cross) would be expected to produce heavier and older lambs than those of lighter sire breeds. In this study, lambs from the five terminal sire breeds were selected to be slaughtered within the range of 45-55 kg, (100-120 lb.) live weight so that each sire has equal numbers of lambs of each sex within this weight category (Graph 1).

PROCEDURES

Animals

Rams of five terminal sire breeds Suffolk (SUF), Charollais (CHR), Texel (TXL), Canadian Arcott (CAR) and Ile de France (IDF) were mated to the Lakeland College ewes to produce crossbred lambs. In total 142 lambs were utilized in this project, with approximately 30 lambs per ram breed (15 wethers and 15 ewe lambs) from five different terminal breeds. Using five rams per breed, each ram was bred to a minimum of six ewes, for the total of 30 or more lambs per sire breed. Several rams sired less than six progeny; therefore additional lambs were selected from the other sires within the respective breeds to obtain 30 lambs per breed. The Canadian Arcott and Ile de France rams sired a total of only 26 lambs each (Table 1). In breeds where there were more than 30 lambs, naturally raised lambs and lambs with a market weight less than 130 pounds were utilized.

Slaughter and Sample Collection

The premium weight range for carcasses at Sunterra Meats is 20–25 kg, (45-56 lb.), corresponding to live weights of approximately 45–55 kg (95-120 lb.). Over a period of seven weeks, lambs were weighed, selected for this weight range and transported to Sunterra Meats in Innisfail for slaughter. Data was collected on the carcass, including carcass weight, GR measurement, carcass conformation scores and cutability (weight of wholesale cuts from a carcass after trimming to a constant degree of fatness).

Following 24 hours of chilling, the carcasses were split and the short loin roasts (longissimus muscle) were deboned from the left side, 15 cm posterior from the 12^{th} thoracic. All loins were vacuum-packaged, placed on ice and transported in a cooler to the Lacombe Research Centre where they were aged 7 days in a 4^{o} C refrigerator, then frozen. In order to balance the taste panel model of 30 loin samples per breed, 8 loins were substituted from extra loins by gender from Suffolk and Charollais animals due to the fact there were missing animals in both the Canadian Arcott (4) and Ile de France (4) breed groups. All 150 frozen loin roast samples were sorted for the project and stored in a walk-in freezer at -25^{o} C for approximately 120 days. The assigned vacuum packaged loin samples were removed from the freezer and placed on trays to thaw at 4^{o} C in a refrigerator for 24 hours prior to panels.

Sensory Evaluation

On the day of evaluation, roast samples were removed from the refrigerator and the fat covering thickness was measured using an electronic digital caliper. Each loin roast was trimmed of fat and any external excess muscle down to the silver skin, then measured for length, width, depth, and weighed. Each loin was subjectively scored for muscle colour using photos from the American Lamb Council, Guide to Lamb Colour, (1=pink, 2=pale red, 3=cherry red, 4=slightly dark red, 5=moderately dark red, 6=extremely dark red). Marbling was subjectively evaluated using the beef marbling standard photos from the AMSA on a six point scale, (1=devoid, 2=trace, 3=slight, 4=small, 5=moderate, 6=abundant). The loins were placed silver skin down on a wire rack in an oval roasting pan (28 cm x 18 cm x 7 cm deep) and type T thermocouple probes were inserted diagonally into the thickest portion close to 2/3 of the length of each roast. The five assigned loin roasts, one roast per terminal sire, were placed into a preheated electric convection oven (Baker's Pride X-800) at 177° C in an assigned position for cooking. Cooking time and temperature rise was monitored every 5 seconds using a Hewlett Packard Data Acquisition Unit connected to a laptop computer. All roasts were cooked to an internal temperature of 71° C then removed from the oven and cooking time recorded. The probe was removed from the roast and the roast was allowed to cool for 3 to 4 minutes prior to weighing to calculate percent cooking loss.

In the order that the roasts were removed from the oven, they were then sub-sampled by being cut into five 1.9 cm slices from the posterior end. The remaining anterior loin section (approximately 5.5-6.0 cm long) was placed into a plastic bag and immersed in ice to cool for 20 minutes, subsequently refrigerated overnight for shear measurements. Each taste panel slice was cut into 1.9 x 1.9 cm cubes removing the bottom silver skin and outside edges with the top browning remaining. The eight most uniform cubes were then placed in pre-warmed glass jars in a six jar rack and covered with an assigned random three-digit coded aluminium lid and held in a 7^{o} C circulating water bath prior to serving. The samples were served to an experienced eight member sensory panel, screened and trained according to AMSA guidelines (AMSA, 1995). Each panellist placed their rack of sample jars into a Pyrex dish hot water bath provided in each booth, which maintained the samples at a constant temperature of 4^{o} C $\pm$ 3^{o} C.

The five samples for each panellist were presented in a design assigned in Compusense 5 release 4.6 software. Panellists rated their samples in well ventilated, partitioned booths, under red lighting. Panellists cleansed their palate between each sample with apple juice diluted 50% with filtered water, unsalted crackers and filtered room temperature water. Attribute ratings were electronically collected using eight-point descriptive scales for initial and overall tenderness (8=extremely tender; 1=extremely tough), juiciness (8=extremely juicy; 1=extremely dry), lamb flavour intensity (8=extremely intense lamb flavour; 1=extremely bland lamb flavour), off flavour intensity (8=extremely bland or none, 1=extremely intense off flavour). Flavour desirability and overall palatability were rated on an eight point hedonic scale, (8=extremely desirable; 1=extremely undesirable).

Initial tenderness was rated on the first bite through the cut surface with the incisors, juiciness was rated after eight chews with the molars, flavour desirability was evaluated after 10 to 15 chews, lamb flavour and off flavour intensity between 10 to 20 chews and overall tenderness after 25 chews. At the end of each ballot, all panellists had the opportunity to comment on any off flavours or texture characteristics that were found in the samples. At each panel session, panellists rated five samples, one from each breed, for the total of four sessions a day over a three week period.

Shear Measurement

Following twenty four hours refrigeration, the shear section of the loin was cut in half and the sides and silver skin were removed to facilitate muscle fibre orientation. Using a 1.27 cm diameter borer, four cores were removed parallel to the muscle fibres. The three most uniform cores were selected and sheared with the Instron 4301 Material Testing System equipped with a Warner-Bratzler cell and Series 9 Software (Instron Canada, Burlington ON). Each core was sheared once perpendicular to the fibre grain and the mean of the three cores was used to determine peak shear force in kg/cm^2.

Statistical Analysis

Shear measurements, loin dimensions, cooking and sensory data on 142 lambs were analyzed by Mixed-model analysis (SAS Institute, Inc., 2001) to examine the fixed effects of breed of sire and sex of the lamb, with hot carcass weight as a covariate.

Results

Progeny of the Texel (TXL) and Canadian Arcott (CAR) had the lowest shear values ($P < 0.05$) and the highest trained sensory panel ratings for initial and overall tenderness although the panel ratings were not significantly different ($P > 0.05$) from the other breeds (Table 2). The progeny of the Charollais (CHR) and Suffolk (SUF) rams had the highest shear values ($P < 0.05$) and the lowest numerical sensory panel ratings for initial and overall tenderness ratings. All of the loin samples had shear force values less than 5 kg (Graph 2), which is regarded as tender by consumers (Shorthose et al. 1986). The taste panel evaluated six lambs out of the 142 (4.23%) as Slightly Tough in Overall Tenderness (Graph 3). All six of these lambs had shear values of less than 3.75 kg. The relationship between shear values and the taste panellist scores for both initial and overall tenderness was moderate ($r = -0.63$; $P = 0.0001$).

The overall cooking time for the Texel progeny were marginally longer ($P < 0.05$) than the progeny of the other sires (Graph 4), which was not attributable to gross differences in shape dimensions. This slight increase in cooking time may be related to muscle fibre type or moisture content, analysis which were not measured in the present study.

The length of the short loins of the Texel progeny were slightly shorter ($P < 0.05$) than that of the other lamb breeds. Measurements for loin thickness and depth were related to hot carcass weight and not to breed or gender effects (Table 2). The fat thickness measurement on the loins from the Suffolk lambs were significantly less ($P < 0.05$) than the other sired lambs and the Charollais lambs the greatest, although on several of the loins fat the surface was cut or partially removed making the accuracy of this measurement questionable (Table 2). The GR measurement and the fat thickness measurement had a positive correlation ($r = 0.22$; $P = 0.007$).

There were no significant differences between breeds or genders for lamb flavour intensity, off flavour, juiciness or overall palatability ratings (Table 3). This is in agreement with other authors (Crouse et al. 1983; Dransfield et al. 1979; Ellis et al. 1997) that differences in lamb flavour or eating quality due to breed of sire were not observed. Also differences in flavour intensity due to gender were not observed ($P > 0.05$) which supports reports by Jeremiah et al. 1998; and Ellis et al. 1997.

Although numerically small, the only significant difference ($P = 0.04$) by gender was on the subjective colour attribute of the loin muscle prior to roasting, with means of 3.77 for the ewe lambs and 3.54 for the wether (Table 2). This small difference would likely not be noticeable to consumers as it is less than one full unit in difference. A slightly higher ($P = 0.18$) proportion of the loins from the ewe lambs were rated as Slightly Dark Red compared to the wether lambs (62 vs 53% respectively; Graph 5).

CONCLUSION

Based on the results of this study there are no differences in eating quality by gender or amongst progeny from these five terminal sires within the hot carcass weight range of 22–27 kg (50–60 lb). Certain terminal sire breeds may be suited to different production systems for such traits as rate of gain, carcass weight, and level of fat cover without detriment to sensory traits. However, the trend towards even larger leaner carcasses continues, more research will be required to determine its effect on lamb eating quality.

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Table 1. Means (S.D.) live and hot carcass weights in pounds

Sire Breed	No. Lambs	Live Weight (S.D.)	Hot Carcass Weight (S.D.)
CAR	26	112.8 (8.9)	55.3 (6.4)
CHR	30	112.2 (5.3)	58.2 (4.0)
IDF	26	113.1 (4.8)	58.6 (5.0)
SUF	30	114.8 (6.6)	57.3 (5.3)
TXL	30	112.8 (5.5)	58.2 (5.2)

Table. Least-square means for loin composition traits

	Sire Breed					Sex	
	CAR	CHR	IDF	SUF	TXL	Female	Male
No. of Lambs	26	30	26	30	30	78	64
Fat	0.45 abc	0.51 a	0.40 bc	0.38 c	0.47 ab	0.45	0.44
Depth	2.45	2.43	2.57	2.34	2.39	2.45	2.48
Width	6.36	6.55	6.55	6.38	6.48	6.42	6.52
Length	21.00 a	21.14 a	20.78 a	21.45 a	19.70 b	20.62	21.01
Color	3.71	3.67	3.67	3.63	3.60	3.77 a	3.54 b
Marbling	3.84	3.83	4.40	3.91	3.99	3.96	4.09
Cook Loss	16.46	17.88	17.42	17.79	18.27	17.12	18.00
Seconds per gram	4.87 b	4.88 b	4.80 b	4.86 b	5.36 a	4.96	4.95
Shear Force (cm^2)	2.09 b	2.62 a	2.33 ab	2.47 a	2.08 b	2.30	2.34

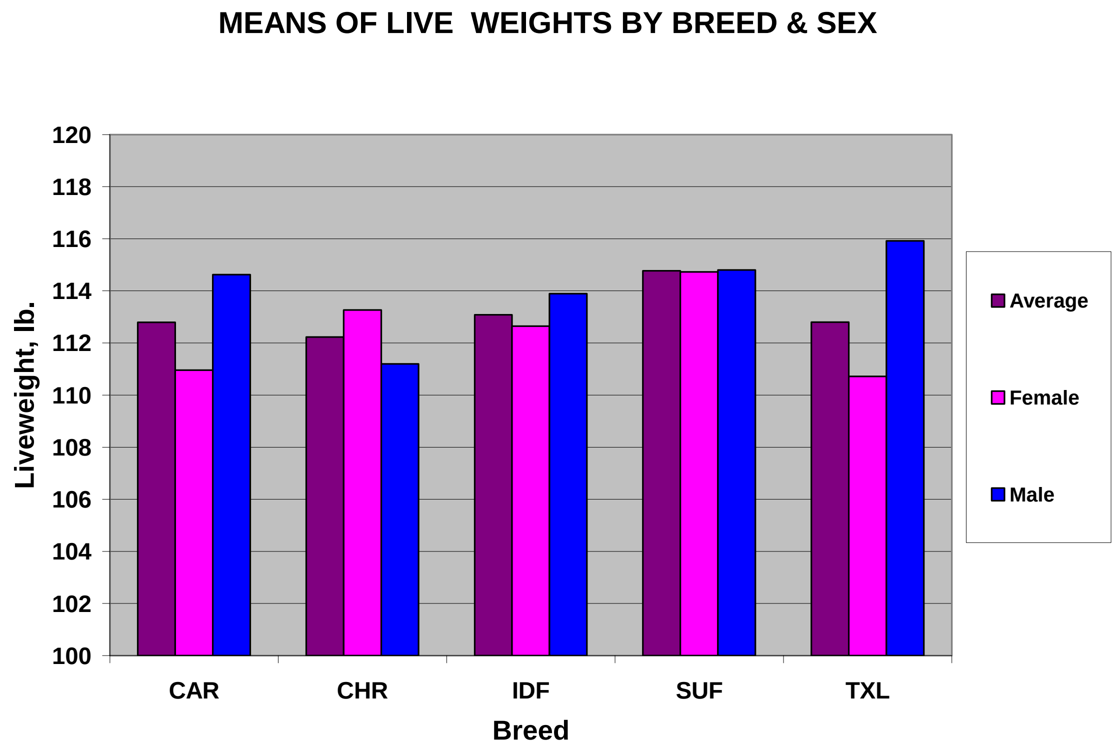
a,b,c Means in the same row, within trait, with different letters differ ($P < 0.05$).

TABLE 3: Least-square means for sire effects for taste panel attribute evaluation

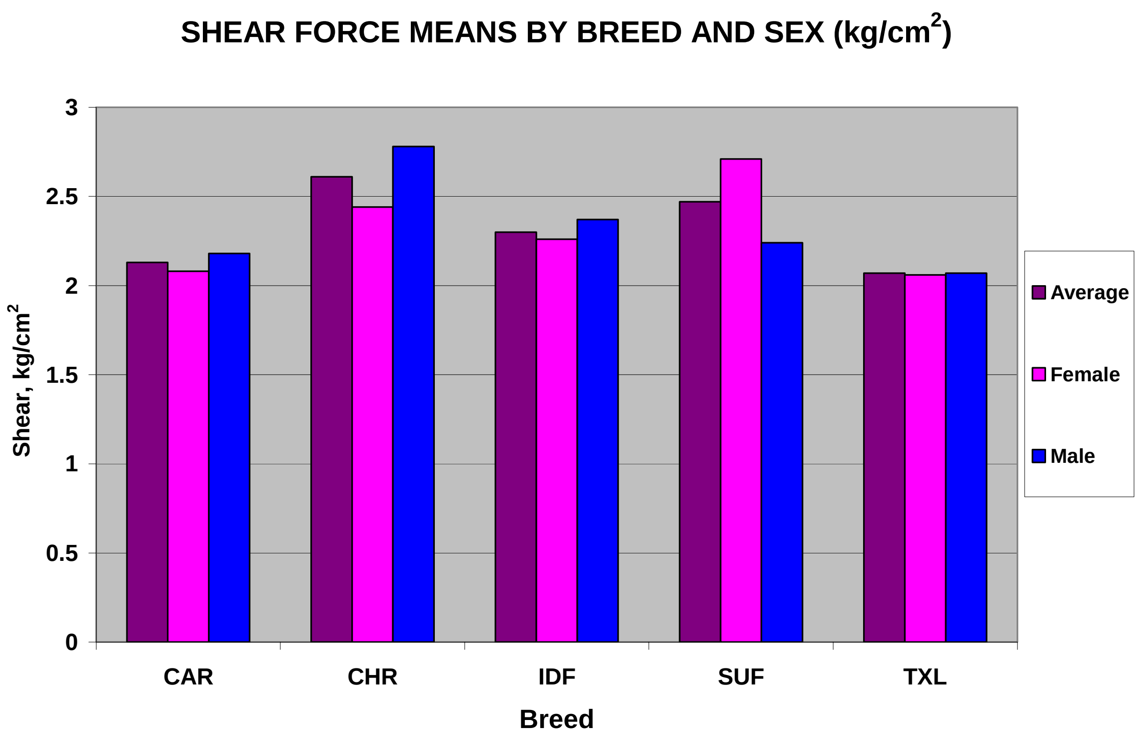
	Sire Breed					Sex	
	CAR	CHR	IDF	SUF	TXL	Female	Male
No. of Lambs	26	30	26	30	30	78	64
Initial Tenderness	6.04	5.82	5.95	5.81	6.20	6.02	5.91
Juiciness	5.38	5.40	5.64	5.41	5.50	5.43	5.51
Flavour Desirability	4.88	4.90	4.89	4.88	5.01	4.96	4.87
Lamb Flavour Intensity	4.77	4.71	4.85	4.78	4.79	4.74	4.90
Off Flavour	6.63	6.66	6.66	6.72	6.77	6.70	6.68
Overall Tenderness	6.06	5.75	6.10	5.84	6.18	6.00	5.97
Overall Palatability	4.45	4.40	4.40	4.44	4.55	4.49	4.41

NOTE: No significant differences in sensory panel attributes were found amongst breed, sires or sex.

Graph 1.

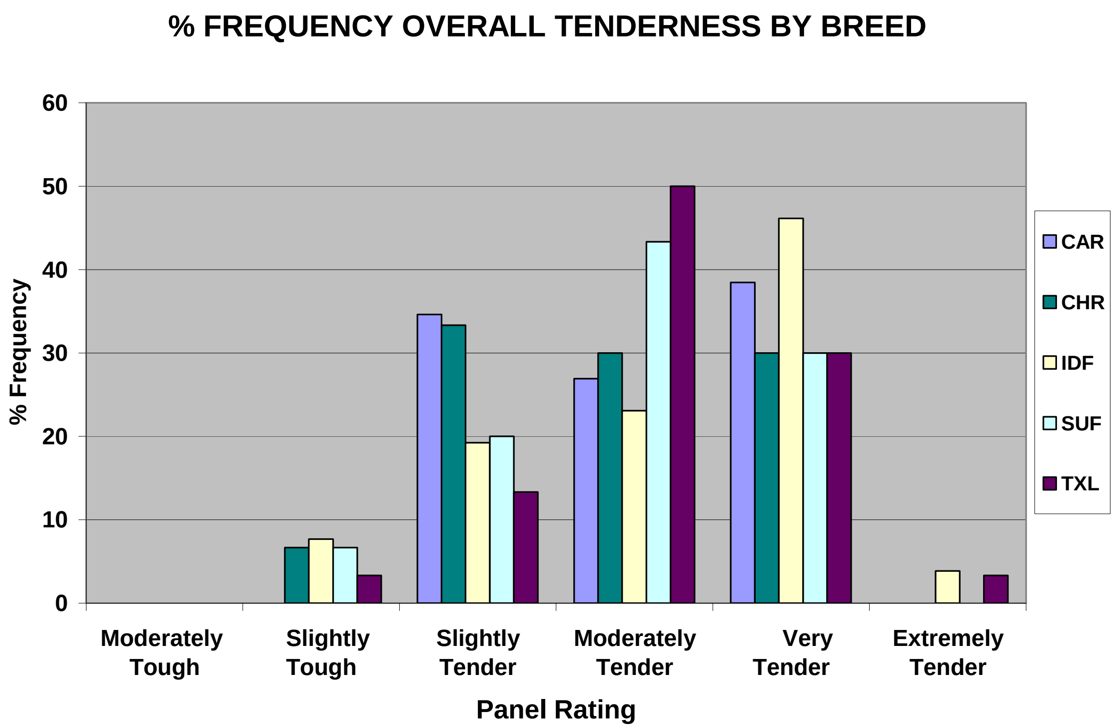

MEANS OF LIVE WEIGHTS BY BREED & SEX
120
118
116
114
112
110
108
106
104
102
100
Liveweight, lb.
CAR
CHR
IDF
SUF
TXL
Breed
Average
Female
Male

Graph 2.

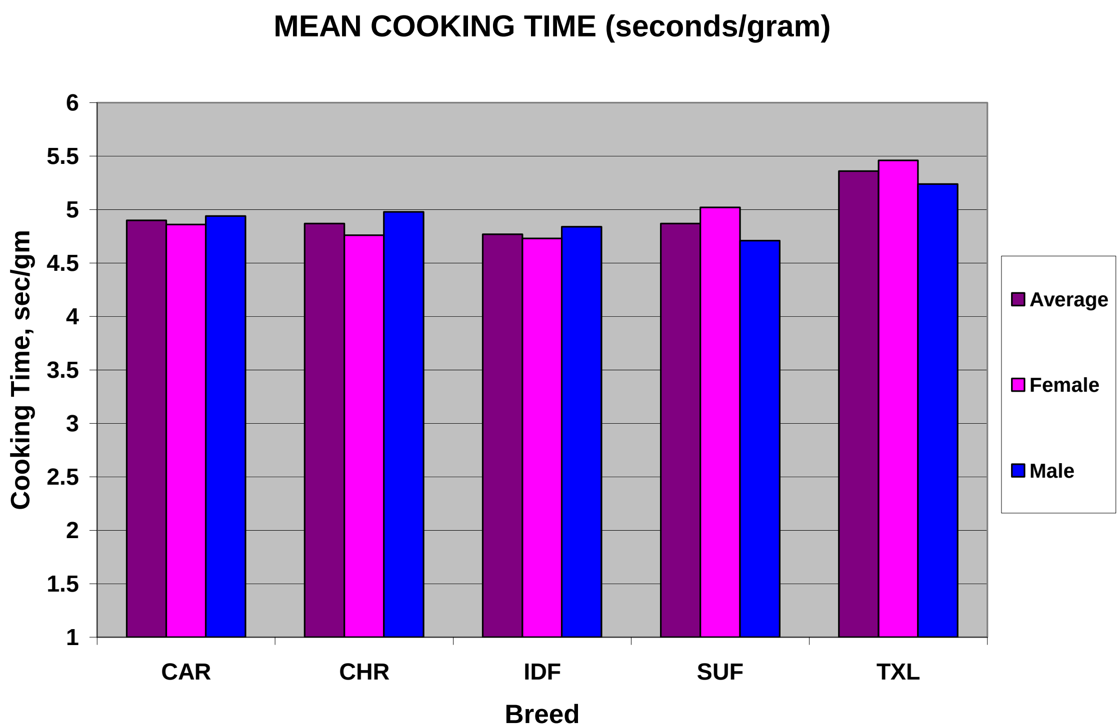


SHEAR FORCE MEANS BY BREED AND SEX (kg/cm2)
3
2.5
2
1.5
1
0.5
0
Shear, kg/cm2
CAR
CHR
IDF
SUF
TXL
Breed
Average
Female
Male

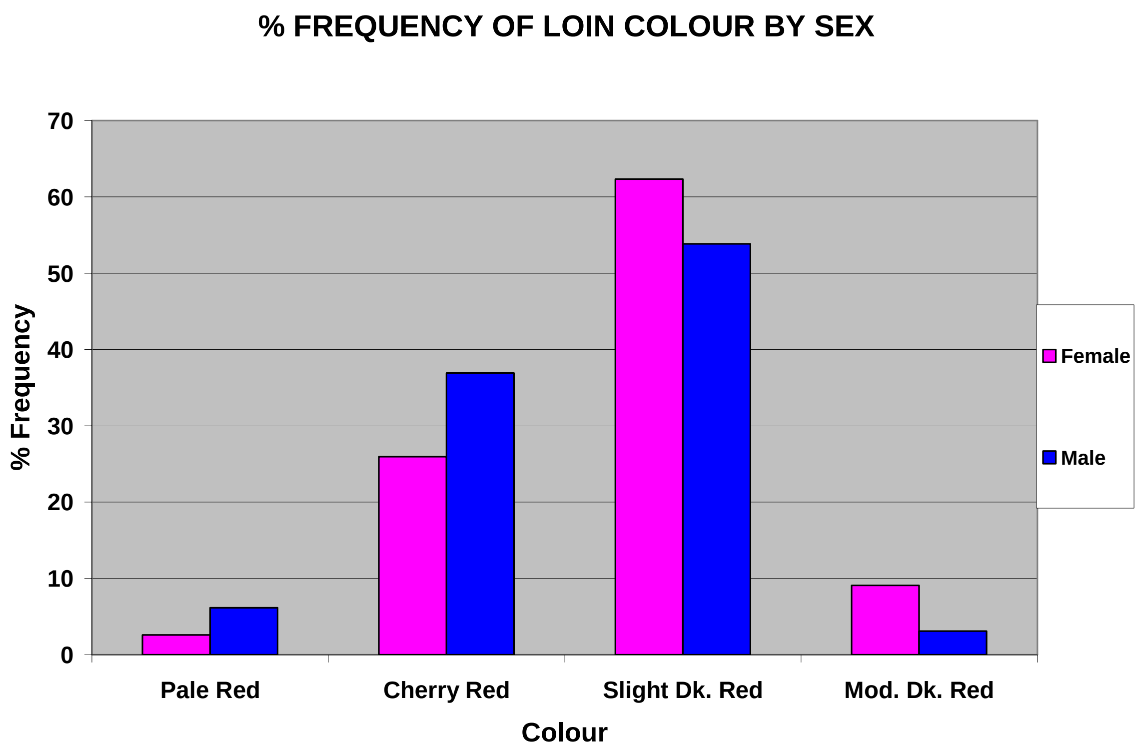
Graph 3.


% FREQUENCY OVERALL TENDERNESS BY BREED
60
50
40
30
20
10
0
% Frequency
CAR
CHR
IDF
SUF
TXL
Moderately Tough
Slightly Tough
Slightly Tender
Moderately Tender
Very Tender
Extremely Tender
Panel Rating

Graph 4.


MEAN COOKING TIME (seconds/gram)
Cooking Time, sec/gm
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
CAR
CHR
IDF
SUF
TXL
Breed
Average
Female
Male

Graph 5.



% FREQUENCY OF LOIN COLOUR BY SEX
70
60
50
40
30
20
10
0
% Frequency
Female
Male
Pale Red
Cherry Red
Slight Dk. Red
Mod. Dk. Red
Colour