## DEVELOPMENT OF A QUALITY CLASSIFICATION SYSTEM FOR LAMB CARCASSES

#### L.E. JEREMIAH

Agriculture and Agri-Food Canada Research Centre 6000 C & E Trail, Lacombe, Alberta, Canada T4L 1W1

#### BACKGROUND

Canadian lamb grading standards existing at the time of this study (Agriculture Canada, 1978) were based soley upon measures of carcass weight, length, and fatness and utilized the presence of spooljoints to segregate lamb from mutton. Consequently, grading standards were based neither upon expected palatability nor consumer acceptance, and to date, studies have not been conducted and reported, which compare Canadian lamb carcass grades for palatability and consumer acceptance. Therefore, the present study was designed to develop a quality classification system for lamb carcasses based upon consumer acceptance.

### MATERIALS AND METHODS

A total of 1660 commercial lambs were selected on the basis of age, slaughter weight, gender and fatness to fill specific subclasses (Jeremiah et al., 1997) and to provide a meaningful representative sample of the entire range of lambs currently being marketed in Canada. These lambs were purchased from commercial sheep producers with breeding records and certified birthdates, so that both the breeding and chronological ages could be ascertained. The lambs were predominantly crossbreds, involving some combination of the following breeds: Cheviot, Columbia, Dorset, Finnish, Landrace, Hampshire, Leicester, Montadale, Ranbouillet, Romanoff, Romney, Shropshire, Southdown, Suffolk, Targhee, and/or Texel. Breeds and breed crosses were allocated as evenly as possible among age/weight/gender subclasses and care was taken to prevent a given breed or breed-cross from constituting a majority in any given age/weight/gender subclass. Fatness and gender were ascertained the day prior to slaughter. Fatness was ascertained both subjectively by a trained and experienced evaluator and ultrasonically, and the same fatness criteria were applied to all age/slaughter weight/gender subclasses. Breed composition necessarily varied among age/slaughter weight subclasses, but was relatively constant with subclasses. Since the lambs were purchased from different producers, it is possible they were fed differently and it is possible this may have influenced compositional and quality properties. The actual frequency distribution of lambs evaluated was previously presented by age, weight, gender, and fatness subclass (Jeremiah et al., 1997). All lambs were transported and slaughtered under simulated commercial conditions. Prior to slaughter (approximately 20 hours) lambs were given a subjective fatness score by a trained and experienced evaluator (1 = lean, 3 = fat). Chronological age, gender, and dentition score (1 = 0 to 4 teeth cut, 5 = two temporary incisors replaced) were also recorded. Immediately before slaughter liveweight was recorded and immediately after slaughter the warm carcass was weighed, and the left side of each carcass was probed at the following anatomical sites using a Hennessy lamb grading probe: between the tenth and eleventh and between the twelfth and thirteenth thoracic vertebra four and eleven centimeters off the midline, and four centimeters off the midline at the second and fifth lumbar vertebra. Measurements of fat, lean, and total tissue depth were taken at each of these locations, and these measurements were repeated 24 hours later on the left side of the cold carcass. All warm carcasses were subjectively scored for fat cover uniformity (1 = devoid of fat cover, 5 = complete fat cover) and conformation (1 = very thin muscling, 5 = very thick muscling). After chilling for 24 h at 1°C (±1°C), all carcasses were subjectively and objectively evaluated. Subjective fat thickness at the twelfth thoracic vertebrae (4 cm from the midline) was subjectively estimated and then measured using a ruler. Carcass muscling was estimated by an experienced evaluator using a 5-point descriptive scale (1 = very thin, 5 = very thick), subcutaneous fat cover colour (1 = white, 5 = yellow) and uniformity (1 = devoid of fat cover, 5 = complete fat cover) were also assessed on the cold carcass. The number of break and spool joints on the front legs of each carcass was recorded and the breakjoints were subjectively evaluated for colour and moistness (1 = very red and moist, 4 = white and dry). In addition, the shape (1 = round, 2 = oval, 3 = flat) and colour (1 = red, 4 = white) of the ribs were subjectively evaluated. Transmission of light through the ribcage was also subjectively scored (1 = opaque, 5 = translucent). Flank firmness (1 = soft, 5 = very firm), streaking (1 = devoid, 6 = abundant), and colour (1 = red, 4 = white) were also subjectively evaluated, as was the amount of feathering between the ribs (1 = devoid, 6 = 1)abundant). Carcass grades were assigned by an Agriculture Canada grader in accordance with Canadian lamb carcass grading standards (Agriculture Canada, 1978). Carcasses were then split and the amount of sacral ossification (1 = no ossification, 5 = complete ossification) was determined. The left side of each carcass was then separated between the twelfth and thirteenth thoracic vertebra and subcutaneous fat thickness, body wall thickness, and width, depth and area of the longissimus muscle was measured. Hunter "L", "a", and "b" values for the longissimus muscle were also obtained using the Macbeth Series 1500 color measuring system (Macbeth, Newbergh, N.Y., U.S.A.). The lean tissue from the left side of each carcass was pooled, ground twice through a 3 mm plate and subsampled for determination of moisture, fat, and protein, using procedures previously described (Murray et al. 1989). Percent transmission and expressible juice were also determined using procedures previously outlined (Murray et al. 1989), with the exception that the 20 g subsamples of ground carcass lean were centrifuged at 37 000 x g for 60 minutes, rather than for 15 minutes. A total of 3320 lamb leg roasts (1660 shank and 1660 butt) were distributed to lamb consuming households in 21 central Alberta regions for the consumer evaluation of acceptability of flavour, juiciness, tenderness, and overall eating satisfaction. A total of 1528 and 1529 responses were obtained for shank and butt leg roasts, respectively. It was the intent that households participating in the study be at least occasional lamb consumers, and 96.5 and 95.8% of the respondents receiving shank and butt roasts, respectively, had consumed lamb previously. However, 92.4 and 91.5% of the respondents receiving shank and butt roasts, respectively, were infrequent consumers of lamb (2-3 times per month or less). Consuming households were instructed to prepare the roasts they received at the same time using the method they normally employed to prepare lamb leg roasts, but to record the cooking method and time employed, and the degree of doneness at the point of consumption. The vast majority of respondents cooked their roasts by oven roasting after thawing (83.3%) and most respondents cooked their roasts for 60 to 120 minutes (56.9%) and to a medium to well done degree of doneness (90.9%). Following preparation each household was asked to reach a consensus rating for the acceptability of flavour, juiciness, tenderness and overall palatability using a 5-point scale (1 = dislike extremely, 5 = like extremely).

## RESULTS AND DISCUSSION

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A total of 39 carcass parameters were regressed on consumer ratings of the acceptability of overall palatability of shank and butt leg  $r_{0asts}$  using regression analysis to examine potential relationships. The only traits which were significantly (P<0.05) related to consumer acceptance of shank roasts were: fat cover score (r=0.08), subjective fat thickness (r=0.07), objective fat thickness (r=0.07), objective fat thickness (=0.06), flank firmness score (r=0.06), carcass grade (r=0.07), and mean loin-eye area (r=0.05), and the only traits which were significantly for the state of t significantly (P<0.05) related to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.06), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.07), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.07), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), conformation score (r=0.07), subject to consumer acceptance of butt roasts were: fat cover score (r=0.07), subject to cover score (r= subjective fat thickness (r=0.06), objective fat thickness (r=0.08), fat cover uniformity score (r=0.10), fat colour score (r=0.11), rib <sup>colour</sup> score (r=0.06), objective rat thickness (r=0.06), rat cover uniformity score (r=0.10), flank streaking score (r=0.06), ribcage light transmission (r=0.10), flank firmness score (r=0.01), flank streaking score (r=0.06), ribcage (r=0.06)feathering score (r=0.05), muscling score (r=0.06), carcass grade (r=0.10), fat thickness (r=0.04), body wall thickness (r=0.07), hot  $10/11 \times 10^{-10}$  Based on the fact certain of these traits measure the 10/11 rib fat thickness (r=0.05), and cold fifth lumbar fat thickness (r=0.08). Based on the fact certain of these traits measure the same restriction of the second provide the same restriction of the second provide the same parameters and the strength of the relationships of these traits to other palatability and acceptability ratings, twelve traits were selected for use in an attempt to predict consumer acceptance. The twelve traits selected were: subjective fat thickness, fat cover miformity score, hot carcass weight, flank firmness score, flank streaking score, fat colour score, ribcage light transmission, rib colour score, hot carcass weight, flank firmness score, flank streaking score, flank colour score, flank colour score, marbling score, rib flatness score, and ribcage feathering score. Even when all twelve of these traiters in the accentability of overall shank roast Tails were utilized in a prediction equation, they accounted for only 1% of the variation in the acceptability of overall shank roast palatakity. Palatability, and only 2% of the variation in the acceptability of overall butt roast palatability. Therefore, the futility of attempting to obtain a meaningful prediction of consumer acceptance, based upon carcass parameters, became evident. The role of fatness in lamb amb quality and its relationship to palatability is not completely understood and remains controversial at the present time. However, research findings to date indicate any relationship existing between fatness and palatability is low in magnitude. Consequently, it would appear lamb carcasses could be segregated into cutability groups, without also segregating them according to product desirability, based upon palatability.

Although none of the indicators of physiological maturity were highly related to consumer ratings of the acceptability of overall leg <sup>roash</sup> none of the indicators of physiological maturity were mgnly related to consumer family documented. Consequently, it <sup>would</sup> would be the difference in eating quality between lamb and mutton has been thoroughly documented. Consequently, it <sup>would</sup> <sup>appear</sup> prudent some indicator of physiological maturity should be included in any grading or classification system to distinguishing appear prudent some indicator of physiological maturity should be included in any grading or classification system to distinguish lamb from mutton. The only maturity indicator evaluated, which was not significantly related (P>0.05) to chronological age was breakjoint score (Table 3). The two traits most highly related to chronological age were sacral ossification score and rib colour score. However, lamb carcasses are not usually split in commercial practice. Therefore, it would be very difficult, if not impossible, to utilize sacral ossification as a maturity indicator for grading or classification purposes. In addition, the colour score only encompassed the range from red to white within the expectations for lamb. Consequently, it could not be effective. effectively utilized to distinguish lamb from mutton. On the other hand, sheep continue to lose their temporary teeth and to have them replaced with permanent teeth. Therefore, dentition score would appear to be well suited as a technique to distinguish lamb <sup>a inutton.</sup> However, since the consumer acceptability of leg roasts from failed with domain beyond a dentition score of 5 (2 <sup>better</sup>), it would appear prudent to make the endpoint for distinguishing lamb from mutton beyond a dentition score of 5 (2) Permanent incisors) so that sheep with no more than two permanent incisors are classified as lamb, while those with more than two Permanent incisors) so that sheep with no more than two permanent incisors are classified as mutton. Both breakjoint colour score and bib colour incisors or those that have lost their third temporary incisor are classified as mutton. Both breakjoint colour score and the colour score were significantly related to the proportion of leg roasts which were rated unacceptable in overall palatability by construction of leg roasts which were rated unacceptable in overall palatability by <sup>consumers</sup> (P<0.05 and P<0.01, respectively). There was a lower incidence of roasts from lambs with breakjoint and rib colour  $s_{corres}^{corres}$  of 1 rated unacceptable (4.90 and 4.65% respectively) than when they were from lambs with higher breakjoint and rib colour scores of 4 (11.43) <sup>sc</sup>ores. Likewise, there was a higher incidence of unacceptable roasts from lamb with breakjoint and rib colour scores of 4 (11.43 and 7.746 and 7.74% respectively) than when they were from lambs with lower breakjoint and rib colour scores. In addition, lamb with flat  $\frac{1}{10}$  (tib flatness score 3) produced a higher incidence of unacceptable leg roasts (8.61%) than those with round and oval shaped the flatness score 3) produced a higher incidence of unacceptable leg roasts (8.61%) than those with round and oval shaped the flatness score 3) produced a higher incidence of unacceptable leg roasts (0.0170) that these three the second appear prudent for a statistic flatness scores 1 and 2; 6.23 and 5.75% respectively). Consequently, based upon these facts, it would appear prudent for a statistic flatness scores 1 and 2; 6.23 and 5.75% respectively). Brading or classification system to segregate carcasses into three quality groups, based upon these facts, it is colour and rib colour and factors of classification system to segregate carcasses into three quality groups, based upon breakjoint colour and rib colour and factors of classification system to segregate carcasses into three quality groups, based upon breakjoint colour and rib colour and factors of classification system to segregate carcasses into three quality groups, based upon breakjoint colour and rib colour and factors of classification system to segregate carcasses into three quality groups, based upon breakjoint colour and rib colour and rib colour and reak the classification system to segregate carcasses into three quality groups, based upon breakjoint colour and rib colour and reak the classification system to segregate carcasses into three quality groups, based upon breakjoint colour and rib colour and reak the classification system to segregate carcasses into the classification system Nathess scores, as follows: Group 1 possessing very red and moist breakjoints and round, red ribs, Group 2 possessing slightly red to be the red or have traces of red, and Group 3 possessing white and dry to red breakjoints and oval shaped ribs, which are either slightly red or have traces of red, and Group 3 possessing white and dry breakjoints and flat, white ribs.

## CONCLUSIONS

Lamb should be defined as carcasses from ovines weighing 32 kg live or more, and with no more than two (2) permanent incisors. Mutton should be defined as carcasses from ovines weighing 32 kg live of more, and with no more than two (2) permanent incisors or carcasses from ovines that have lost the defined as carcasses from ovines that have lost the <sup>1</sup> their third temporary incisor. Milk-fed lamb should be defined as carcasses from ovines weighing less than 32 kg live. Consequently, classification recommendations arising from the present study apply only to carcasses from ovines defined as lamb, acoust according to the previous definitions. Lamb carcasses so defined can be effectively segregated into three (3) quality groups based upon expected consumer acceptance, by utilizing simple, subjective evaluations of the breakjoints and ribs, as follows: Group 1 possessing very red and moist breakjoints and round, red ribs, Group 2 possessing slightly red to red breakjoints and oval shaped the which are either slightly red or have traces of red colour, and Group 2 possessing singular to the the traces and flat, white ribs. Qlassification of lamb carcasses on this basis will allow compensation to producers based upon carcass merit, reflecting consumer acceptance.

# REFERENCES

Agriculture Canada (1978). Canada Gazette 112 (part 2, no. 22), 4221.

<sup>Autre</sup> Canada (1978). Canada Gazette 112 (part 2, 10, 22), 7221. <sup>Autre</sup> Canada (1978). Canada Gazette 112 (part 2, 10, 22), 7221. <sup>Autre</sup> Canada (1978). SID Sheep Goat Res. J. (in press).