## 4:14 Relationship between fat content and sensory scores for palatability of beef

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Canadian consumers have become increasingly conscious of the fat content of red meats and the health implications of a diet high in fat. The Canadian beef grading system was revised to adjust for the desire for a lower fat content in beef expressed by consumers (Canada's New Beef Grading System, 1972). The contribution of fat to the palatability of Canadian beef is still unclear. Hawrysh and Berg (1976) found that although fat cover at the rib-eye and marbling varied between different youthful Canadian grades the palatability scores did not. Hawrysh et. al., (1975) found maturity and marbling to significantly affect flavour scores for ST roasts whereas Breidenstein et. al., (1968) found marbling but not maturity to affect palatability scores for ST steaks.

This study examined the relationship between fat content and sensory scores for tenderness, juiciness and flavour, and between fat content and cooking losses.

### Materials and Methods

Data for this study were collected from three trials which were conducted from 1980 to 1983. Each trial consisted of approximately 20 small rotational crossbreeds, 20 large rotational crossbreeds and 20 Holsteins, assigned to either a concentrate or forage diet ad-libitum as described by Jones et. al., (1984). Animals were scanned ultrasonically and slaughtered over a wide range of fatness (0-15 mm fat thickness at 11/12 ribs). Carcass fat (physically separated adipose tissue) was obtained from the left of the carcass. Grade classification and marbling scores were determined according to Canadian criteria and standards at 24 h after slaughter. Longissimus dorsi (LD) and semitendinosus (ST) roasts were removed from the right side of the carcass at 24 h aged for 7 days at 20°C, vacuum packed and frozen at -18°C until time of testing.

Roasts were defrosted at refrigeration temperature at time of testing. Cooking was assigned according to a randomized block design. Roasts were cooked uncovered at 160°C to an internal temperature of 65°C. Cooked roasts were allowed to stand two hours before testing during which the internal temperature rose to 69°C. Sensory evaluation consisted of eight member trained panels evaluating 1.2 cm cube samples using a 15 cm unstructured scale with intensity anchor points for tenderness, juiciness and flavour and criteria described by Gullett et. al., (in press). Training for intensity of beef flavour was done with samples of beef broth. Tenderness and juiciness training consisted of providing samples varying in intensity of these attributes. Panelists were selected on their ability to discriminate between samples of meat and consistency in scoring duplicates. Samples were presented to panelists in a random order and evaluation took place under red lighting to mask any colour differences between samples.

Cooking losses were determined as evaporation, drip and total (evaporation plus drip) calculated as the percent of the original weight of the roast. Muscle fat (lipid content of the muscle tissue) was determined for samples taken adjacent to the area used for sensory evaluation and roast fat (lipid content of whole commercially trimmed roast) from samples removed from the remainder of the cooked roast as described by Gullett et. al., (under review). Press fluid was determined following the method of Sanderson et.al., (1963).

Statistical analysis consisted of analyses of variance for effect of Grade and marbling scores. Tukey-Kramer test was used to determine significance between means (Staline, 1981). Partial correlations were calculated from error sums of squares and products matrix for panel means, sensory scores, carcass fat means, muscle fat means, and roast fat means to examine relationships between fat content and sensory scores. Statistical Analysis System (SAS) was employed for the statistical analysis (Helwig and Council, 1979).

### Results and Discussion

The grade distribution and distribution of marbling scores for animals in the three trials is shown in Table 1. A majority of the animals were graded A1 and A2 and received marbling scores of 5 and 6 representing small to modest amounts of marbling representative of the meat used for the retail trade in Canada. Analysis of variance showed grade and marbling scores were most related to carcass fat ($P<0.001$). In Trials 1 and 3, the group representing marbling scores of moderate to abundant marbling contained significantly more carcass fat than the three other groups. In Trial 2 the group scored slight to devoid of marbling was significantly lower in carcass fat content (Table 2 and 3). Animals grading A1 and A2 contained significantly ($P<0.05$) more carcass fat than those grading C1 and C2 but not always more than those grading B1.

Muscle and roast fat content for LD roasts was more affected by grade and marbling scores than those for ST roasts and these effects were not consistent between the three trials (Tables 2 and 3). Muscle fat content for LD roasts from animals scored modest to abundant marbling was greater than from animals receiving lower marbling scores in Trials 1 and 3. In Trial 2 only the two extreme marbling groups were significantly different in fat content. Data presented in Tables 2 and 3 suggested that the 10 point visual marbling scale is finer than is practable on the basis of fat content. Although fat content (carcass, muscle and roast) differed between animals graded A and C and between higher and low marbling scores only one significant correlation was obtained between carcass fat and either roast or muscle fat suggesting that any relationship is lost in the trimming process (Tables 4 and 5). In spite of this, significant partial correlations were obtained between carcass fat content and flavour scores for LD roasts in Trials 1 and 3 (Table 4). Analysis of variance also showed a significant effect for marbling on flavour for Trials 1 and 3 (Table 2). LD roasts from Grade A animals exhibited significantly more intense meaty flavour than lower grades. No significant effects were obtained for ST roasts. In Trial 1 carcass fat was also significantly correlated with tenderness and juiciness for LD roasts but not for ST roasts (Tables 4 and 5).

Muscle fat and roast fat for LD roasts was more related to drip loss during cooking. There was little relationship for ST roasts. In Trial 2 roast fat of LD roasts was significantly correlated with juiciness scores (Table 4). As expected moisture content was negatively correlated with fat content ($P<0.001$). Evaporation loss was negatively correlated with percent press fluid ($P<0.05$) for both LD and ST roasts and positively correlated with juiciness scores for LD roasts in Trial 3 and ST roasts in Trial 2. Significant correlations were obtained between flavour scores and juiciness scores (Tables 4 and 5) suggesting that even a trained panel does not completely separate these two sensory parameters possibly because more juicy meat allows better detection of meat flavour by the taste receptors. The relationship between carcass fat content and flavour in LD muscle combined with the relationship between flavour and juiciness scores might account for the belief that fat contributes to juiciness even though there was little direct relationship observed here. The relationship between carcass fat and flavour observed here could be an effect of age as reflected by increased body size, or it may reflect contributions made by components of the adipose tissue such as fatty acid composition. If it were stricly an age effect, it would be expected to affect both the LD and ST roasts whereas the effect as observed here was on the higher fat content LD roasts.

Hawrysh and Berg (1976) observed little difference in sensory scores for LD and ST roasts from animals grading A1 to A4, although fat coverage over the rib-eye and degree of marbling were significantly different ($P<0.01$). However when maturity was a factor as well as degree of marbling significantly higher flavour scores were obtained for the mature marbled ST roasts but not for the LD roasts (Hawrysh et.al., 1975). Breidenstein et. al., (1968) reported flavour score for ST steaks were significantly influenced by marbling but not by maturity. While this study found that a significant correlation existed between carcass fat and flavour scores, fat content of the muscle and the roast did not. Grade and marbling scores in this study were more related to muscle and roast fat in the LD roasts than the ST roasts, as was carcass fat with flavour.

### References

Breidenstein, B.B., Cooper, C.C., Cassens, R.G., Evans, G. and Bray, R.W. 1968. Influence of marbling and maturity on the palatability of beef muscle. 1. Chemical and organoleptic considerations. J. Anim. Sci. 27:1532.

Canada's New Beef Grading Systems, 1972. Mimeographed report. Can. Dep. Agric., Can. Cattlemen's Assoc., Can. Fed. Agric., Meat Packers Council of Canada.

Gullett, E.A., Rowe, D.L. and Jones, S.D.M. (under review). Quality of roasts from bulls and steers of early and late fattening types. Can. Ins. Food Sci. Technol. J.

Gullett, E.A., Rowe, D.L., and Hines, R.J. (In press). Sensorial assessment of the eating quality of meat. Can. Inst. Food Sci. Technol. J.

Hawrysh, Z.J. and Berg, R.T. 1976. Studies on beef eating quality in relation to the current Canada grade classification. Can J. Anim. Sci. 56:383.

Hawrysh, Z.J., Berg, R.T. and Hawes, A.D. 1975. Eating quality of mature marbled beef. Can. Inst. Food Sci. Technol. J. 8:30.

Helwig, J.T. and Council, K.A. 1979. SAS User's Guide. SAS Institute Inc., Raleigh, N.C.

Jones, S.D.M., Rompala, R.E. and Jeremiah, L.E. 1984. The relationship between liveweight and carcass weight in steers of different maturity type fed high and low energy diet. 30th European Meeting of Meat Research Workers, Bristol, U.K.

Sanderson, M. and Vail, G.E. 1963. Method for determining press fluid in cooked beef. J. Food Sci. 28:596.

Stoline, M.R. 1981. The status of multiple comparisons: Simultaneous estimation of all pairwise comparisons in one-way ANOVA designs. Amer. Statistician 35(3):134.

Table 1. Grade distribution and distribution of marbling scores for animals in the three trials.

| | Trial 1 | Trial 2 | Trial 3 |
|---|---|---|---|
| Grades | | | |
| A1 and A2 | 21 | 44 | 38 |
| B1 | 12 | 9 | 4 |
| C1 and C2 | 12 | 4 | 27 |
| Marbling Scores | | | |
| Grp1 | 7 (1,2 & 3)[1] | 11 (1,2,3,4) | 19 (1,2,3,4) |
| Grp2 | 7 (4) | 12 (5) | 22 (5) |
| Grp3 | 18 (5) | 20 (6) | 14 (6) |
| Grp4 | 13 (6 & 7) | 14 (7,8,9) | 14 (7,8,9) |

[1] Grouping of marbling scores for analysis of variance.

Table 2. Mean fat content and mean flavour scores for LD roasts from three trials based on marbling scores.

| | | Trial 1 | Trial 2 | Trial 3 |
|---|---|---|---|---|
| Carcass fat | Grp1 | 13.84a[1] | 15.44a | 15.54a |
| | Grp2 | 18.41ab | 19.41b | 18.84b |
| | Grp3 | 19.13b | 18.70b | 20.65b |
| | Grp4 | 22.93c | 21.36b | 24.85c |
| Muscle fat (%) | Grp1 | 2.86a | 4.34a | 3.41a |
| | Grp2 | 3.44a | 5.00ab | 4.66ab |
| | Grp3 | 3.68a | 5.18ab | 5.22b |
| | Grp4 | 5.81c | 6.87b | 9.26c |
| Roast fat (%) | Grp1 | 19.75a | 18.66a | 16.67a |
| | Grp2 | 26.39bc | 20.96ab | 20.93ab |
| | Grp3 | 25.79b | 21.36ab | 22.95b |
| | Grp4 | 30.62c | 24.35b | 28.99c |
| Flavour[2] | Grp1 | 7.58a | 7.98a | 7.54a |
| | Grp2 | 8.38ab | 8.18a | 8.03a |
| | Grp3 | 8.89b | 7.57a | 7.74a |
| | Grp4 | 9.16b | 8.53a | 8.25b |

[1] Means within a column not followed by the same letter are significantly different (P<0.05)
[2] Maximum score for intensity = 15.

Table 3. Mean[1] fat content for ST roasts from three trials based on marbling scores.

| | | Trial 1 | Trial 2 | Trial 3 |
|---|---|---|---|---|
| Carcass fat | Grp1 | 14.21a | 15.44a | 15.55a |
| | Grp2 | 18.93ab | 19.54b | 18.84ab |
| | Grp3 | 19.15b | 18.70b | 20.48b |
| | Grp4 | 23.23c | 20.96b | 25.36c |
| Muscle fat (%) | Grp1 | 2.67a | 4.08a | 3.42a |
| | Grp2 | 2.94a | 3.40a | 3.42a |
| | Grp3 | 4.45a | 4.03a | 3.93a |
| | Grp4 | 7.86a | 6.14a | 5.70b |
| Roast fat (%) | Grp1 | 5.09a | 4.54a | 4.82a |
| | Grp2 | 3.90a | 6.07ab | 4.54a |
| | Grp3 | 5.32a | 4.92a | 5.06ac |
| | Grp4 | 6.39a | 7.36b | 6.70c |

[1] Means within a column not followed by the same letter are significantly different (P<0.05)

Table 4. Partial correlation coefficients for LD ROASTS.

| | Muscle fat | Roast fat | Tenderness | Juiciness | Flavour | Evap. loss | Drip Loss |
|---|---|---|---|---|---|---|---|
| **Trial 1** | | | | | | | |
| Fat content | | | | | | | |
| Carcass | -0.1100 | -0.1219 | 0.4180** | 0.3669* | 0.4576* | 0.0868 | -0.0300 |
| Muscle | | 0.6315*** | -0.2270 | -0.0531 | -0.0542 | -0.0651 | 0.4857** |
| Roast | | | -0.2153 | -0.0103 | 0.0683 | -0.2602 | 0.5961*** |
| Tenderness | | | | 0.7646*** | 0.4750* | 0.2089 | -0.1573 |
| Juiciness | | | | | 0.5749*** | 0.1276 | -0.0991 |
| Flavour | | | | | | -0.1613 | -0.1169 |
| **Trial 2** | | | | | | | |
| Fat content | | | | | | | |
| Carcass | -0.1419 | -0.0900 | 0.0943 | 0.0546 | 0.0947 | 0.0220 | -0.1748 |
| Muscle | | 0.4377** | 0.1065 | 0.1835 | -0.0699 | 0.2179 | 0.3005* |
| Roast | | | 0.0728 | 0.3243* | 0.0649 | 0.0687 | 0.2283 |
| Tenderness | | | | 0.2980 | 0.0469 | -0.0495 | 0.0245 |
| Juiciness | | | | | 0.3218* | -0.0272 | 0.1567 |
| Flavour | | | | | | 0.1016 | -0.0409 |
| **Trial 3** | | | | | | | |
| Fat content | | | | | | | |
| Carcass | -0.2478* | -0.1701 | 0.0193 | 0.0772 | 0.3271** | 0.0430 | -0.0734 |
| Muscle | | 0.6111*** | -0.0478 | 0.0251 | -0.0925 | 0.1889 | 0.3873** |
| Roast | | | -0.1077 | -0.0879 | -0.1834 | -0.0718 | 0.4519** |
| Tenderness | | | | 0.1523 | -0.1488 | 0.0713 | 0.0119 |
| Juiciness | | | | | 0.3324** | 0.3495 | 0.1308 |
| Flavour | | | | | | 0.0700 | -0.1747 |

*P<0.05
**P<0.01
***P<0.001

Table 5. Partial correlation coefficients for ST roasts.

| | Muscle fat | Roast fat | Tenderness | Juiciness | Flavour | Evap. loss | Drip loss |
|---|---|---|---|---|---|---|---|
| **Trial 1** | | | | | | | |
| Fat content | | | | | | | |
| Carcass | 0.0173 | 0.0176 | 0.0127 | 0.2223 | -0.0467 | -0.0573 | -0.0709 |
| Muscle | | 0.4853** | -0.2092 | -0.0580 | -0.1244 | 0.2259 | 0.0843 |
| Roast | | | -0.1152 | -0.1395 | -0.2386 | 0.1287 | 0.1459 |
| Tenderness | | | | 0.6158*** | 0.5159** | 0.0768 | 0.0893 |
| Juiciness | | | | | 0.6084*** | -0.0838 | 0.0835 |
| Flavour | | | | | | -0.0848 | 0.0966 |
| **Trial 2** | | | | | | | |
| Fat content | | | | | | | |
| Carcass | 0.0083 | 0.1490 | -0.0174 | -0.0078 | 0.1378 | 0.0599 | -0.0556 |
| Muscle | | 0.7001*** | 0.2125 | 0.1610 | -0.0851 | -0.1084 | -0.2978* |
| Roast | | | 0.1184 | -0.0167 | -0.2071 | -0.0641 | -0.0039 |
| Tenderness | | | | 0.3134* | -0.0996 | -0.0065 | -0.1909 |
| Juiciness | | | | | 0.2664 | 0.3007* | -0.1354 |
| Flavour | | | | | | 0.1239 | 0.0375 |
| **Trial 3** | | | | | | | |
| Fat content | | | | | | | |
| Carcass | -0.1571 | -0.0631 | -0.2094 | -0.0644 | 0.1958 | -0.1312 | 0.0362 |
| Muscle | | 0.7827*** | -0.0342 | -0.0150 | -0.1178 | 0.1306 | 0.1983 |
| Roast | | | -0.0911 | -0.0670 | -0.1303 | -0.0130 | 0.1892 |
| Tenderness | | | | 0.4002** | -0.1108 | -0.1975 | -0.2743* |
| Juiciness | | | | | 0.2876* | -0.1355 | -0.1653 |
| Flavour | | | | | | -0.0547 | -0.0443 |

* P<0.05
** P<0.01
*** P<0.001