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R59-22

The Effect of Grade, Weight and Class of Beef Carcasses upon Certain Chemical and Sensory Evaluations of Beef Quality^{a, b}

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(Manuscript received July 8, 1958)

GRADE, CLASS, AND WEIGHT are all contributing factors in determining price of beef carcasses and are so considered since each is felt to have some effect on either the yield of edible product or on the final eating qualities. The effect of grade, class, and weight upon yield of prefabricated beef cuts has been reported in a previous paper (4).

This article reports on the effect of grade, class, and weight upon sensory flavor, tenderness, juiciness and over-all acceptance and upon percentage ether extract in the loin eye sample and mechanical shear value.

MATERIALS AND METHODS

A total of 334 beef carcasses were used. These carcasses represented the Choice, Good and Commercial (also Standard) grades and included steer, heifer, and cow classes in 400 to 500, 600 to 700, and 800 to 900 pound carcass weight groups, where possible (4).

Carcasses were chosen by a U.S.D.A. Grading Service representative to fit the middle of the specified grade.

After a 24- to 48-hour chill, carcasses were cut according to the method described (4). Two adjacent loin strip steaks were removed, wrapped and freezer-stored at -20° F. until being randomly withdrawn for testing. One steak was used for the determination of sensory acceptance, tenderness, flavor, and juiciness. These sensory evaluations were conducted by the Food Acceptance Branch, Quartermaster Food and Container Institute for the Armed Forces. A randomly selected panel was used to evaluate over-all acceptance, whereas a selected trained panel was used to evaluate sensory tenderness, flavor, and juiciness. The nine-point hedonic scale was used to evaluate sensory preference or acceptance, while other structured scales were used to evaluate tenderness, flavor, and juiciness (see Table 1). In converting these responses to numerical values for statistical analysis, highest ratings were assigned to the most desirable end of each scale. Withdrawal of steaks for testing was randomized to minimize the effect of environment, individual preference, and preparation upon final results. Steaks were grilled to a like degree of "doneness" as determined by appearance and internal temperature which was observed by use of thermocouples.

The second loin strip steak was used for chemical analysis and to provide cores for mechanical shear evaluations. Steaks

^a This paper reports research undertaken by the Quartermaster Food and Container Institute for the Armed Forces, QM Research and Engineering Command, U. S. Army, and has been assigned number 873 in the series of papers approved for publication.

^b The authors wish to acknowledge the assistance of R. A. Merkel, R. Lenaerts, E. V. Kwiat, T. W. M. Wilson, C. D. Harral, F. Valleri, B. Goldstein and J. F. Price in planning, tabulation of data and performing chemical and physical evaluations and M. M. Van Zandt for grading and subjective evaluations.

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were removed from the freezer and allowed to temper at room temperature for 45 minutes or until soft enough to remove cores. Six ½-inch cores were removed from each tempered loin strip steak, the cores allowed to thaw completely, and then chilled at 40° F. for one hour. Samples were cooked in a 158° F. water bath for exactly 3 minutes and then stored overnight at 40° F. in a closed container to preclude moisture loss. Shear values were obtained with a Warner-Bratzler shear machine.

Ether extract content of a loin eye sample was determined by the A.O.A.C. procedure.

The analysis of variance was used to determine if differences existed between grades, classes, and weight groups with regard to the sensory and chemical factors reported (Table 3). In making the comparison between grades, data were used only from steer carcasses weighing 400 to 500 and 600 to 700

TABLE 1
Sensory evaluations of steaks
Rating scales used

Numerical score	Sensory acceptance	Sensory flavor	Sensory juiciness	Sensory tenderness
1	Dislike extremely	Extremely poor	No juiciness	Extremely tough
2	Dislike very much	Very poor	Slight juiciness	Very tough
3	Dislike moderately	Poor	Moderate juiciness	Moderately tough
4	Dislike slightly	Below fair above poor	Much juiciness	Slightly tough
5	Neither like nor dislike	Fair	Extremo juiciness	Slightly tender
6	Like slightly	Below good above fair		Moderately tender
7	Like moderately	Good		Very tender
8	Like very much	Very good		Extremely tender
9	Like extremely	Excellent		

pounds, heifer carcasses weighing 400 to 500 pounds, and cow carcasses weighing 600 to 700 pounds, since these are the only groups found in all three grades. For a similar reason, only Choice and Good carcasses weighing 600 to 700 pounds and Commercial (Standard) carcasses of 400 to 500 pounds were considered in making the comparison between steers, heifers, and cows. In making the weight analysis, data from Good and Choice steers were used. A separate analysis of variance was used for analyzing for differences between grades, classes, and weight groups. In each analysis, the other two treatment variables were ignored when analyzing for differences in one given variable, since there were too many missing groups to perform a factorial analysis.

RESULTS AND DISCUSSION

In this study, sensory acceptance as determined by the nine-point hedonic scale was not significantly affected by grade (Table 3). There was a tendency

TABLE 2
Sensory and chemical evaluations¹
Lot averages

Number of animals	Grade	Class	Carcass weight	Sensory acceptance ²	Sensory flavor ³	Sensory juiciness ⁴	Sensory tenderness ⁵	Mech. shear value ⁶	Ether extract
			<i>cwt.</i>						%
20.....	Choice	Steer	4-5	7.69	6.75	3.00	4.75	8.25	6.74
20.....	Choice	Steer	6-7	7.05	5.90	3.15	4.90	8.49	6.91
20.....	Choice	Steer	8-9	6.42	6.35	2.95	4.55	8.16	9.42
20.....	Choice	Heifer	4-5	7.20	6.50	2.95	4.90	8.27	7.18
20.....	Choice	Heifer	6-7	7.95	6.75	3.25	5.45	7.60	8.33
20.....	Choice	Cow	6-7	8.15	6.50	3.05	5.25	7.20	8.12
20.....	Good	Steer	4-5	7.70	6.15	2.80	4.50	8.93	4.66
20.....	Good	Steer	6-7	6.45	5.80	2.80	4.45	9.03	5.63
20.....	Good	Steer	8-9	6.70	6.25	3.05	4.35	9.33	8.17
20.....	Good	Heifer	4-5	7.15	6.05	2.60	4.30	9.44	4.71
20.....	Good	Heifer	6-7	7.10	6.45	2.80	4.55	9.10	5.09
20.....	Good	Cow	6-7	7.30	6.40	2.95	5.05	8.63	7.22
21.....	Com'l	Steer	4-5	7.05	6.25	2.70	3.95	10.22	3.03
20.....	Com'l	Steer	6-7	7.00	6.15	2.70	3.90	10.60	3.60
14.....	Com'l	Heifer	4-5	7.43	6.14	3.00	4.86	9.27	4.57
20.....	Com'l	Cow	4-5	7.20	5.80	2.95	4.95	9.28	4.10
20.....	Com'l	Cow	6-7	6.80	6.15	2.80	4.30	9.65	9.09

¹ Values determined on loin eye (*Longissimus dorsi*) samples.

² Based on 9-point hedonic scale (See Table 1).

³ Based on a 9-point subjective scale.

⁴ Based on a 5-point subjective scale.

⁵ Based on an 8-point subjective scale.

⁶ Expressed in pounds of shear force.

toward higher ratings for Choice grade steaks. However, because of tremendous individual variation, this was not significant. Individual variation may have resulted partly from differences in individual preference, environment, etc., as well as inherent differences in the steaks. However, a highly significant difference due to classification or weight of carcass was noted. A higher preference was indicated for loin strip steaks from cows or heifers as compared to steers. A higher preference was also shown for steaks from 400 to 500 pound carcasses when compared to those from heavier cattle. Wanderstock and Miller (7) previously reported a difference between two groups of carcasses that varied in grade, with a preference for the higher grade. However, Aldrich and Lowe (1) failed to note a difference in "palatability" between beef round cuts from the Good *versus* the Choice grade.

Flavor and juiciness were not significantly affected by either carcass grade, class, or weight. Again, a tremendous variation existed in individual values for flavor and juiciness, resulting in lower variance ratios. Wanderstock and Miller (7) reported a grade difference with regard to flavor, tenderness, and juiciness, but Aldrich and Lowe (1) uncovered no difference between Good and Choice round cuts when flavor and juiciness were compared. Jacobson and Fenton (3) found juiciness to decrease with age.

Carcass grade exerted a highly significant effect upon tenderness as determined by either a mechanical shear value or a sensory evaluation. Higher graded steaks were more tender. Similar findings have previously been reported by Wanderstock and Miller (7) and Paul and Bratzler (5). Wierbicki *et al.* (8) reported that carcass grade was closely related to tenderness in samples of 3 days post mortem, but less closely related at 15 days post mortem. Perhaps the reason why a difference is noted in tenderness, but not in over-all acceptance is the fact that a trained panel was used for determination of sensory tenderness,

whereas an untrained panel was used to indicate over-all acceptance. The trained panel may have been more sensitive in determination of a given sensory aspect. Raffensperger and Pilgrim (6) have given some indication of the superiority of a trained, selected panel. Class of carcass exerted a significant effect upon sensory tenderness and shear value. Higher tenderness scores and corresponding lower shear values were found for cows and heifers. Carcass weight failed to show a significant effect on either tenderness determination. Hankins (2) stated that

TABLE 3
Yield summaries and statistical analysis of
sensory and chemical evaluations
All determinations based on loin eye samples

Grade comparison ¹	Average values			
	Com'l	Good	Choice	F Value
Sensory acceptance.....	7.04	7.15	7.52	2.12
Sensory flavor.....	6.12	6.10	6.41	1.33
Sensory juiciness.....	2.78	2.79	3.04	3.02
Sensory tenderness.....	4.20	4.58	4.95	4.84**
Mechanical shear value.....	9.99	9.01	8.18	20.39**
Ether extract (%).....	5.05	5.65	7.21	11.74**
Class comparison ²	Cow	Heifer	Steer	F Value
Sensory acceptance.....	7.55	7.49	6.85	4.38**
Sensory flavor.....	6.23	6.48	5.98	2.06
Sensory juiciness.....	2.98	3.02	2.88	0.54
Sensory tenderness.....	5.08	4.96	4.43	3.31*
Mechanical shear value.....	8.54	8.59	9.25	3.42*
Ether extract (%).....	6.31	6.26	5.21	3.94*
Weight comparison ³	4-5	6-7	8-9	F Value
Sensory acceptance.....	7.69	6.75	6.56	5.18**
Sensory flavor.....	6.45	5.85	6.30	2.09
Sensory juiciness.....	2.90	2.98	3.00	0.20
Sensory tenderness.....	4.62	4.68	4.45	0.27
Mechanical shear value.....	8.59	8.76	8.75	0.14
Ether extract (%).....	5.64	6.03	8.64	15.43**

* Indicates significance at 5% level of probability.

** Indicates significance at 1% level of probability.

¹ Grade comparison includes steers (4-5 and 6-7 cwt.), heifers (4-5 cwt.) and cows (6-7 cwt.).

² Class comparison includes Choice (6-7 cwt.), Good (6-7 cwt.) and Commercial (4-5 cwt.).

³ Weight comparison includes Good and Choice steers.

meat tenderness tended to vary with age of the animal from which the carcass was obtained. Perhaps Federal grade standards have a compensatory effect for heavier carcasses so that a weight effect was not shown. In other words, heavier carcasses need more finish and quality to be included in the same grade, therefore, this additional finish and quality compensated for the possible effect of heavier carcass weight. Perhaps, if various carcass weight groups were equalized with regard to marbling or other subjective quality factors when being compared, then a weight effect might be observed upon tenderness.

Weight was found to have an effect on preference but not upon either flavor, juiciness, or tenderness. Thus, it is difficult to speculate as to which factors were responsible. Perhaps the effect on preference was an accumulative effect of the other factors. The effect of either grade, class, or weight upon preference closely paralleled their effect upon tenderness.

Ether extract of the loin eye (*Longissimus dorsi*) sample revealed that differences were attributable to grade, class, and weight. High to low values were found in Choice, Good, and Commercial steaks, in that order. Less difference was found between Commercial and Good than between Good and Choice. This is undoubtedly because some heavy cow carcasses were included in the Commercial group. These cattle need more marbling to qualify for this grade, according to the Federal grade standards. Cows and heifers displayed equal levels of loin eye ether extract, and both contained more marbling in loin eye steaks than steers. Marbling also markedly increased with carcass weight. The largest difference existed between the 600 to 700 pound and the 800 to 900 pound weight groups. Jacobson and Fenton (3) have previously reported increased fat in *Longissimus dorsi* samples as age of animal increased. Age of animal should closely parallel carcass weight, so essentially this study concurs with results of Jacobson and Fenton.

U.S.D.A. grade standards appeared to do a good job of differentiating between various levels of tenderness, as demonstrated both by sensory evaluations and by mechanical shear results. This was paralleled by definite increases in loin eye ether extract in the higher grades. Perhaps the differences in marbling were partly responsible for the differences in tenderness.

Steaks from steer carcasses represented in this study received a lower acceptance rating than those from cow or heifer carcasses. A lower tenderness

score and a higher shear value was also shown in the steer classification, as well as a lower average ether extract value. Perhaps the standards are too easy on steer carcasses. An objective evaluation of tenderness may do a superior job of categorizing carcasses with regard to final eating qualities; regardless of class, grade, or weight.

Weight affected acceptance score. The only other factor similarly and significantly affected by weight groups was percentage ether extract in the loin eye sample.

SUMMARY

The effect of carcass weight, grade, and class upon sensory acceptance, flavor, juiciness, and tenderness, mechanical shear value, and percentage ether extract has been shown.

Higher ether extract values, lower shear values, and higher tenderness ratings were associated with higher grades.

Steaks from steer carcasses showed lower acceptance and tenderness ratings, lower ether extract content and higher shear values than those from cows and heifers.

Steaks from 400 to 500 pound carcasses received highest acceptance ratings, when weight groups were compared. Highest ether extract of the loin eye (marbling) was found in the heaviest carcasses.

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