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Factors causing livery flavor in beef steaks from the chuck and loin (2003)

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FACTORS CAUSING LIVERY FLAVOR IN BEEF STEAKS FROM THE CHUCK AND LOIN[1]

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Summary

The infraspinatus muscle (top blade) from the chuck clod, the gluteus medius muscle (top sirloin) from the sirloin, and the psoas major muscle (tenderloin) from the loin were obtained from 140 A- and B-maturity carcasses with either low-Slight or Small marbling and with either normal pH (5.7 or less) or high ultimate pH (6.0 or higher) to evaluate factors that could cause livery flavor in cooked beef. Muscles were aged for 7, 14, 21, or 35 days. A highly trained, flavor-profile sensory panel evaluated charbroiled steaks from these muscles. Approximately 8% of all sensory panelist judgments were scored to have some livery flavor. Numerous statistical interactions were found among traits, which made it difficult to make clear conclusions. In general, marbling and aging time had little direct effect on livery flavor, and livery flavor was not related to raw muscle lipid oxidation.

Introduction

Consumers primarily purchase beef because of its desirable flavor and texture. Consumers regard any beef eating experience where uncharacteristic or undesirable flavors are detected as an "unfavorable" eating experience. Purveyors have identified one such undesirable flavor as "livery", occurring primarily in top sirloin and tenderloin steaks. Reducing the incidence of "livery" flavor would benefit the beef industry, and information regarding prevention of "livery flavor" should help reduce unsatisfactory beef eating experiences.

Flavor problems are seldom reported to the retail markets where beef products are purchased. Although several researchers have reported the occurrence of livery flavor, essentially no research has been conducted to determine factors causing livery flavor development. This project was funded with Beef Checkoff dollars and coordinated by the National Cattlemen's Beef Association.

Experimental Procedures

Subprimal Selection. Beef chuck, shoulder clods; loin, top sirloin butts; and loin, full tenderloins were obtained from 140 carcasses from two commercial beef slaughter and processing facilities at six different sampling times. The infraspinatus, gluteus medius, and psoas major muscles were excised from each of the respective subprimals. Carcasses were selected to fit into two groups: carcasses of A-

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and B-maturity bone. Within maturity groups, two pH subgroups, pH of 5.7 or less (normal) and pH of 6.0 or greater (dark cutters) were selected. Ribeye muscle pH was measured at 24 to 48 hours postmortem. The carcasses also were selected for USDA marbling score of Slight^{00} to Slight^{50} or Small^{00} to Modest^{00} (Table 1). Due to the low incidence of B-maturity x high pH carcasses, we were unable to select an equal number of these carcasses. Subprimals were fabricated at 7 days postmortem, and the individual muscles of interest were removed. Steaks 1-inch thick were cut from the muscles, randomly assigned to an aging treatment (7, 14, 21, or 35 days), and vacuum packaged. The steaks assigned to the 7-day aging treatment were frozen at -40°F and stored until just prior to trained flavor-profile panel evaluations. The remaining steaks were aged at 36 to 39°F until either 14, 21, or 35 days postmortem. All steaks were then frozen and stored at -40°F until sensory panel evaluation.

Flavor-Profile Sensory Panel Evaluations. The **Plan** procedure of SAS was used to determine the treatments represented each day for the panel evaluations, to reduce any order bias. Steaks were thawed at 39°F for approximately 24 hours prior to trained flavor-profile sensory panel evaluations. The steaks were cooked on a Wells Model B-44 Electric Charbroiler and turned every 4 minutes until an internal temperature of 158°F was reached.

The highly trained flavor panel scored the cooked steaks using a 15-point scale, with 15 being most intense and 0 being none. The standards for each attribute were determined by the panelists and were used each time the panel met. Reference material for the livery flavor standard was generated by combining 80% lean ground beef with ground beef liver and cooking to 160°F. The panelists were provided reference standards with 1, 3, and 5% liver (by weight) during their evaluations that were assigned ratings of 1.5, 3.5, and 5.0, respectively.

After cooking, the steaks were cut perpendicular to the surface into cubes measuring 1.0 x 0.5 x 0.5 inch. Steaks were evaluated for the previously identified attributes and scored to the nearest 0.5 on the 15-point scale. Panelists were presented not more than 15 samples per session to minimize sensory fatigue and adaptation. The duration of each session was 1.5 hours, and panelists were allowed a 5-minute break after receiving one-half of the samples. The evaluations were conducted in an atmospherically controlled room with the temperature and humidity levels set at 70 ± 2°F and 55 ± 5%, respectively.

Statistical Analyses. The **Mixed** procedure of SAS was used to analyze all flavor profile data. The flavor panel data were analyzed in a split-plot design structure. The data were analyzed with maturity, marbling, pH, and muscle serving as whole plot fixed effects, and aging time as the subplot fixed effect. Interactions and main effects with $P<0.05$ were considered significant.

Results and Discussion

The percentage of total observations (9,397) rated as livery were: 0.4% rated as 0.5, 1.0% rated as 1.0, 2.9% rated as 1.5, 1.9% rated as 2.0, 1.2% rated as 2.5, 0.9% rated as 3.0, 0.8% rated as 3.5, 0.3% rated as 4.0, 0.1% rated as 4.5, 0.1% rated as 5.0. The three-way interaction for livery flavor suggests that neither marbling, maturity, nor aging time had a consistent effect on livery flavor (Table 2). There was a slight trend for muscles from A-maturity carcasses with small marbling to have less livery flavor and muscles from carcasses with B-maturity to have more livery flavor, but this was not a clear trend, and most samples scored 0 for livery flavor. Both the top sirloin and tenderloin steaks had a more

intense livery flavor ($P<0.05$) than the top blade, but the small numerical difference (0.07 on a 15-point scale) likely is of little practical importance (Table 3). The treatment combination of B-maturity, Slight marbling, and 35 days aging had more livery flavor ($P<0.05$) than any other, but its mean score of 0.47 on a 15 point scale is not a very strong indicator.

Livery flavor is a complex trait, its incidence is sporadic, and its cause(s) likely involve interactions among numerous traits. In general, marbling did not affect livery flavor.

Table 1. Distribution of Carcasses Sampled with Different Maturity, Marbling, and pH Combinations

No. of Carcasses	Maturity	USDA Marbling	pH
20	A	Slight	Normal
20	A	Small	Normal
20	A	Slight	High
20	A	Small	High
20	B	Slight	Normal
20	B	Small	Normal
8	B	Slight	High
12	B	Small	High

Table 2. Aging Time × Maturity × Marbling Interaction for the Livery Flavor Attribute

Aging Time	Maturity	Marbling	Livery Flavor*	Standard Error
7 days	A	Slight	0.17[c]	0.05
7 days	A	Small	0.18[c]	0.05
21 days	A	Small	0.21[bc]	0.05
35 days	A	Slight	0.21[bc]	0.05
7 days	B	Small	0.21[bc]	0.05
14 days	A	Slight	0.22[b]	0.05
14 days	B	Small	0.22[b]	0.05
35 days	A	Small	0.22[bc]	0.05
21 days	B	Slight	0.23[bc]	0.06
35 days	B	Small	0.24[bc]	0.05
14 days	A	Small	0.25[b]	0.05
21 days	A	Slight	0.25[bc]	0.05
21 days	B	Small	0.27[bc]	0.05
7 days	B	Slight	0.27[bc]	0.06
14 days	B	Slight	0.32[b]	0.06
35 days	B	Slight	0.47[a]	0.06

[abc]Means within a column not bearing a common superscript letter differ (P<0.05).
*0 = none, 15 = Most Intense.

Table 3. Muscle Effect on the Livery Flavor Attribute

Muscle	Livery Flavor*	Standard Error
Top Blade	0.20[b]	0.04
Top Sirloin	0.27[a]	0.04
Tenderloin	0.27[a]	0.04

[ab]Means within a column having different superscript letters differ (P<0.05).
*0 = none, 15 = Most Intense.