COMPARATIVE RIPENING OF BEEF FROM GRASS-FATTENED AND GRAIN-FATTENED STEERS [1]

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INTRODUCTION

Cattle fed and finished on grass usually bring a lower price on United States markets than similar cattle finished on grain. The reasons advanced for the price discrimination are many. One of the principal objections raised is that the beef from cattle fattened on grass does not keep or ripen satisfactorily. In order to obtain much-needed information on the "grass beef" problem, a cooperative study was made by the Virginia Agricultural Experiment Station, the Virginia State Division of Markets, and the United States Department of Agriculture Bureau of Animal Industry and Agricultural Marketing Service. The first experiment was conducted in 1937–38 and was followed by similar experiments in 1938–39 and 1939–40. The present paper reports the phase of this study concerned with the comparative ripening qualities of the two kinds of beef.

METHODS OF EXPERIMENTATION

Beef-type steers produced in southwestern Virginia and averaging low Good in grade of feeder were selected for this study. In each of the 3 experiments, 40 steers about 2½ years old and of similar breeding, weight, and condition were used. All cattle were wintered in 1 group on a medium plane of nutrition, and they lost an average weight of approximately 100 pounds.

At the beginning of the grazing season the cattle were divided into 2 comparable groups of 20 head each. Group 1 was turned on bluegrass (*Poa pratensis*) pasture and received only grass and block salt for approximately 5 months. Group 2 was placed in dry lot and fed shelled corn, cottonseed meal, and mixed hay. These cattle had access to block salt and were fed to the same degree of fatness as those on grass. The feed required consisted of 649 pounds of corn, 80 pounds of cottonseed meal, and 412 pounds of hay per 100 pounds of grain. At the end of the feeding period each group was divided as equally as possible into two comparable subgroups of 10 animals each. One subgroup in each instance was shipped to the United States Department of Agriculture, Beltsville Research Center, Beltsville, Md., and the other to the Jersey City market.

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At Beltsville the cattle were slaughtered and the carcasses were chilled to approximately 34° F. Ether extract of the eye muscle of the ninth-tenth-eleventh-rib cut was determined for each of the 20 carcasses. Three pairs of these carcasses were selected for the study reported in this paper. Each pair consisted of a carcass of a grass-fed steer and that of a grain-fed steer. The pair mates were of as nearly the same fat content of eye muscle as was possible to obtain from the 10 carcasses representing each type of feeding. From these 3 pairs of carcasses the 12 sixth-seventh-eighth-rib cuts were used for the study on ripening.

Beginning 15.7 days after slaughter, on the average, in the 3 experiments, the analytical work on the rib samples from the right side of the 6 carcasses was begun. The eye muscle was removed from the sixth-rib cut, ground 3 times, and mixed thoroughly for chemical analysis. Preparatory to determination of the expressible-juice content and to tests for flavor and aroma, the seventh-eighth-rib cut was cooked at an oven temperature of 125° C. to an internal meat temperature of 58° C. The juice content was determined by a method, developed by the Bureau of Animal Industry, which involves the testing of small samples of cooked meat in a hydraulic press under certain conditions of temperature, pressure, and time.[2] Flavor and aroma were judged by a committee of qualified persons.

To subject the meat to an extremely critical test, the sixth-seventh-eighth-rib cuts from the left side of the carcass were stored at 33° to 36° F. for 50 days. At the end of this period, all moldy and slimy surfaces were removed from the samples. The same procedure was then followed as described for the 15.7-day period.

To measure the autolysis, or break-down, of muscle tissue during ripening, the content of amino and nonprotein nitrogen, as well as that of other tissue components, was determined. Moisture, ether extract, total nitrogen, amino nitrogen (by formol titration), and ash determinations were made according to methods recommended by the Association of Official Agricultural Chemists.[3] Nonprotein nitrogen was determined by treating 5 gm. of ground meat with 100 cc. of 10-percent trichloroacetic acid. Sulfydryl determinations were made according to the Okuda iodate method [4] with the use of Lavine's modification.[5] Reducing substances were determined by the Somogyi-Shaffer-Hartmann method, as given in Hawk and Bergeim.[6] Although reducing values were obtained by this method, the values are expressed as total reducing substances in terms of glucose. The reduction obtained is probably due to intermediate products formed during the conversion of glycogen. The data obtained on total nitrogen, amino nitrogen, nonprotein nitrogen, and sulfydryl were analyzed statistically by the use of Fisher's *t* test.[7]

[2] The method used for determining expressible juice was that briefly given in the Reports of the Chief of the Bureau of Animal Industry for 1937 and 1939, and later improved. A paper giving the details of the method has been prepared for publication.

[3] ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. OFFICIAL AND TENTATIVE METHODS OF ANALYSIS . . . Ed. 4, 710 pp., illus. Washington, D. C. 1935.

[4] OKUDA, YUZURU. A NEW METHOD FOR THE DETERMINATION OF CYSTINE IN PROTEINS (THE IODINE METHOD). Jour. Biochem. 5: 217–227. 1925.

[5] Personal communication from T. F. Lavine, Lankenau Hospital Research Institute, Philadelphia, Pa.

[6] HAWK, PHILIP B., and BERGEIM, OLAF. PRACTICAL PHYSIOLOGICAL CHEMISTRY. Ed. 11, 968 pp., illus. Philadelphia. 1937.

[7] FISHER, R. A. STATISTICAL METHODS FOR RESEARCH WORKERS. Ed. 3, rev. and enl., 283 pp., illus. Edinburgh and London. 1930.

EXPERIMENTAL RESULTS

The paired samples of the ninth-tenth-eleventh-rib cuts used in the 3-year study were of approximately equal fatness, as indicated by the ether-extract content of the eye muscle. The differences in the ether extract among the nine pairs at time of slaughter ranged from 0 to 0.09 percent, the mean difference being 0.051 percent. Table 1 presents data on the comparative composition of the beef after ripening for an average period of 15.7 days. These data show that the beef from the grain-fed and grass-fed steers differed little in moisture, ash, protein, and ether extract. Any changes in these constituents that occurred during the short period of ripening were similar for the two types of beef. In the amino-nitrogen determinations, there was no difference, on the average, between the meats representing the two types of fattening. For each of the 3 years, as well as for the average of the 3 years, there were only small differences in nonprotein nitrogen. The total reducing substances show no appreciable difference, but the percentage of sulfydryl in the beef from the grass-fed cattle was appreciably higher than that in the grain-fed cattle. However, the higher sulfydryl content was not interpreted as indicating that more ripening had occurred in the beef from the grass-fed cattle.

Table 1 also presents data on the 50-day ripening period for the same constituents. As was found after the short period of ripening, the differences between the two kinds of beef in moisture, ash, protein, and ether extract were of minor importance. Furthermore, such small changes as did occur in these constituents as a result of the longer ripening period were similar in the beef from the grain-fattened and grass-fattened cattle.

On the other hand, the values for nonprotein nitrogen and amino nitrogen were considerably higher after 50 days of ripening than after an average of 15.7 days. The increase represents what normally occurs in ripening meat as a result of attack by enzymes and bears out the results of previous work. However, the important point is that the increase was similar in the two kinds of beef.

There was little difference, between the two kinds of beef, in total reducing substances and only a small increase as a result of a longer ripening period. Sulfydryl values increased between the 15.7- and 50-day intervals somewhat more rapidly in the beef from grain-fattened cattle, with the result that there was less difference between the two kinds of beef after 50 days than after 15.7 days. During ripening, labile sulfur from the protein molecule splits off and is liberated as H_2S and other volatile compounds. The sulfydryl is probably derived from cystine, glutathione, and other sulfur-bearing amino acids that are liberated during autolysis.

With respect to the content of amino and nonprotein nitrogen (the indices of protein break-down) as well as total nitrogen, the differences between the two kinds of beef were found to have no statistical significance either for the 15.7- or the 50-day ripening period. Sulfydryl values, on the other hand, were significantly higher for the beef from grass-fattened cattle after 15.7 days of ripening, owing probably to the higher sulfydryl content of the grass ration. After 50 days, however, the difference was not significant. The latter

TABLE 1.—*Comparative chemical composition and percentage of expressible juice of beef from grain-fattened and grass-fattened steers after a short (an average of 15.7 days) and a long (50 days) period of ripening*

SHORT PERIOD OF RIPENING

Item	Data for indicated year and type of fattening											
	1937–38			1938–39			1939–40			3-year average		
	Grain	Grass	Difference	Grain	Grass	Difference	Grain	Grass	Difference	Grain	Grass	Difference
Animals—number	3	3		3	3		3	3		9	9	
Ripening period—days	18	18		16	16		13	13		15.7	15.7	
Moisture—percent	72.73	73.15	−0.42	75.62	73.39	+2.23	72.54	72.26	+0.28	73.63	72.93	+0.6967
Ash—do	1.087	1.110	−.023	1.067	1.050	+.017	1.200	1.190	+.010	1.1177	1.1167	+.0010
Protein—do	23.12	22.39	+.73	21.81	22.72	−.91	22.47	22.74	−.27	22.47	22.62	−.1500
Ether extract—do	4.62	4.67	−.05	2.50	3.05	−.55	3.26	3.97	−.71	3.46	3.90	−.4367
Total nitrogen—do	3.70	3.58	+.12	3.49	3.58	−.09	3.60	3.64	−.04	3.60	3.60	−.0033
Nonprotein nitrogen—do	.388	.401	−.013	.419	.418	+.001	.408	.421	−.013	.405	.413	−.0083
Nonprotein nitrogen as related to total nitrogen—percent	10.50	11.21	−.71	11.99	11.67	+.32	11.33	11.58	−.25	11.28	11.49	−.2133
Amino nitrogen—do	.0689	.0702	−.0013	.0601	.0596	+.0005	.0558	.0550	+.0008	.0616	.0616	0
Amino nitrogen as related to total nitrogen—percent	1.86	1.96	−.10	1.72	1.66	+.06	1.55	1.51	+.04	1.71	1.71	0
Total reducing substances—do	.1567	.1687	−.0120	.0597	.0587	+.0010	.1547	.1523	+.0024	.1237	.1266	−.0029
Sulfydryl—do	.0303	.0560	−.0257	.0300	.0433	−.0133	.0312	.0441	−.0129	.0305	.0478	−.0173
Protein, fat-free—do	23.85	23.16	+.69	22.14	23.38	−1.24	23.39	23.64	−.25	23.13	23.39	−.2667
Ratio of moisture to protein	3.15:1	3.27:1	−.12:1	3.47:1	3.23:1	+.24:1	3.23:1	3.18:1	+.05:1	3.28:1	3.22:1	+.057:1
Expressible juice—do	34.70	35.96	−1.26	40.20	39.70	+.50	44.80	48.50	−3.70	39.90	41.39	−1.49

LONG PERIOD OF RIPENING

Animals—number	3	3		3	3		3	3		9	9	
Ripening period—days	50	50		50	50		50	50		50	50	
Moisture—percent	72.01	72.55	−0.54	72.59	72.31	+0.28	72.74	72.09	+0.65	72.45	72.32	+0.1300
Ash—do	1.110	1.077	+.033	1.060	1.120	−.060	1.127	1.063	+.064	1.0989	1.0867	+.0122
Protein—do	23.43	22.52	+.91	23.63	24.20	−.57	22.98	22.81	+.17	23.35	23.18	+.1700
Ether extract—do	2.99	3.77	−.78	2.58	2.47	+.11	2.42	3.07	−.65	2.66	3.10	−.4400
Total nitrogen—do	3.75	3.60	+.15	3.78	3.87	−.09	3.68	3.65	+.03	3.74	3.71	+.0300
Nonprotein nitrogen—do	.525	.504	+.021	.505	.505	0	.533	.515	+.018	.521	.508	+.0130
Nonprotein nitrogen as related to total nitrogen—percent	14.00	13.98	+.02	13.34	13.02	+.32	14.51	14.11	+.40	13.95	13.70	+.2467
Amino nitrogen—do	.0966	.0981	−.0015	.1024	.0989	+.0035	.1019	.1029	−.0010	.1003	.1000	+.0003
Amino nitrogen as related to total nitrogen—percent	2.58	2.73	−.15	2.71	2.55	+.16	2.77	2.82	−.05	2.68	2.70	−.0200
Total reducing substances—do	.3640	.3690	−.0050	.0363	.0413	−.0050	.0790	.0697	+.0093	.1598	.1600	−.0002
Sulfydryl—do	.1050	.1087	−.0037	.0664	.0728	−.0064	.0778	.0938	−.016	.0831	.0918	−.0087
Protein, fat-free—do	24.27	23.42	+.85	24.30	24.79	−.49	23.73	23.77	−.04	24.10	23.99	+.1067
Ratio of moisture to protein	3.07:1	3.22:1	−.15:1	3.07:1	2.99:1	+.08:1	3.17:1	3.16:1	+.01:1	3.10:1	3.12:1	−.02:1
Expressible juice—do	31.70	31.60	+.10	38.90	42.00	−3.10	47.00	46.60	+.40	39.20	40.06	−.86

finding indicates that ripening may produce volatile sulfydryl compounds and that some loss results. Except for sulfydryl, the small differences obtained in these constituents are believed to be within the range of experimental error.

After an average ripening period of 15.7 days, no difference was observed in the flavor and aroma of the cooked seventh-eighth-rib cuts from the two kinds of meat. After 50 days, the characteristic flavor and aroma of ripened beef were rather pronounced, but again no difference in flavor and aroma between the grain-fattened and grass-fattened beef was detected. The results after both short and long periods of ripening indicate that the expressible-juice content of the beef from grass-fattened cattle was not significantly different from that of the grain-fattened steers.

SUMMARY AND CONCLUSIONS

A 3-year study was carried on in 1937–40 at the United States Department of Agriculture, Beltsville Research Center, Beltsville, Md., to compare the ripening of meat from steers about 2½ years old fattened on bluegrass pasture with that from cattle fattened on corn, cottonseed meal, and hay when the two kinds of beef are of equal fatness. Rib cuts from 18 paired carcasses, representative of a total of 120 animals, were used during the 3 years. Pair mates of as nearly the same fat content of eye muscle as possible were selected. One sixth-seventh-eighth-rib cut from each carcass was ripened at 33°–36° F. for an average of 15.7 days; the other, for 50 days.

No significant difference was found in the rates of ripening of the beef from the two types of feeding. This result was shown chemically by data on basic composition and especially by determinations of amino and nonprotein nitrogen. The sulfydryl content of beef from grass-fattened cattle was the higher but had no bearing on the rate of ripening, inasmuch as the indexes of protein break-down were similar for beef from both types of feeding. The higher sulfydryl content of beef from grass-fattened cattle is probably due to the higher content of sulfydryl of the grass ration.

No difference was observed in the flavor and aroma or in the expressible-juice content of the two kinds of beef.