Effect of Finish and Ripening on Vitamin B_6 and Pantothenic Acid Content of Beef

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Total vitamin B_6 and pantothenic acid contents of loin (longissimus dorsi) and round (semimembranosus) muscles of beef from grain- and grass-finished steers were determined on the day of slaughter and after aging for 7, 21, and 42 days. The amount of vitamin B_6 was not affected by conditions of finishing or aging. No significant difference in pantothenic acid was associated with finish, but slight increases occurred with 21 and 42 days of aging. Semimembranosus muscle contained significantly more of both vitamins than longissimus dorsi muscle.

Both vitamin B_6 and pantothenic acid are considered essential dietary components for humans (*8*). Pyridoxal phosphate, the active form of vitamin B_6, serves as coenzyme in numerous transaminase, decarboxylase, and other enzymatic reactions, while pantothenic acid functions metabolically as part of coenzyme A (*3*).

There is little information available concerning factors which affect tissue concentration of the B vitamins in ruminants. In earlier work from this laboratory it was shown that beef from grain- or grass-finished steers was an equally good source of thiamine, riboflavin, and niacin (*6*). However, significant changes in the amounts of two of these B vitamins were associated with post-mortem aging. Thiamine content of loin and round muscle was increased significantly by 21 days of aging at 34° F., while niacin content decreased approximately 30% under the same conditions. In view of these findings it seemed pertinent to investigate the effect of grain and grass finishing, as well as aging, on the vitamin B_6 and pantothenic acid content of beef.

Experimental

Meat used in this study was obtained from five pairs of Hereford "high-grade" steers, closely matched as to age and genetic background. The grain-finished steer of each pair was full-fed a mixture of 75% concentrate and 25% hay for 3 to 5 months prior to slaughter. The grass-finished steer remained on pasture consisting primarily of orchard grass and Ladino clover. At slaughter the animals were 18 to 24 months old. The grain-finished averaged approximately 1000 pounds and graded U.S.D.A. High Good. The grass-finished averaged approximately 850 pounds and graded U.S.D.A. Low Good.

Approximately 1-pound samples of the longissimus dorsi and semimembranosus muscles were removed on the day of slaughter and after the carcasses had aged 7, 21, and 42 days. Details of ripening and sampling have been reported (*6*, *7*).

The raw samples were analyzed for total pantothenic acid and vitamin B_6. To prepare samples for vitamin assays the meat was trimmed of external fat, diced, and ground twice in an electric grinder, first through a coarse plate and then through a fine plate (perforations $^3/_8$-inch and $^3/_{16}$-inch diameter, respectively). The ground samples were packed in moisture-vapor-resistant laminated freezer paper and frozen at −20° F. in an air blast freezer, then stored in a home freezer at approximately 0° to −8° F. Vitamin B_6 analyses were completed within 6 months on all but one pair of steers. Samples from two animal pairs were stored more than 1 year before completing the pantothenic acid analyses.

Vitamin B_6 and pantothenic acid were measured microbiologically using the yeast-growth methods of Atkin *et al.* (*1*, *2*), which employ *S. carlsbergensis* as the test organism. Incubation was carried out in 50-ml. Erlenmeyer flasks without shaking as recommended by Lushbough *et al.* (*5*). Bound vitamin B_6 was released by autoclaving in dilute HCl (pH 1.6) at 15 pounds of pressure for 4 hours. A double enzyme system of 2% intestinal phosphatase and 10% Dowex-treated pigeon liver was used for the release of bound pantothenic acid (*11*).

No attempt was made to measure free vitamin B_6 or pantothenic acid or to determine the distribution of vitamin B_6 among the three active forms: pyridoxine, pyridoxamine, and pyridoxal. The standard recovery of vitamin B_6 averaged 102.4 ± 0.76% (standard error of mean) and pantothenic acid averaged 93.7 ± 0.61%. Data were tested by analysis of variance.

Results

Vitamin B_6. Data for vitamin B_6 are shown in Table I. The grain-finished loin averaged 7.4 μg. per gram and the round 8.3 μg. per gram. While the values for grass-finished beef were consistently a little lower, averaging 6.8 and 7.4 μg. per gram for loin and round, respectively, the difference was not significant, as indicated in Table II. The values for the round muscle were significantly higher than those for the loin muscle ($P < 0.01$) for both types of

Table I. Vitamin B_6 Content of Longissimus Dorsi and Semimembranosus Muscles of Grain- and Grass-Finished Steers[a]

Days of Ripening	Moist Basis, μg./G.		Fat-Free, Dry Basis, μg./G.	
	Grain-finished	Grass-finished	Grain-finished	Grass-finished
	Longissimus dorsi			
0	7.5 ± 0.17	6.7 ± 0.40	31.9 ± 0.54	28.6 ± 1.67
7	7.4 ± 0.28	6.9 ± 0.39	31.5 ± 0.81	29.7 ± 1.46
21	7.0 ± 0.48	6.5 ± 0.40	30.5 ± 1.78	28.3 ± 1.38
42	7.6 ± 0.31	7.1 ± 0.59	31.8 ± 1.30	29.8 ± 2.24
Mean	7.4 ± 0.16	6.8 ± 0.21	31.4 ± 0.57	29.1 ± 0.80
	Semimembranosus			
0	8.3 ± 0.27	7.3 ± 0.22	34.6 ± 0.90	31.1 ± 1.10
7	8.6 ± 0.33	7.2 ± 0.41	35.5 ± 1.16	30.6 ± 1.93
21	7.9 ± 0.04	7.3 ± 0.06	33.1 ± 0.44	30.9 ± 0.36
42	8.4 ± 0.40	7.6 ± 0.55	34.3 ± 1.62	31.7 ± 2.14
Mean	8.3 ± 0.15	7.4 ± 0.17	34.4 ± 0.55	31.0 ± 0.72

[a] Averages from 5 steers ± standard error of mean.

Table II. Mean Squares for Vitamin B_6 and Pantothenic Acid

Source	d.f.	Vitamin B_6		Pantothenic Acid	
		Moist basis	Fat-free, dry basis	Moist basis	Fat-free, dry basis
Replications (pairs)	4	4.157	59.953	0.511	19.444
Feeds	1	11.773	160.716	9.296[a]	147.316
Error (main plot, rep. × feeds)	4	1.793	26.391	1.036	19.430
Ripening periods	3	0.876	5.890	0.323	7.922[b]
Muscles	1	10.915[b]	118.317[b]	5.476[b]	70.088[b]
Ripening periods × muscles	3	0.019	0.139	0.049	0.656
Ripening periods × feeds	3	0.182	2.055	0.050	0.542
Feeds × muscles	1	0.782	5.065	0.064	0.040
Feeds × ripening periods × muscles	3	0.120	2.784	0.008	0.318
Error (subplot)	56	0.343	5.401	0.122	1.876

[a] Significant ($P < 0.05$). [b] Significant ($P < 0.01$).

Table III. Pantothenic Acid Content of Longissimus Dorsi and Semimembranosus Muscles of Grain- and Grass-Finished Steers[a]

Days of Ripening	Moist Basis, μg./G.		Fat-Free, Dry Basis, μg./G.	
	Grain-finished	Grass-finished	Grain-finished	Grass-finished
	Longissimus dorsi			
0	4.1 ± 0.15	3.4 ± 0.18	17.1 ± 0.78	14.2 ± 0.83
7	4.1 ± 0.22	3.6 ± 0.13	17.7 ± 1.14	15.4 ± 0.56
21	4.2 ± 0.19	3.6 ± 0.16	18.2 ± 1.00	15.9 ± 0.56
42	4.4 ± 0.40	3.6 ± 0.20	18.4 ± 1.94	15.2 ± 0.82
Mean	4.2 ± 0.12	3.6 ± 0.08	17.9 ± 0.60	15.2 ± 0.35
	Semimembranosus			
0	4.7 ± 0.15	3.8 ± 0.17	19.3 ± 0.66	16.2 ± 0.76
7	4.6 ± 0.18	3.9 ± 0.12	19.3 ± 0.72	16.5 ± 0.39
21	4.8 ± 0.22	4.2 ± 0.23	20.5 ± 0.85	18.0 ± 0.89
42	4.9 ± 0.15	4.1 ± 0.21	20.1 ± 0.78	17.4 ± 0.76
Mean	4.8 ± 0.08	4.0 ± 0.09	19.8 ± 0.36	17.0 ± 0.37

[a] Averages from 5 steers ± standard error of mean.

finish. Ripening up to 42 days had no significant effect on the vitamin B_6 content of these two muscles from either grain- or grass-finished animals.

Pantothenic Acid. Data for pantothenic acid are presented in Table III. The grain-finished loin averaged 4.2 μg. per gram and the round 4.8 μg. per gram. The slightly lower values for the grass-finished animals, averaging 3.6 and 4.0 μg. per gram for loin and round, respectively, were significant ($P < 0.05$) only when calculated on a moist fat basis. The slightly higher value of the round than loin was significant ($P < 0.01$) for both grain- and grass-finished beef. Aging appeared to cause a slight increase in pantothenic acid when values were calculated to a fat-free, dry basis. In applying Duncan's multiple range test (*4*) significant differences ($P < 0.05$) were obtained between 0 and 21 days and between 0 and 42 days of ripening. All other comparisons among ripening periods were not significant.

Discussion

The data obtained in this study indicate that finishing beef on grain as compared to pasture does not significantly affect the vitamin B_6 or pantothenic acid content of beef tissue. Likewise, aging the beef up to 42 days had only a slight effect on the muscle content of pantothenic acid and no effect on vitamin B_6. While the slightly higher content of vitamin B_6 and pantothenic acid in the round (semimembranosus) muscle of animals on both feeds was significant, the difference would not be of importance in human nutrition.

The vitamin B_6 content of loin muscle ranged from 6.5 to 7.6 μg. per gram and of round muscle from 7.2 to 8.6 μg. per gram. These values are slightly higher than the value of 5.9 μg. per gram as determined by rat bioassay and 3.2 μg. per gram determined microbiologically on raw beef rib (*5*). Lean dried beef was reported to contain 15.93 μg. per gram of vitamin B_6 when determined microbiologically as the sum of pyridoxine, pyridoxal, and pyridoxamine (*10*). Assuming that lean beef averages 70 to 75% moisture, this value would also be less than that obtained in the present study.

The pantothenic acid content of the loin muscle ranged from 3.4 to 4.4 μg. per gram and the round from 3.8 to 4.9 μg. per gram. These values are in good agreement with values previously reported for beef rib (*9*) but slightly lower than the average value of 5.4 and 6.6 μg. per gram reported for rib and round of beef when determined microbiologically with *Lactobacillus plantarum* and the enzyme system employed in the present study for release of bound pantothenic acid (*11*).

Grain- and grass-finished beef as produced for this study were equally good sources of vitamin B_6 and pantothenic acid. Normal amounts of aging appeared not to affect the concentration of vitamin B_6 but pantothenic acid slightly increased with 21 and 42 days of aging.

Literature Cited

(1) Atkin, L., Schultz, A. S., Williams, W. L., Frey, C. N., *Ind. Eng. Chem., Anal. Ed.* **15,** 141 (1943).
(2) Atkin, L., Williams, W. L., Schultz, A. S., Frey, C. N., *Ibid.*, **16,** 67 (1944).
(3) Chow, B. F., in "Nutrition," Beaton, G. H., McHenry, E. W., Vol. **II,** Academic Press, New York, 1964.
(4) Duncan, D. B., *Biometrics* **11,** 1 (1955).
(5) Lushbough, C. H., Weichman, J. M., Schweigert, B. S., *J. Nutr.* **67,** 451 (1959).
(6) Meyer, B., Thomas, J., Buckley, R., *Food Technol.* **14,** 190 (1960).
(7) Meyer, B., Thomas, J., Buckley, R., Cole, J. W., *Ibid.*, **14,** 4 (1960).
(8) National Academy of Sciences–National Research Council, "Recommended Dietary Allowances," Publ. **1146** (1964).
(9) Schweigert, B. S., Guthneck, B. T., *J. Nutr.* **51,** 283 (1953).
(10) Toepfer, E. W., Polansky, M. M., Richardson, L. R., Wilkes, S., J. Agr. Food Chem. **11,** 523 (1963).
(11) Zook, E. G., MacArthur, M. H., Toepfer, E. W., U. S. Dept. Agr., Handbook **97** (1956).

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