# EFFECT OF TIME-ON-FEED ON THE NUTRIENT COMPOSITION OF BEEF STEAKS

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## Story in Brief

Forty-eight Angus x Hereford steers were used to assess the effect of time-on-feed on the nutrient composition of beef rib steaks. The steers were fed a high concentrate diet and serially slaughtered at 28 day intervals over a 196 day feeding period. Day 0 served as a grass-fed control. At slaughter, steaks from the ninth rib were removed and trimmed of exterior fat and epimysial connective tissue for chemical analyses. Increased time-on-feed resulted in a cubic increase in intramuscular fat content with a resultant linear decrease in moisture and protein content. The most substantial increase in fat content was noted after 84 days on feed. Ash content decreased cubically but individual mineral concentrations did not differ significantly. Total and neutral lipid contents both increased linearly with time-on-feed. Polar lipid concentrations remained constant over time-on-feed. With increased time-on-feed, the neutral lipid fraction became more unsaturated. The ratio of saturated fatty acids to unsaturated fatty acids differed quadratically over time.

(Key Words: Beef, Proximate Composition, Lipids.)

## Introduction

Due to an increasingly health conscious society, the inclusion of beef as part of the American diet has been the focus of debate, primarily due to beef's saturated fat content and possible link to coronary heart disease (CHD) (Truswell, 1978). Current recommendations by the American Heart Association regarding dietary fat focus on replacing the intake of saturated fat with that of unsaturated fats. Monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) have been shown to reduce plasma LDL-cholesterol and consequently reduce the risk of CHD (Mattson & Grundy, 1985).

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As time on a high concentrate diet increases, cattle deposit greater amounts of fat which consequently decreases moisture and mineral concentrations in the muscle. This increase in intramuscular fat content is due primarily to an increase in triglycerides as the phospholipids remain constant throughout growth (Link, 1970). PUFA are predominately located in the phospholipid fraction and since this fraction is diluted by the increase in triglycerides, PUFA decrease with increased time-on-feed (TOF). Conversely, changes in the MUFA and saturated fatty acids (SFA) over TOF have not been studied extensively. The objective of this study was to assess the effect of time-on-feed on the nutrient composition of beef steaks.

## Materials and Methods

Forty-eight Angus x Hereford steers, approximately 16 months of age were obtained from a native range stocker operation in northwestern Oklahoma. Steers were blocked by weight into eight equally sized groups to be serially slaughtered at 28 day intervals (0-196 days). Steers were fed a high concentrate diet (87.50% dry matter, 2.11 Mcal/kg NEm, 1.36 Mcal/kg NEg) except for Day 0 which served as a grass-fed control. All steers were conventionally slaughtered at the Oklahoma State University Meat Laboratory. A one inch boneless rib steak corresponding to the ninth rib was removed from each carcass, vacuum packaged and stored at -20°F. After removal of all exterior fat and epimysial connective tissue, the lateral half of each longissimus muscle (LM) was pulverized in liquid nitrogen prior to chemical analyses.

Duplicate samples were dried at 216°F for 24 hours, extracted with ether and then ashed at 1250°F for 8 hours to determine moisture, crude fat and ash content, respectively (AOAC, 1984). Crude protein content was determined using the KJELTEC Auto 1030 Analyzer. Individual mineral concentrations were determined using a Perkin-Elmer Model 403 Atomic Absorption Spectrometer. Samples were solvent extracted to obtain two fractions: neutral (NL) and polar (PL) lipid. The NL fraction contains mono-, di- and triglycerides while the PL fraction contains the phospholipids. NL and PL were esterified and analyzed for fatty acid content using a HP5890A Gas Chromatograph.

General Linear Model procedure of SAS was used to test the effect of time-on-feed (TOF). Differences between means were compared using Tukey's t-tests. Orthogonal polynomials were computed to determine linear, quadratic and cubic effects over TOF.

## Results and Discussion

The performance and carcass data of these steers along with palatability attributes have been reported previously (May et al. 1989). Proximate composition data of the LM is reported in Table 1. Increased TOF resulted in a cubic increase in fat content with a concomittant linear decrease in moisture and protein contents (P<.01). The fat content in the LM doubled between 84 and 112 days on feed but did not differ (P>.05) from 0 to 84 or from 112 to 196 days. Ash content decreased cubically (P<.05), however, Ca, P, Mg, Na, K and Fe concentrations (Table 2) did not differ (P>.05). Mg and K did show a tendency for a cubic effect (P<.10). All values are in agreement with those published in the USDA Agricultural Handbook 8-13 (USDA, 1990).

Percent total lipid (Figure 1) increased linearally with increased TOF which resulted in a similar increase in NL (P<.05). PL content did not differ (P>.05) with increased TOF. The amount of NL increases proportionally with the increase in total lipid. When expressed as a percentage of total lipid (Figure 2), NL increased quadratically while the PL decreased quadratically. Therefore, increases in the amount of NL coincided directly with increases in total lipid. Thus as animals deposit greater amounts of intramuscular fat during growth the relative proportions of PL are diluted with the increasing amounts of NL.

**Table 1. Proximate composition of the LM.**

| TOF | % Moisture | % Protein | % Fat | % Ash |
|---|---|---|---|---|
| 0 | 74.58$^{a}$ | 21.71$^{a}$ | 2.09$^{a}$ | 1.09$^{a}$ |
| 28 | 74.08$^{a}$ | 21.83$^{a}$ | 2.62$^{a}$ | 1.08$^{a}$ |
| 56 | 73.32$^{ab}$ | 20.51$^{ab}$ | 4.10$^{a}$ | 1.07$^{ab}$ |
| 84 | 73.64$^{a}$ | 21.41$^{ab}$ | 4.02$^{a}$ | 1.08$^{a}$ |
| 112 | 70.45$^{bc}$ | 19.50$^{b}$ | 8.67$^{b}$ | 0.99$^{bc}$ |
| 140 | 68.93$^{c}$ | 20.33$^{ab}$ | 9.35$^{b}$ | 0.99$^{bc}$ |
| 168 | 68.59$^{c}$ | 20.58$^{ab}$ | 9.64$^{b}$ | 0.99$^{b}$ |
| 196 | 67.47$^{c}$ | 20.07$^{ab}$ | 10.14$^{b}$ | 0.98$^{c}$ |
| SEM | 0.70 | 0.41 | 0.80 | 0.02 |

$^{abc}$ Means with different superscripts in the same column differ significantly (P<.05).

Table 2. Mineral composition of the LM[a].

| TOF | Mg | Na | K | Ca | Fe | P | Zn |
|---|---|---|---|---|---|---|---|
| | | | mg/100 g sample | | | | |
| 0 | 17.78 | 85.35 | 329.83 | 19.55 | 5.36 | 226.00 | 5.66 |
| 28 | 20.96 | 86.33 | 315.23 | 24.98 | 5.08 | 188.73 | 6.70 |
| 56 | 19.31 | 92.76 | 321.79 | 23.45 | 5.12 | 198.93 | 8.11 |
| 84 | 20.75 | 100.65 | 336.31 | 23.17 | 5.30 | 185.43 | 12.17 |
| 112 | 21.97 | 91.91 | 324.85 | 30.50 | 5.37 | 189.07 | 8.43 |
| 140 | 15.44 | 92.40 | 295.27 | 15.05 | 4.97 | 216.47 | 7.48 |
| 168 | 17.71 | 107.85 | 283.72 | 21.02 | 5.76 | 204.47 | 8.94 |
| 196 | 19.66 | 89.00 | 332.97 | 24.33 | 5.68 | 202.00 | 9.41 |
| SEM | 0.70 | 4.68 | 5.09 | 2.17 | 0.08 | 7.31 | 0.66 |

[a] Means did not differ across TOF (P>.05).

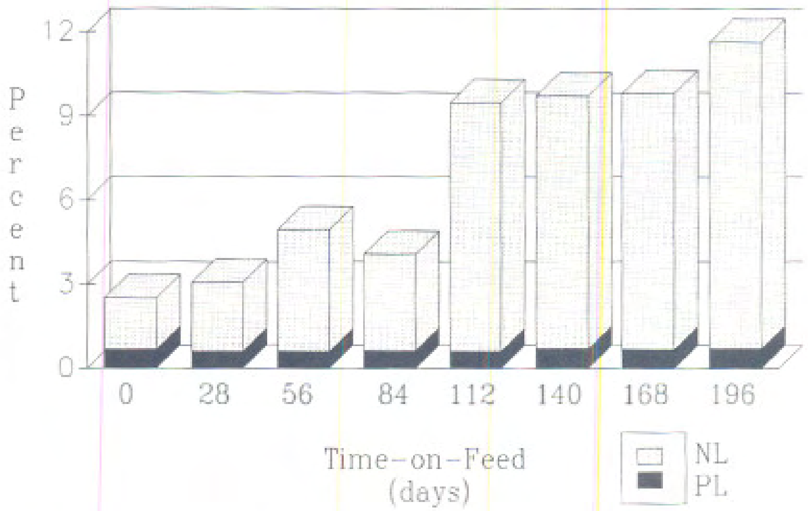


Figure 1. Lipid composition of the LM.

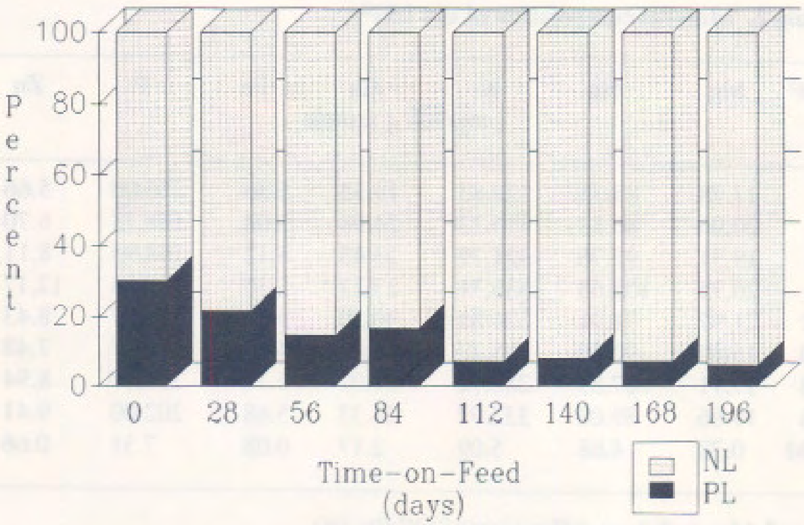


**Figure 2. Percent NL and PL in the LM on a TL basis.**

Oleic (C18:1), stearic (C18:0) and palmitic (C16:0) acids were the most abundant fatty acids present, respectively, and accounted for approximately 80% of total lipid. The percent SFA (Figure 3) in the LM showed a quadratic effect ($P<.01$) while the percent MUFA showed a linear increase of 8.8% and percentage PUFA showed a linear decrease of 8.1% ($P<.01$) over TOF. Over two-thirds of the PUFA were located in the PL, thus, since PL decreased as a percentage basis of TL, the PUFA were diluted by the increase in the NL. The increase in MUFA was due primarily to a significant increase in oleic acid (C18:1) ($P<.05$). Increased TOF resulted in increased unsaturation in the NL fraction. The ratio of SFA to unsaturated fatty acids (UNSFA) (Table 3) differed quadratically ($P<.01$) with TOF following the same trend as the change in SFA due to the cancellation effect of the MUFA increase and PUFA decrease. On the average the SFA:UNSFA ratio was 0.97, meaning that over 50% of the fat in the LM was unsaturated.

In summary, cattle need to consume a high concentrate diet approximately 112 days before slaughter to acquire the level of intramuscular fat in the LM to obtain the choice quality grade. Extending the time cattle are fed a high concentrate diet past 112 days does not significantly increase intramuscular fat deposition but does reduce PUFA concentrations and increase the MUFA content in the LM.

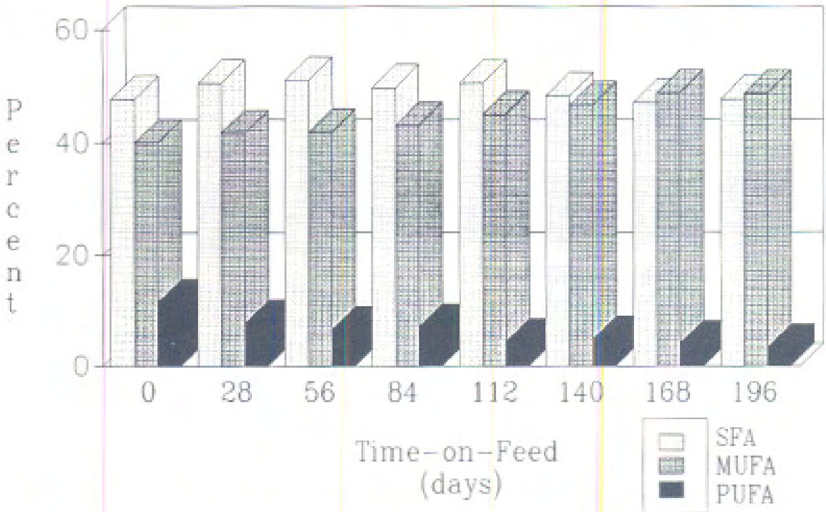


**Figure 3. Fatty acid composition of the LM.**

**Table 3. Ratio of saturated fatty acids to unsaturated fatty acids in the LM.**

| TOF | SFA:UNSFA |
|---|---|
| 0 | 0.92[ab] |
| 28 | 1.02[ab] |
| 56 | 1.05[a] |
| 84 | 0.99[ab] |
| 112 | 1.02[ab] |
| 140 | 0.94[ab] |
| 168 | 0.89[b] |
| 196 | 0.92[ab] |
| SEM | 0.01 |

[a,b] Means with different superscripts differ significantly ($P<.05$).

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