LOW COST COW/CALF PROGRAM

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# From Grass to CLA

To maximize the quantities, in a desirable ratio, of omega-3 and omega-6 fatty acids in the fatty tissues and milk of ruminant animals, they've got to spend some time in the pasture. The more time the better. A bunch of Irishmen[1] recently reported the results of a study - on the impact of the duration of grazing on tissue-fatty acid profiles. Sixty Charolais, crossbred heifers (732 lb) were assigned randomly to four treatments. Heifers in treatment groups 1, 2 and 3 were confined and fed perennial ryegrass silage ad libitum and about 6.5 lb of a barley/beet pulp concentrate. One group of 15 heifers remained on this regime for the entire 158-day study. A second group was moved to pasture 118 days before slaughter and a third went to pasture 59 days before slaughter. The fourth group was never confined and went directly to pasture for the entire 158 days. All cattle were slaughtered on the same day. Samples of longissimus muscle and kidney and subcutaneous fats were collected for fatty acid analyses.

| Fatty Acid Proportions X 100 | | | | |
|---|---|---|---|---|
| Fatty | Days At Pasture | | | |
| Acids | 0 | 40 | 99 | 158 |
| neutral lipids in fat from muscle | | | | |
| ω-6 | 1.58 | 1.71 | 1.63 | 1.76 |
| ω-3 | 0.79 | 0.96 | 1.01 | 1.23 |
| ω-6:ω-3 | 2.04 | 1.80 | 1.61 | 1.43 |
| polar lipids in fat from muscle | | | | |
| ω-6 | 20.06 | 21.94 | 17.79 | 18.07 |
| ω-3 | 8.45 | 10.21 | 10.81 | 12.12 |
| ω-6:ω-3 | 2.36 | 2.17 | 1.65 | 1.49 |
| total lipids in fat from muscle | | | | |
| ω-6 | 3.50 | 3.80 | 3.06 | 3.46 |
| ω-3 | 1.59 | 1.90 | 1.88 | 2.37 |
| ω-6:ω-3 | 2.21 | 1.99 | 1.63 | 1.46 |
| $\Delta^9$ desat | 0.470 | 0.450 | 0.458 | 0.466 |
| fatty acids in subcutaneous fat | | | | |
| ω-6 | 1.65 | 1.57 | 1.67 | 1.72 |
| ω-3 | 0.63 | 0.66 | 0.89 | 1.06 |
| ω-6:ω-3 | 2.64 | 2.43 | 1.94 | 1.65 |
| $\Delta^9$ desat | 0.512 | 0.505 | 0.524 | 0.527 |

*where: ω= omega, $\Delta^9$ desat = delta 9 desaturase index.*

## No Surprises

This study is a cut above many of the studies about foraging ruminants and tissue fatty acid profiles. Total tissue fat deposited during the 158-day experiment was the same for all treatments. As cattle get fatter, the kind of fat (deposited) changes. Not so in this study. The authors went the extra mile to measure the fatty acid composition of the polar lipids, as well as neutral fat in the muscle. Most commonly, when we speak of fat, we are talking about neutral fat. Neutral fat consists primarily of triglycerides (*three fatty acids hooked to the alcohol glycerol*). It is the fat we see (such as the subcutaneous fat) and serves as an energy reserve. Polar fat consists of diglycerides (*two fatty acids*) and another molecule, usually phosphoric acid, in the place of the third fatty acid. Polar fat makes up the membranes, e.g., cell walls. The kinds of fatty acids, contained in the polar fat, can impact the ease of movement of molecules in and out of the cell. The ω-3s contribute to cell wall porosity. This is the basis of some of the health claims for humans consuming grass-fed beef and/or milk. As indicated in the previous table, the proportion of ω-6 fatty acids, in the neutral fat fraction of muscle, increased nonlinearly with time on pasture. The ω -3s increased linearly. The ratio, ω-6:ω-3, declined from 2.04 to 1.43 by 158 days on pasture. Overall, the proportions of the CLAs are much higher in the polar lipid fraction of muscle. The ω-6s declined while the ω-3s increased, resulting in a declining ratio of ω-6 to ω-3. These trends hold when the neutral and polar lipids are combined into total lipids from muscle fat. Fatty acid proportions, found in the subcutaneous fat, differed from those in muscle fat. There wasn't much of a trend up or down for the ω-6 fraction, while the ω-3 proportions increased considerably. Consequently, the ratio of ω-6 to ω-3 declined.

## Why Grass

It commonly is believed that grass-fed cattle form fatty acid profiles (in their tissues) that contain high levels of CLAs (in the desired ratio) because that is the way they exist in the grass. The truth: the fats, contained in the forage, form the proper medium for the formation of the starting materials that will lead to the CLAs. Dietary fats must run the gauntlet set up by the rumen microorganisms. Unsaturated fatty acids are toxic to the bacteria so they are put though the process of biohydrogenation, orchestrated by the rumen microorganisms. Hydrogen is pumped in, thus eliminating many of the double bonds. A major end product is stearic acid - an 18-carbon, totally saturated acid. Biohydrogenation, however, is not complete. A significant level of a monounsaturated fatty acid, vaccenic (*named after vacca, cow in Spanish*), is formed and remains in the post-rumen ingesta. Vaccenic acid is absorbed from the gut and distributed throughout the body. Vaccenic acid is desaturated endogenously in the tissues and udder, by the enzyme $\Delta^9$ desaturase, to form CLA. In the current study, desaturase activity (in muscle and subcutaneous fat) was the same for all grazing times (first table). Therefore, duration of grazing did not cause a difference in the level of $\Delta^9$ desaturase. Fatty acids that were formed in the rumen (on the grass diet) were predisposing to the final CLA found in the tissue. Vaccenic acid per se accumulated in the muscle and subcutaneous fats, with the duration of time on pasture (in this study). Some recent studies suggest that human tissues contain $\Delta^9$ desaturase and CLA is formed from the vaccenic acid from ruminant meat and milk.

| Fatty Acid Profile of Feedstuffs | | | |
|---|---|---|---|
| | Conc. | Silage | Pasture |
| SFA[a] | 27.04 | 21.43 | 21.68 |
| MUFA[b] | 16.54 | 4.40 | 5.13 |
| PUFA[c] | 53.79 | 62.20 | 59.41 |

[a] total saturated fatty acids

[b] monounsaturated fatty acids

[c] polyunsaturated fatty acids

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[1] Noci, F, F J Monahan, P French and A P Moloney. 2005. The fatty acid composition of muscle fat and subcutaneous adipose tissue of pasture-fed beef heifers: Influence of the duration of grazing. J. Anim. Sci. 83:1167.