

Fatty acid composition of milk from pasture-fed and grain-fed American Milking Devon Cows

Procedure-The samples were prepared according to the method of Chouinard (1999). Samples were analyzed according to the method of Snow (2010).

The fatty acid composition of Devon milks was determined by gas chromatography. In this analysis, the individual fatty acids that make up milk triglycerides are separated and measured. The analysis constitutes removing the individual fatty acids from the glycerol backbone and then derivitizing them to make them more volatile. This is shown in Figure 2.

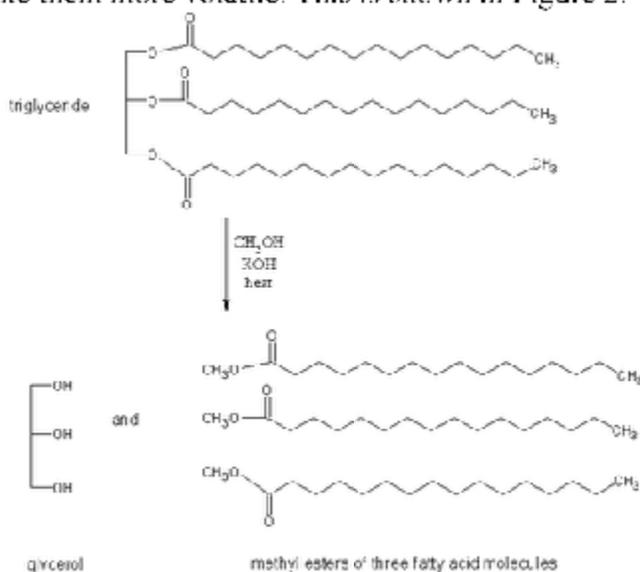


Figure 1: Chemical derivitization of triglycerides to fatty acid methyl esters.

A triglyceride is made up of three fatty acids linked chemically to glycerol and about 97.5% of the fat in milk is in the form of triglycerides. When CH₃COH (methanol) KOH (potassium hydroxide) and heat are added, the fatty acids are removed and joined to a methyl group. Now they are smaller and easy to separate in a gas chromatograph.

The samples are injected into the machine at 250°C and then enter into a tiny capillary column. As they move through the column, propelled by hydrogen gas, they separate from each other. At the end they are burned and make a signal. The more signal, the more fatty acid there is. Figure 2 shows a 'chromatogram' of fatty acids that were separated. The little ones on the left (like C4:0, C6:0 and C8:0) are what make milk fat have the interesting melting properties it has. Fats without short chain fatty acids typically are much harder and don't have such a nice texture.

The designation C18:0 and C18:1 refers to the structure of the fatty acids. The 'C' means carbon. The next number tells us how long the fatty acid is. So...both C18:0 and C18:1 are eighteen carbons long. The number after the colon tells us how many 'desaturations' a fatty acid has. C18:0 has zero, and thus is a 'saturated' fat. C18:1 has one desaturation and is a 'monounsaturated' fatty acid. C18:2 has two desaturations and thus is 'polyunsaturated' as is C18:3. The difference between the two polyunsaturates (C18:2 and C18:3) are the position of the

double bonds. C18:2 is an omega-6 fatty acid and C18:3 is an omega-3 fatty acid. The fatty acid composition of milks from Devon cows fed two diets are shown in Figure 1.

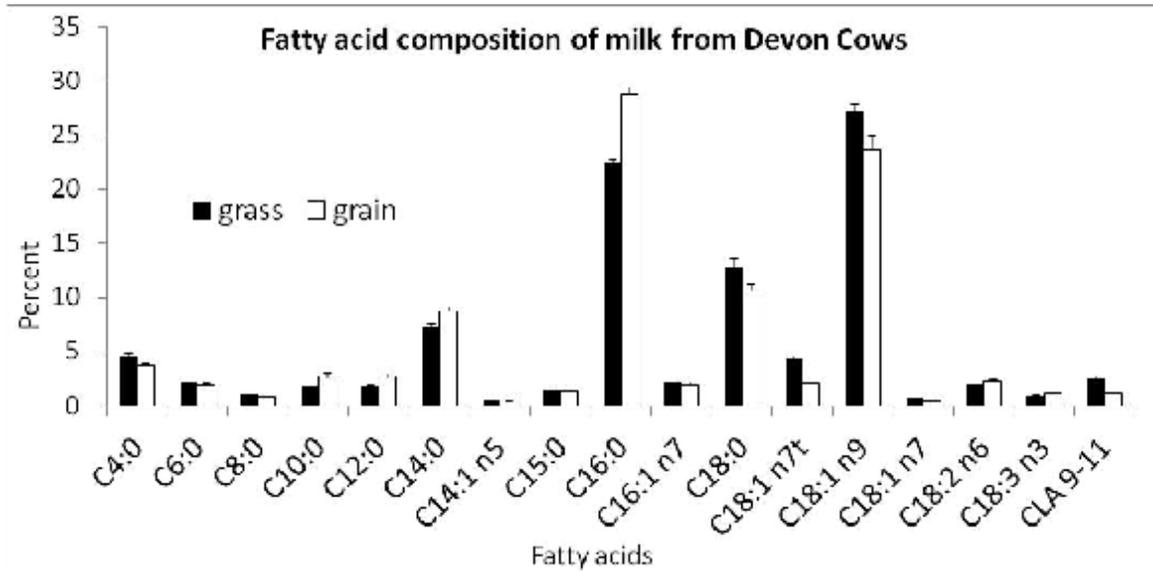


Figure 1: Most abundant fatty acids in Devon Milk between pasture-fed and grain-fed animals.

In the milk fat analysis we take the area of each peak and add them together. We then list each individual fatty acid as a percentage of that whole. The data from the current samples is shown in Table 1. On the left there is data from a reference sample. This data comes from a study published in 2010 that surveyed the milk sold in all parts of the US and found the composition was remarkably consistent. Therefore it is a good benchmark against which to compare the Devon milks.

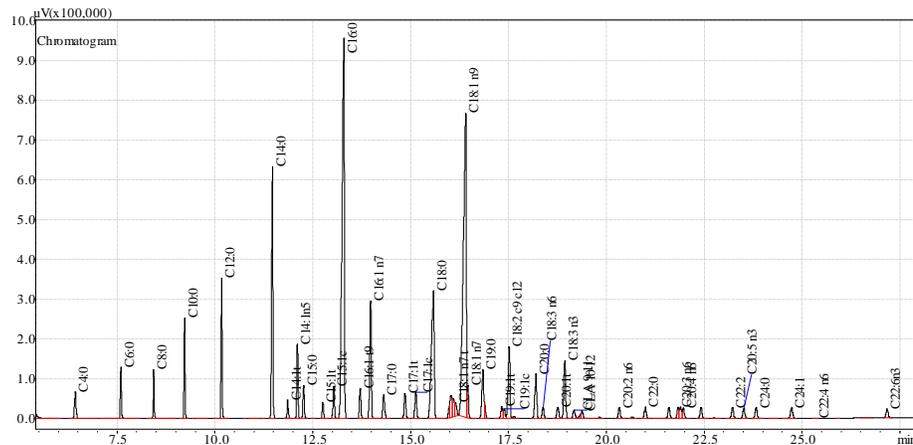


Figure 2: Separation of fatty acids in a gas chromatograph. The x-axis is time and the y-axis is the signal the fatty acids generate. More signal means more fatty acids.

According to the table, Devon milk from pasture-fed cows has similar amounts of C4:0, C6:0, C8:0. It has a little less C10:0, C12:0, C14:0 and C16:0. The short chain fatty acids (C4:0-C10:0) are very pungent when free from the triglyceride and give feta cheese its characteristic aroma. These fatty acids are absorbed in the stomach and small intestines and do not affect circulating

cholesterol. There were also differences in the C14:0, C16:0, C18:0 and C18:1. The first two (C14:0 and C16:0) are considered the two saturated fats that raise LDL cholesterol and are the basis of why we are told to avoid saturated fats. C18:0 is also saturated, but has no effect on LDL.

The other interesting differences are in the C18:1n7t and CLA 9-11. These two fatty acids are actually ‘trans’ fats, but not like the ones in margarine. The trans fats in milk come from biohydrogenation in the rumen, and surprisingly have been linked to interesting nutritional properties. Work in lab animals like mice and rats have shown these fatty acids have some anticancer properties and may improve metabolism. However, I don’t believe this has been effectively shown in humans. The milk from Devon cows fed pasture has more of both of these fatty acids.

Table 1: Fatty acid composition of typical US milk (reference) and of the Devon milks from grass-fed and grain-fed cows.

| Fatty acids | reference | grass | grain |
|------------------------|------------------|--------------|--------------|
| C4:0 | 4.15 | 4.49 | 3.73 |
| C6:0 | 2.13 | 2.11 | 1.93 |
| C8:0 | 1.19 | 0.99 | 0.86 |
| C10:0 | 2.59 | 1.86 | 2.75 |
| C12:0 | 2.87 | 1.89 | 2.73 |
| C14:0 | 9.53 | 7.32 | 8.79 |
| C14:1 n5 | 0.82 | 0.56 | 0.53 |
| C15:0 | 0.89 | 1.41 | 1.35 |
| C16:0 | 28.08 | 22.42 | 28.77 |
| C16:1 n7 | 1.48 | 2.11 | 1.94 |
| C18:0 | 11.68 | 12.77 | 10.72 |
| C18:1 t7 | 1.58 | 4.33 | 2.09 |
| C18:1 n9 | 23.58 | 27.15 | 23.70 |
| C18:2 n6 | 3.19 | 1.98 | 2.26 |
| C18:3 n3 | 0.38 | 0.94 | 1.17 |
| CLA 9-11 | 0.55 | 2.47 | 1.13 |
| saturated | 63.11 | 55.26 | 61.64 |
| monounsaturated | 27.46 | 34.14 | 28.26 |
| polyunsaturated | 4.12 | 5.39 | 4.56 |
| Ω6/Ω3 ratio | 8.39 | 2.10 | 1.93 |

When we look at the broad classes of milk fatty acids we see a couple of interesting trends. Overall, Devon milk appears to have a somewhat lower saturated fatty acid composition. In addition, it is higher in the monounsaturated fatty acids. To a dietician this would be considered a good thing. Also of interest is the fact that the Devon milks are higher in omega-3 fatty acids and lower in omega-6 fatty acids. Together, this gives them a lower omega-6/omega-3 ratio. Both the omega-6 and the omega-3 fatty acids are essential nutrients, and if we don’t get enough we will show deficiency symptoms. However, practically this isn’t possible as all foods have at least a little bit. The omega-6 fatty acids are precursors for inflammatory signaling and are associated with redness and swelling in injuries. In fact, the non steroidal anti-inflammatory drugs (NSAIDs) like ibuprofen and naproxen work by shutting down this system, as does aspirin. Omega-3 fatty acids are antagonistic to these processes. Some nutrition professionals believe a

lot of our Western Diseases can be attributed to excess omega-6 consumption and inadequate omega-3 intake.

In general, all of the differences we see in the pasture-fed Devon milks would be considered a good thing nutritionally. However, this is not the same as saying that they will cure a lot of diseases. The only way to determine that is to test it in a controlled trial. There may well be other components of Devon milk that may be healthful, but this analysis is only specific for the fat composition.

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References

- Chouinard, P. Y., Corneau, L., Barbano, D. M., Metzger, L. E., & Bauman, D. E. (1999). Conjugated linoleic acids alter milk fatty acid composition and inhibit milk fat secretion in dairy cows. *J Nutr*, *129*, 1579-1584.
- Snow, D. R., Jimenez-Flores, R., Ward, R. E., Cambell, J., Young, M. J., Nemere, I., & Hintze, K. J. (2010). Dietary milk fat globule membrane reduces the incidence of aberrant crypt foci in Fischer-344 rats. *Journal of Agriculture and Food Chemistry*, *58*, 2157-2163.