Fatty Acids in Wagyu Beef

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The purpose of this talk is to give you a background in lipids and health, talk about the composition of Wagyu and how to change that composition as well as other important issues.

Here's something everyone recognizes – cholesterol. Cholesterol is a necessary component of all diets. There really is no 'good' and 'bad' cholesterol in foods. In your blood the 'good' is that associated with high density lipoproteins (HDL) and the 'bad' cholesterol is associated with the low density lipoproteins (LDL).

Next are saturated fatty acids (SFA). They have no double bonds between carbon atoms. SFA are designated as 12:0, 14:0 etc. This designation for the fatty acid refers to the number of carbons (ie. 12, 14) followed by the number of double bonds (ie. 0).

Monounsaturated fatty acids (MUFA) have one double bond. They can be present in the cis or trans form. For example, the cis form is oleic, with a designation of 18:1. The trans form is eleidic. Oleic is the most prevalent form of MUFA in beef. The trans form is formed during the preparation of processed foods such as margarine.

Polyunsaturated fatty acids (PUFA) have two or more double bonds such as linoleic (18:2) and linolenic (18:3). Linoleic acid is prevalent in corn and soy oils and is present in meats. Linolenic acid is found in soy, flax and forages. Now let's talk about omega 6 vs. omega 3 PUFA. Omega 6 means there are 6 carbons to the first double bond from the methyl end of the fatty acid. Omega 3 means it's first double bond is three carbons from the methyl end. The compounds formed from one can't be formed from the other. Arachidonic acid (20:4) is an important omega 6 PUFA, and Eicosapentanoic acid (EPA, 20:5) and docosahexenoic acid (DHA, 22:6) are omega 3 PUFA found in fish oil. DHA serves an important function in the brain.

How do fatty acids affect food functionality? As the carbon length increases so does the melting point. So consequently 18:0 is firmer than 16:0. The more double bonds there are the lower the melting point. This has a greater effect than carbon length. So 18:0 is firmer than 18:1 which is firmer than 18:2. This is like mutton vs. beef vs. pork. The percentage of fatty acid also affects the texture and mouth feel of the food. Mutton has high levels of stearic acid and when eaten it coats your mouth, beef has more oleic while pork has more polyunsaturated fatty acids. Palatability and texture are also affected by fatty acids. PUFA's are very susceptible to oxidative rancidity, giving it the warmed over flavor. Nonruminants like pigs on a high fat diet deposit the type of fat they consume so if they consume peanut oil there fat will be very soft and oily. The microbes in the rumen alter the fatty acid deposited by cattle.

How do fatty acids affect health? Some saturated fatty acids increase plasma cholesterol levels. This is not due to the increased melting point. Saturated fatty acids decrease the cholesterol removed by the liver therefore increasing the LDL cholesterol levels remaining in the blood. Stearic acid, a SFA, doesn't have the negative effect because an enzyme, delta 9 desaturase, converts the stearic acid to oleic, which is a MUFA and it doesn't have the detrimental effects. Monounsaturated fatty acids in the cis configuration decrease LDL but not HDL. This is like oleic acid, which is the most prevalent fatty acid in beef. Polyunsaturated fatty acids decrease LDL and HDL.

Omega or N-3 fatty acids such as linolenic (18:3), EPA (20:5), which is found in fish, with some in beef, and DHA (22:6), also found in fish may reduce the risk of heart attack, it decreases blood clots, and is also positive for diabetics. The U.S. diet is high in Omega or N-6 fatty acid such as linoleic (18:2) and arachidonic (20:4) and low in omega 3 fatty acids. An N-6/N-3 ratio of 4/1 may be desirable. The typical U.S. diet is much higher than that. Corn and soybean oils are high in omega-6 but they can and are being genetically altered to reduce the N-6/N-3 ratio. In contrast, flax seed and grass are high in Omega-3 fatty acids.

Conjugated linoleic acids (CLA) are 18:2 but they have the double bonds in different locations. Ruminants are a good source of CLA because they synthesize it from linoleic acid in the rumen. CLA may reduce heart disease risk, reduce muscle mass and decrease fat and also reduce the risk of cancer.

Let's look at fatty acid composition. Most beef is higher in MUFA than SFA especially nonstearate SFA. There is increasing evidence that diets with moderate amount of fat, protein and carbohydrates are best. It would be interesting to know how much the pasta push has contributed to the diabetes epidemic? Long fed Wagyu beef is much higher in MUFA than SFA. It has been shown that after 90 days on an 80-90% concentrate diet with an average daily gain of greater than 3 lbs. the ratio of MUFA to SFA is 1.1/1. When the diet is changed and the animals are fed for 160 days the ratio is 1.5-1.6 /1. There are few major consistent differences in fatty acid profiles of Wagyu versus other breeds but in general there is more of everything in Wagyu. Some sire differences have been shown indicating selection could be possible but sire differences are not huge. Different diets, time on feed and interactions are very important and can cause changes.

Fatty acid profiles can be changed in many ways. MUFA's can be increased with time on feed. Grass feeding increases N-3 and CLA. Flax increases N-3. High linoleic acid (sunflower/safflower oils) increases CLA, especially when fed in higher roughage diets. By increasing oil during backgrounding the CLA also increases. When animals are fed on diets containing grass, grain, oil or yellow grease it was found that the N-6/N-3 was much higher in grain vs. grass fed. CLA was 36 mg/100g raw meat when fed grass vs. 12 mg on grain. When oil was added to the backgrounding diet, the CLA increased to 60 mg and yellow grease supplementation also increased the CLA to 25 mg/100g raw meat.

What is the nutritional significance of all this? You would probably need about 1000-3000 mg of N-3 and CLA per day for nutritional significance. A 100g serving of ground beef from an oil-supplemented steer would have 150-500 mg. So it will not supply the CLA alone, but perhaps as a part of a complete diet.

How about grass feeding? The taste is affected. It has been found that Wyoming Lean Beef, which is grass fed is equivalent to grain fed in tenderness if it is electrically stimulated, blade tenderized and aged properly. The variety of grass fed also makes a difference – all grasses are not the same. For palatability many studies indicate about 100 days on feed is required for maximal tenderness. Would rapid growth on grass or a combination of grass/grain or a higher roughage diet, have the same effect?

What does the future hold? How can we predict the things that have happened in the last few years such as E.coli, mad cow disease (BSE) first in Europe, then Japan and Canada, hoof and mouth disease, WalMart and case ready products and finally country of origin labeling?

How would these scenarios change the overall picture? First what would happen with high fuel cost, decreased availability or increased cost of irrigation water, elimination of cheap grain prices, continued or increased trade barriers to New Zealand, Australian and South American beef, resistance to confinement (grain) feeding and decreased availability of antibiotics? Those factors would clearly favor grass-fed beef production. On the other hand what if there is continued cheap fuel, plentiful irrigation water and/or environmentally sustainable grain production, continued cheap grain policies, free trade and limited interest in social/nutritional differences between grain and grass feeding or changes to equalize their differences? Those factors clearly favor grain feeding of beef.

Many challenges and uncertainties face the beef industry. Thankfully, we have quality people in the industry, like you, who will turn these challenges into opportunities.

Thank you.