Nutrient Composition and Residue Analysis of Grain-Finished and Grass-Fed and Finished Beef: A Comparative Study

Foote Cattle Company

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Executive Summary

Overview

This study evaluated the nutritional composition and antibiotic, hormone, and beta-agonist drug residue in conventionally raised grain-finished compared to grass-fed and finished beef.

Problem

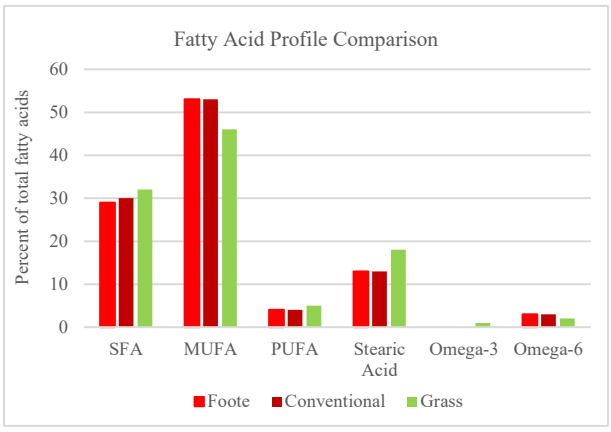
There is a misconception that beef raised, fed, and finished on grass and labeled "antibiotic-free" and "hormone-free" is healthier and safer for the consumer compared to conventionally raised grain-finished beef.

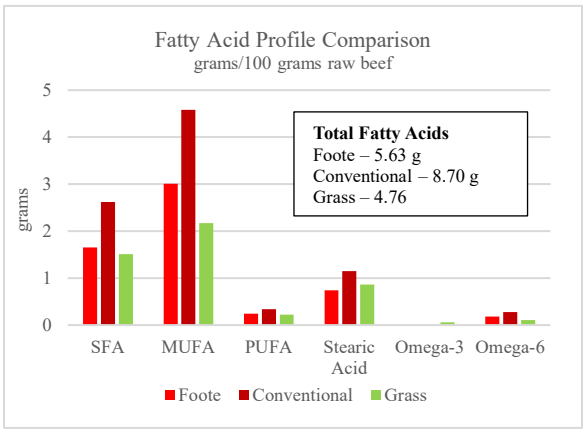
Solution

- Regardless of how the beef was raised, all beef samples resulted in no antibiotic, hormone, or beta-agonist residues in the meat.
- Beef samples from grain-finished sources had greater monounsaturated fatty acid composition, which are considered the beneficial dietary fats.
- Grass-fed and finished beef resulted in detectable levels of vitamins A, D, and E and omega-3 fatty acids but were at levels to provide 5% or less of recommended daily allowance for healthy adults.
- Most cuts of both grain-finished and grass-finished beef meet USDA guidelines for lean.

Highlights

The only nutritional difference in beef relates to the fatty acid content and profile of grain-finished and grass-finished beef. Grain-finished beef has more total fatty acids with greater percentage of MUFA and less SFA compared to grass-finished beef. The fatty acid profile of grain-finished beef may be more conducive to better health outcomes.





Keys to Success

Educate, inform, and support consumers in building their confidence and trust in agriculture and beef purchasing decisions.

Introduction

Beef remains a primary source of high-quality protein in the U.S. and worldwide. It is valued for its flavor, tenderness, and rich nutrient profile, such as essential amino acids, vitamins, including B12 and riboflavin, minerals like iron and zinc, and beneficial fatty acids (Agarwal and Fulgoni, 2024). These attributes form a strong basis for consumer preference, especially among populations that prioritize both taste and nutritional value in their diets.

Beef raised in the U.S. is often categorized into two different feeding systems: grain-finished or grass-finished beef. Grain-finished beef makes up approximately 95% of the beef market today and is defined as beef from cattle that are fed high-grain diets, often in a feedlot setting, for four to six months before slaughter. Grain finishing increases intramuscular fat, known as marbling, which enhances flavor, tenderness, and juiciness of beef (Corbin et al., 2015). Grass-finished beef is raised entirely on grass or forage-based diets, takes longer to reach market weight, and produces leaner carcasses. Its flavor is often described as earthy, grassy, or gamey, based on consumer panel studies. Flavor differences between grass-finished and grain-finished beef are among the most noticeable and often distinguishable to consumers. Research consistently shows that flavor, juiciness, and tenderness are the top factors influencing beef purchasing decisions (O'Quinn et al., 2018).

Most beef produced in the U.S. is finished on grain-based diets to improve marbling and overall beef quality. For decades, producers have also utilized FDA-approved implants and beta-agonists to improve growth rate, feed efficiency, and produce more lean muscle per animal. In addition, antibiotics are used judiciously, meaning they are administered in a responsible and selective manner, only when necessary and always under the supervision of a licensed veterinarian while adhering to strict withdrawal periods. These technologies and usage laws, established and enforced by the FDA and USDA, help ensure the safety of the beef supply for consumers.

However, the gap between the average American consumer and production agriculture continues to widen. The use of marketing terms such as "all-natural," "raised without the use of added hormones," and "raised without antibiotics" can be misleading and may lead consumers to assume that products without those labels are unsafe, even though all beef must meet strict safety standards. Due to the reduced efficiency and more time needed to finish cattle that do not receive

conventional technologies, consumers are torn between increased prices and concern of safety from misinformation of conventionally raised beef.

The objective of this study was to evaluate nutrient composition and the presence of hormone, beta-agonist, and antibiotic residues in conventionally raised grain-finished beef, compared to beef labeled as grass-fed and finished, antibiotic-free, and hormone-free.

Materials & Methods

Beef ribeye steaks were sourced from three distinct production categories: conventionally raised grain-finished Foote Cattle Company (Foote; n = 5), conventionally raised grain-finished beef from a non-Foote source labeled as "USDA Choice Angus Beef" (Conventional; n = 5), and grass-fed and finished labeled as "Marketside Grass Fed & Finished - No antibiotics or hormones EVER" (Grass; n = 5). The Conventional and Grass ribeye steaks were purchased from a retail grocery store located in Kansas. Product collections were conducted over a five-week period. At each collection, vacuum-sealed ribeye steaks were obtained for each of the specified labels sourced from the retail location. A total of 15 consumer-available beef ribeye steaks were frozen at -20° C until sample preparation and analysis.

Ribeye steaks were thawed at 0 to 4° C for 12 hours. Each steak was dissected into separable lean, seam fat, and external fat components. The separable lean portion included all edible muscle tissue, intramuscular fat (marbling), and connective tissue. Seam and external fat consisted of adipose tissue located between lean tissue and around its outer edges. Both the lean and fat components from each ribeye were homogenized using a commercial meat grinder, and then packaged in individual Whirl-Pak bags, labeled, weighed, and frozen at -20° C until laboratory analysis.

Samples analyzed for macronutrient composition and hormone and beta-agonist residue testing were composited by treatment and submitted to Eurofins Nutrition Analysis Center (n = 3; Des Moines, IA) for analysis. Samples analyzed for micronutrient composition, including trace minerals and heavy metals, were submitted to Universal Testing (n = 15; Quincy, IL) and to Trilogy Analytical Laboratory (n = 15; Washington, MO) for a complete veterinary drug residue assay.

Nutrient Analysis

Nutrient analyses were conducted at three different commercial laboratories. Proximate values, including total protein, fat, moisture, ash, cholesterol, and carbohydrates, were evaluated, along with fatty acid content (45 fatty acids), conjugated linoleic acid (CLA), vitamins (A, D, E, B12, and riboflavin), mineral content (calcium, magnesium, potassium, phosphorus, sodium, copper, cobalt, iron, manganese, and zinc), and heavy metals (arsenic, cadmium, lead, and mercury).

Hormone, Beta-Agonist, & Antibiotic Residue Analysis

Hormone and beta-agonist (Lubabegron) analysis was conducted at Eurofins Nutrition Analysis Center (Des Moines, IA). Each sample was analyzed for a panel of 10 estrogenic and 11 androgenic hormones using the LC-MS/MS method. A complete veterinary antibiotic drug residue assay, including 31 veterinary drugs and ractopamine, was conducted using validated LC-MS/MS methodology at Trilogy Analytical Laboratory (Washington, MO).

Statistical Analyses

Descriptive statistics were used to summarize all quantitative variables. The mean and sample size were calculated for each group. All data analyses were performed using Microsoft Excel.

Results & Discussion

Protein, Total Fat, & Carbohydrates

Macronutrients of protein, fat, and carbohydrates in grain- and grass-finished beef samples are presented in Table 1. Recommended daily allowance (RDA) and acceptable macronutrient distribution range (AMDR) for a healthy adult following a 2,000-calorie diet with a macronutrient ratio of 40% carbohydrate, 30% protein, 30% fat were used for comparison. Each treatment was evaluated based on a single 4-ounce serving of beef. Carbohydrate and protein composition were similar across all treatments. Foote and Conventional grain-finished beef had greater total fat compared to grass-fed beef. This is consistent with previous research that beef intramuscular fat and the composition of the fatty acids are impacted by grass- or grain- feeding (Hwang and Joo, 2017; Van Elswyk and McNeill, 2014). The USDA considers beef to be “lean” when it contains

less than 10 grams of total fat, 4.5 grams or less of SFA and less than 95 mg of cholesterol per 100 grams. Beef from grain-finished beef has fatter carcasses and greater deposition of intramuscular fat into the meat, influencing differences in fatty acid composition (Nogoy et al., 2022). In fact, the only key nutritional difference between grain-finished or grass-fed and finished beef is the fatty acid profile (Adams et al., 2010).

Saturated Fatty Acids

Saturated fatty acids with carbon chain lengths from C12 to C16, excluding stearic acid and smaller SFA and trans fatty acids, have been classified as "cholesterol-raising fatty acids" by the U.S. Dietary Guidelines Advisory Committee (Dietary Guidelines Advisory Committee, 2010). Because stearic acid constitutes approximately one-third of the SFA in beef and considered neutral regarding plasma LDL cholesterol, it is presented separately in Figure 1. The percentage of total fatty acid in grain-finished and grass-fed beef sources resulted in SFA, excluding stearic acid, accounted for 29%, 30%, and 32% of total fatty acids for Foote, Conventional, and Grass samples, respectively. Previous U.S. studies consistently reported increases of total SFA deposition, as a percentage of total fatty acid, in response to grass-feeding beef (Laheska et al., 2008; Duckett et al, 2009; Duckett et al., 2013). However, since grass-fed and finished beef typically have lower total fat compared to grain-finished beef, total SFA as a percentage does not always translate to increased intake of total SFA from grass-fed beef. Figure 2 includes fatty acid composition on a g/100 g basis. Foote beef and grass-fed beef resulted in similar 1.65 g and 1.51 g of SFA per 100 g of beef, respectively. Meanwhile, Conventional grain-finished source resulted in 2.62 g/100 g of SFA but also had a higher level of total fat.

Monounsaturated Fatty Acids

Monounsaturated fatty acids (MUFA) are considered a beneficial dietary fat found in foods such as olive oil, avocados, nuts, and seeds. The role of MUFAs on cardiovascular health is well documented. Increasing MUFA for cholesterol-raising SFA has shown to reduce LDL and lower the risk for type II diabetes and cardiovascular disease by improving markers of glucose tolerance and diabetic control (Dietary Guidelines Advisory Committee, 2010; Food and Agriculture Organization of the United Nations, 2010). Beef is a primary source of MUFA in the form of oleic acid (18:1 n-9) is the most abundant fatty acid in bovine adipose tissue and increases as marbling fat cells differentiate (Van Elswyk and McNeill, 2014). MUFA levels were highest in both grain-

finished sources of beef samples at 53% of total fatty acids. Grass-fed and finished beef resulted in a lower amount of MUFAs at 46% of total fatty acids. These results would agree with previous research suggesting that grain-finished beef has higher MUFA content than grass-fed beef (Leheska et al., 2008; Duckett et al, 2009; Duckett et al., 2013). This response may be due, in part, to reduced delta-9 desaturase enzyme activity and subsequent decrease in oleic acid deposition in adipose tissue of grass-fed beef (Smith et al., 2006).

Polyunsaturated Fatty Acids

Polyunsaturated fatty acids (PUFA) include omega-3 (linolenic acid) and omega-6 (linoleic acid) fatty acids and are considered beneficial fats that can help lower LDL cholesterol and the risk for heart disease. Since the human body cannot synthesize PUFAs, they are considered essential nutrients and must be obtained through the diet (Mititelu et al., 2024). Overall, the PUFA content of beef is low and makes up approximately 5% of total fatty acids (Scollen et al., 2006). Results of total PUFA and omega-3 and omega-6 concentrations from grain- and grass-finished beef samples are provided in Table 1. As a percentage of the recommended adequate intake (AI) for adults, grain-finished beef resulted in less than 0.05 g per 4-ounce serving of beef for omega-3s and slightly greater omega-6 levels at .2 g and .32 g for Foote and Conventional grain-finished beef samples. Grass-fed and finished beef provided 5% of AI for adults of omega-3 and 1% of AI for omega-6 per 4-ounce serving. Although omega-3s were detected in the grass-finished sample, levels were considered low. To meet the adequate dietary intake of omega-3 fatty acids, foods such as salmon and other fish sources, flaxseed, canola oil, and many others would serve as a better source of omega-3s than beef (NIH, 2025). Another PUFA found naturally in beef is conjugated linoleic acid (CLA) that is derived from the biohydrogenation of linoleic acid of bacteria to stearic acid and CLA isomers. Research suggests that CLA may play an important role in promoting fat loss, improving body composition by preserving lean muscle, and supporting heart health by positively impacting cholesterol levels (Basak and Duttaroy, 2020). Results of CLA concentration in grain- and grass-finished beef are presented in Table 1. Foote and Grass samples were 0.9 g of CLA per 4-ounces of beef which suggests no difference in CLA concentration based on how the beef was raised and represented 26% of the daily recommended CLA dose for healthy adults.

Vitamins, Minerals, & Heavy Metals

Beef is widely known for not only being a staple food source of high-quality protein for the America diet, but also for providing several key micronutrients of highly bioavailable iron, zinc, and B vitamins (Wyness et al., 2011; Pereira and Vicente, 2013; Klurfeld, 2015). Vitamin, mineral, and heavy metal results of grain-finished and grass-fed and finished beef samples are presented in Table 2. Concentrations of vitamins A, D, E, B12, and riboflavin are reported per 4-ounce serving of beef, along with the percentage of the recommended daily allowance for an adult (31-50 years old). Vitamins A, D, and E were detected in grass-finished beef, but at levels to provide only 2%, 1%, and 6% of the RDA for healthy adults, respectively, suggesting beef as not a rich source of vitamins regardless of how it was raised. Like the omega-3 content of beef, vitamins A, D, and E would be better sourced from foods known to be rich in vitamins such as fruits, vegetables, eggs, and nuts (FDA, 2011). However, all sources of beef analyzed resulted in considerable concentration of vitamins B12 and riboflavin, zinc, iron and phosphorus. Vitamin B12 levels were 1.98, 2.08 and 1.66 mcg per 4-ounce serving of beef for Foote, Conventional, and Grass samples, respectively. This contributes to more than half of the RDA for healthy adults for vitamin B12 and zinc, about one-third for iron and phosphorus, and about 15-16% of RDA for riboflavin that can be met with one 4-ounce serving of beef. Other minerals, including calcium, magnesium, potassium, and sodium were similar across all treatments and resulted in overall lower RDA percentages. Heavy metals were not detected in any samples evaluated.

Antibiotics

With veterinarian oversight, antibiotics are approved for used in conventional beef production systems to treat sick animals, control the spread of disease, and to prevent illness in at-risk groups. Producers are required to follow label directions and abide by withdrawal periods. In addition, the USDA and FDA test for antibiotic residue in carcasses and food products as another level of safety to consumers to ensure beef products are not contaminated. A complete veterinary drug residue assay was conducted on all samples (n = 15) for Foote, Conventional, and Grass-fed beef. The analysis included 17 different antibiotics commonly used in conventional beef production. Table 3 shows a complete list of the antimicrobials tested, along with the results from each sample analyzed. All samples, regardless of whether they were grain- or grass-fed or labeled

"antibiotic-free," tested below the reporting limit. The sensitivity of the reporting limit varied by antibiotic but ranged from 5 to 250 parts per billion.

Hormones

Hormones, or implants, are natural or synthetic compounds that produce physiological responses similar to natural hormones of the animal and increase the rate and efficiency of growth. Implants have been used in conventional beef production systems since they were first introduced in 1957, and since then have been extensively researched, proven to be effective, and pose no safety risk to humans by the FDA, World Health Organization, and Food and Agriculture Organization. According to USDA NAHMS (2013), up to 92% of feedlot cattle are implanted at least once during the finishing phase. In addition, several life cycle analysis studies have found that use of conventional productivity-enhancing technologies, such as implants and beta-adrenergic agonists, improve average daily gain, feed efficiency, and carcass weight, resulting in reduced greenhouse gas emissions, ammonia emissions, and pressure on water and land resources (Capper and Hayes, 2012; Stackhouse et al., 2012; Aboagye et al., 2022). The development and use of these technologies have allowed producers to produce more beef per unit of animal in a shorter amount of time with fewer resources in efforts to meet the animal protein needs of the projected 9.8 billion people population by 2050 (UN, 2019).

Estrogenic (zeranol and estradiol), androgenic (trenbolone acetate), and combination implants (estradiol and trenbolone acetate) are approved for use in beef cattle. Hormone and beta-adrenergic agonists residue results are presented in Table 4. A total of 21 different estrogens and androgens were analyzed, and all samples tested below the reporting limit. Specifically, estrogens: 17alpha-estradiol, 17beta-estradiol, alpha-zearalanol and beta-zearalanol; and androgens: trenbolone acetate, which are used in conventional beef production systems, resulted in non-detectable levels. According to Codex, maximum residue limits (MRL) for estradiol-17beta are considered "unnecessary" and notated that "residues resulting from the use of this substance as a growth promoter in accordance with good animal husbandry practice are unlikely to pose a hazard to human health." The MRL for trenbolone acetate for cattle muscle is 2 μg/kg and the results presented here were <10 μg/kg for trenbolone acetate; therefore, these analyses need to be repeated with greater sensitivity to evaluate if levels are lower than the MRL threshold. However, recent research of using high resolution tandem mass spectrometry with more sensitive analyses

capabilities evaluated beef samples for anabolic agent residues was completed. The researchers reported that all detected levels of ractopamine, trenbolone-17β, and estradiol in U.S.-sourced beef muscle samples were below the MRL established by Codex and US regulatory standards, indicating no health risk (Snethen et al., 2025).

Beta-Agonists

Beta-agonists are another category of technologies used in conventional beef production systems that improve growth, feed efficiency, and lean muscle deposition. Beta-agonists are supplemented in the final months before slaughter and shift the animal's energy from fat deposition to muscle growth, resulting in increased carcass weight and more beef per animal unit. Two beta-agonists commonly used in conventional beef production are lubabegron and ractopamine hydrochloride. In a recent update of new tolerances for residues of new animal drugs in food by the Code of Federal Regulations, it lists a tolerance for lubabegron in cattle muscle of 3 ppb and 10 ppb for ractopamine. Beef samples were tested for both compounds, with results presented in Table 4. All samples resulted in testing lower than the reporting limit, which was the same value as the new tolerance levels listed above. Regardless of whether the beef was raised conventionally using beta-agonist technologies or not, there were no detectable residues of beta-agonists in any of the beef samples.

Beef Tallow

Beef tallow is used in many culinary and non-culinary uses, such as cooking, frying, baking pies and pastries, making soap and candles, conditioning leather, and moisturizing skin. PUFA and CLA concentrations of beef tallow have been shown to contribute to greater health benefits. Samples of beef tallow sourced from grain- or grass-fed and finished sources were analyzed for fatty acid composition. Results as a percentage of total fatty acids of the tallow are found in Figure 3. Grass-fed and finished beef had a greater percentage of SFA of 34% compared to Foote and Conventional of 29% and 32%, respectively. For MUFA concentration, as a percentage of total fatty acids, Foote and Conventional grain-finished sources were 53% and 48%, respectively compared to grass-fed and finished source at 44%. Similar to the ribeye beef samples, grain-finished beef tallow had greater overall levels of fatty acids with the difference primarily due to greater MUFA levels compared to grass-fed and finished beef (Figure 4).

Conclusion

The nutrient composition of beef was similar across all samples for most nutrients, regardless of how the cattle were raised (grain- or grass-finished, antibiotic-free, hormone-free, conventional, etc.). Total fat and monounsaturated fatty acid (MUFA; considered “healthy fats”) concentrations were higher in grain-finished beef. In contrast, grass-finished beef showed detectible levels of vitamins A and D, as well as omega- 3 fatty acids. However, the concentrations of these nutrients were low, each contributing to less than 5% of the recommended daily adequate intake for adults, suggesting that while present, they are not nutritionally significant in typical serving sizes. In addition, beef labeled and marketed as antibiotic- and hormone- free was in fact free of those compounds, as were Foote grain-finished and conventionally grain-finished beef samples. Regardless of source, beef is safe and a healthy source of high-quality protein, beneficial fats, zinc, iron, vitamin B12, and other nutrients.

In conclusion, this study and these results emphasize the nutritional value and safety of conventionally produced beef and reinforce the importance of science-based communication regarding food labeling. While consumer preferences for grass-finished labeled products are valid, this study demonstrates that properly regulated conventional beef production does not compromise nutrient quality or food safety. Closing the gap between consumer perception and agricultural practices remains critical to ensuring informed purchasing decisions in the marketplace.

Table 1. Percent of daily nutritional goal for adults and nutrient composition of beef from grass-fed or grain-finished sources.

			Treatment[1]					
			Foote Grain-Finished Beef		Grass-Fed & Finished Beef		Conventional Grain-Finished Beef	
Items[4]	Source of Goal[2]	DNG[3]	Amt. per 4 oz[4]	% of DNG[3]	Amt. per 4 oz[4]	% of DNG[3]	Amt. per 4 oz[4]	% of DNG[3]
Macronutrients, g								
Carbohydrates	RDA	200	4.53	2%	2.44	1%	2.96	1%
Protein	RDA	150	25.14	17%	25.57	17%	23.80	16%
Fat	AMDR	67	11.10	17%	8.05	12%	13.39	20%
Fatty Acids, g								
SFA	DG	20	2.70	14%	2.68	13%	4.26	21%
MUFA	AI	33	3.40	10%	2.45	7%	5.18	16%
PUFA	AI	11	0.27	2%	0.25	2%	0.38	3%
Omega-3[5]	AI	1.4	<0.05	0%	0.07	5%	<0.05	0%
Omega-6	AI	15	0.20	1%	0.12	1%	0.32	2%
Others								
CLA, g	EFSA	3.5	0.90	26%	0.90	26%	0.68	19%
Cholesterol, mg		<200	72.66	36%	69.61	35%	67.24	34%
Ash, g	NA	NA	1.08	NA	1.14	NA	1.14	NA
Gluten, ppm	NA	NA	<3.0	NA	<3.0	NA	<3.0	NA

[1]Foote Grain-Finished beef were ribeye steaks sourced from each of the five Foote feedyards; Grass-fed beef were ribeye steaks and purchased from Walmart and labeled as "Marketside Grass Fed & Finished - No antibiotics or hormones EVER"; Conventional grain-finished beef were ribeye steaks and purchased from Walmart and labeled as "USDA choice angus beef."

[2]Recommended Daily Allowance (RDA); Adequate Intake (AI) - intake at this level is assumed to ensure nutritional adequacy; Acceptable Macronutrient Distribution Range (AMDR); 2010 and 2015 Dietary Guidelines recommended limit (DG); European Food Safety Authority Panel (2010).

[3]DNG=Daily Nutritional Goal. Nutrition goal is expressed as an average for adult males and females (19-50 years old) per day to meet the nutrient requirement of nearly all (97-98%) healthy individuals following a 2,000 calorie diet and 40% carbohydrate, 30% protein, 30% fat macronutrient ratio.

[4]Amount of nutrient per 4 oz serving (113 g) of beef as received basis.

[4]Composite sample (5 samples per treatment) analyzed at Eurofins Nutrient Analysis Center (Des Moines, IA).

[5]As alpha-linolenic acid (ALA).

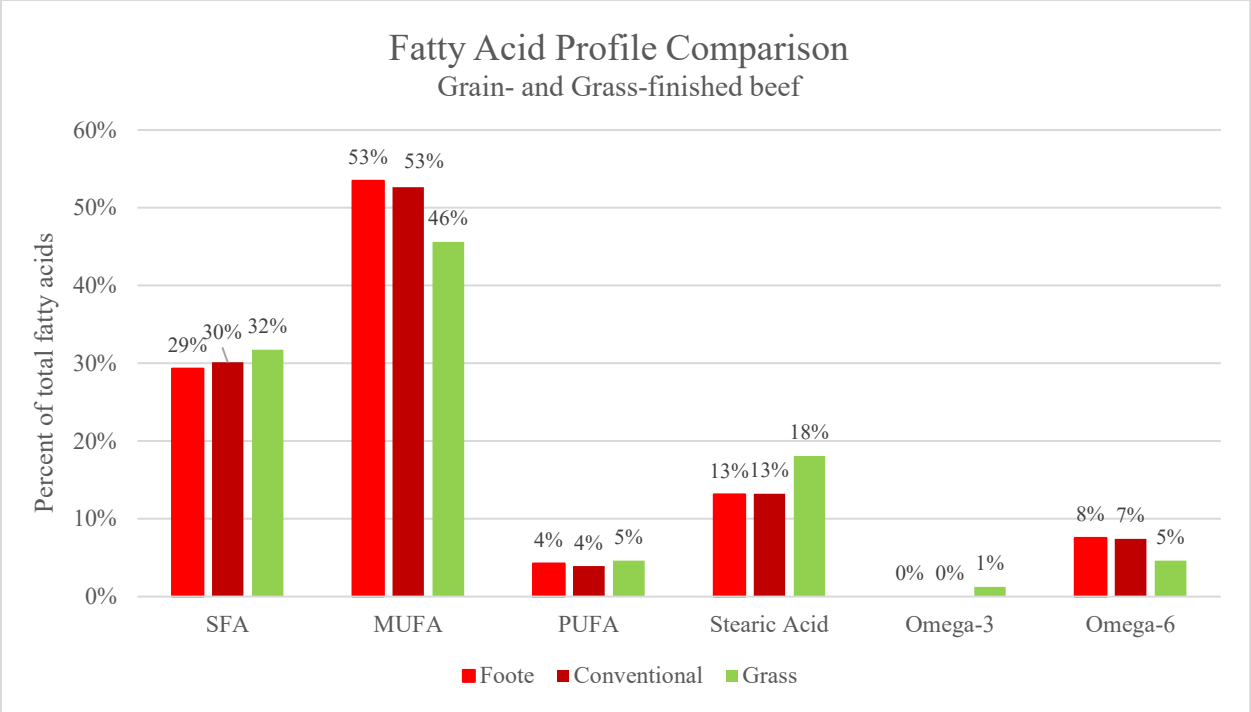


Figure 1. Percent of total fatty acid comparing grain-finished ("Foote" and Conventional") and grass-fed and finished ("Grass") beef samples. Saturated Fatty Acids (SFA, minus stearic acid); Monounsaturated Fatty Acids (MUFA); Polyunsaturated Fatty Acids (PUFA; includes Omega-3 and Omega-6).

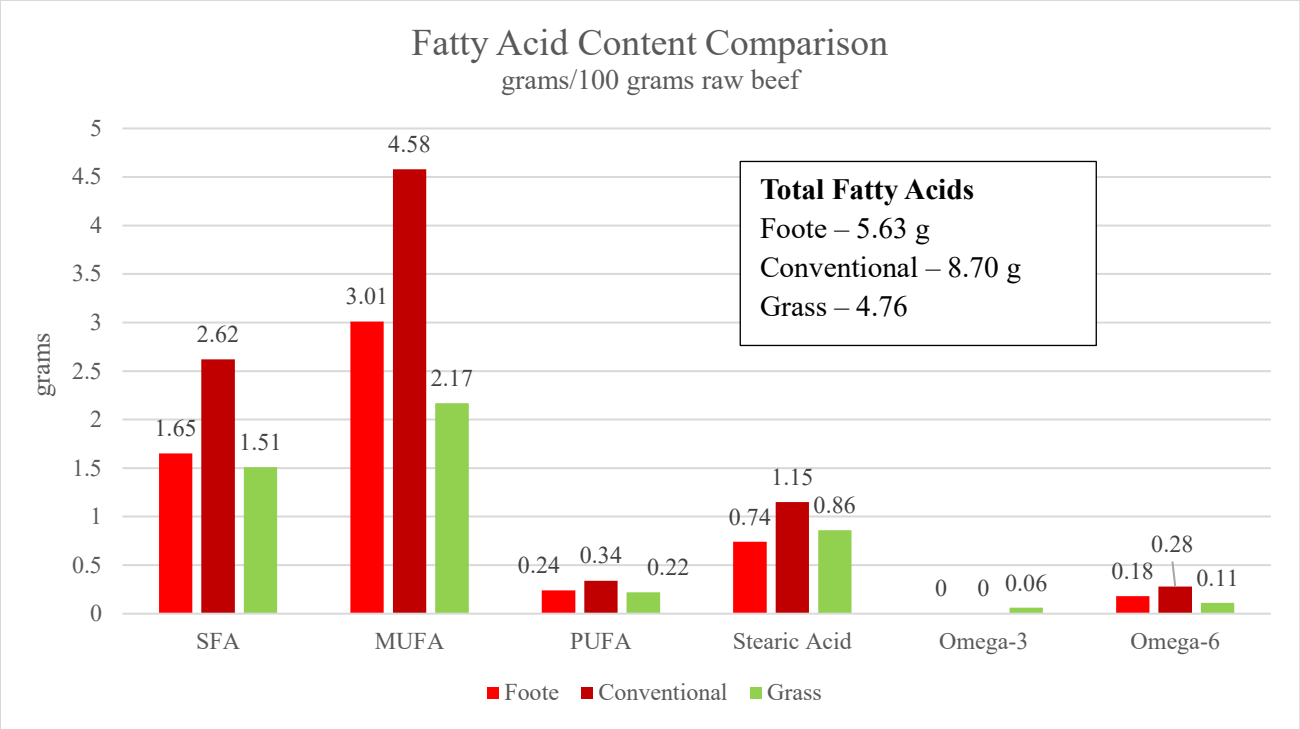


Figure 2. Fatty acid content comparison of grain-finished ("Foote" and Conventional") and grass-fed and finished ("Grass") beef samples. Saturated Fatty Acids (SFA, minus stearic acid); Monounsaturated Fatty Acids (MUFA); Polyunsaturated Fatty Acids (PUFA; includes Omega-3 and Omega-6).

Table 2. Percent of recommended daily allowance for adults and composition of vitamins, trace minerals, and heavy metals in beef from grass-fed or grain-finished sources.

		Treatment[1]					
		Foote Grain-Finished Beef		Grass-Fed & Finished Beef		Conventional Grain-Finished Beef	
Items	RDA[2]	Amt. per 4 oz[3]	% of RDA	Amt. per 4 oz[3]	% of RDA	Amt. per 4 oz[3]	% of RDA
Vitamins[4]							
Vit A, IU	2,644	<30	0%	65.54	2%	<30	0%
Vit D, IU	600	<4	0%	7.32	1%	<4	0%
Vit E, mg	15	0.20	1%	0.93	6%	0.12	1%
B12, mcg	2.4	1.98	83%	1.66	69%	2.08	87%
Riboflavin, mg	1.2	0.19	16%	0.17	15%	0.18	15%
Minerals, mg[5]							
Zn	9.5	6.76	71%	6.10	64%	6.08	64%
Fe	13	4.16	32%	3.01	23%	2.46	19%
Ca	1,000	10.10	1%	10.94	1%	9.74	1%
Mg	370	30.01	8%	30.10	8%	29.27	8%
P	700	228.40	33%	228.50	33%	218.90	31%
K	4,700	402.90	9%	426.40	9%	402.20	9%
Na	2,300	68.34	3%	65.68	3%	66.20	3%
Heavy Metals, ppm[5]							
As	NA	<0.25	0%	<0.25	0%	<0.25	0%
Cd	NA	<0.25	0%	<0.25	0%	<0.25	0%
Hg	NA	<0.05	0%	<0.05	0%	<0.05	0%
Pb	NA	<0.25	0%	<0.25	0%	<0.25	0%

[1]Foote Grain-Finished beef were ribeye steaks sourced from each of the five Foote feedyards; Grass-fed beef were ribeye steaks and purchased from Walmart and labeled as "Marketside Grass Fed & Finished - No antibiotics or hormones EVER"; Conventional grain-finished beef were ribeye steaks and purchased from Walmart and labeled as "USDA choice angus beef."

[2]Recommended Daily Allowance (RDA); Per adult per day following a 2,000-calorie diet; average value of range for adult men and women sourced from the Dietary Reference Intakes reports (www.nap.edu)

[3]Amount of nutrient per 4 oz serving (113 g) of beef as received basis

[4]Composite sample (5 samples per treatment) analyzed at Eurofins

[5]Average of 5 samples per treatment analyzed at Universal Testing.

Table 3. Complete Veterinary Drug Residue screening from grass- or grain-finished beef samples.

Analyte[1]	Used by Foote Cattle Company[2]	Reporting Limit, ppb	Foote Grain-Finished Beef[3] (n=5)	Grass-Fed & Finished Beef[3] (n=5)	Conventional Grain-Finished Beef[3] (n=5)
Amikacin Sulfate	No	25.0	<RL	<RL	<RL
Ampicillin	No	250.0	<RL	<RL	<RL
Bacitracin A	No	125.0	<RL	<RL	<RL
Bambermycin	No	12.5	<RL	<RL	<RL
Carbadox	No	25.0	<RL	<RL	<RL
Ceftiofur	Yes	10.0	<RL	<RL	<RL
Chlortetracycline HCL	Yes	5.0	<RL	<RL	<RL
Danofloxacin Mesylate	No	25.0	<RL	<RL	<RL
Doxycycline	No	20.0	<RL	<RL	<RL
Enrofloxacin	Yes	10.0	<RL	<RL	<RL
Florfenicol	Yes	25.0	<RL	<RL	<RL
Gentamicin	No	125.0	<RL	<RL	<RL
Lasalocid	Yes	12.5	<RL	<RL	<RL
Lincomycin	No	25.0	<RL	<RL	<RL
Melengestrol acetate (MGA)	Yes	5.0	<RL	<RL	<RL
Monensin Sodium	Yes	5.0	<RL	<RL	<RL
Neomycin Sulfate	No	125.0	<RL	<RL	<RL
Oxytetracycline HCL	Yes	5.0	<RL	<RL	<RL
Penicillin G	Yes	25.0	<RL	<RL	<RL
Penicillin V	Yes	10.0	<RL	<RL	<RL
Ractopamine	Yes	10.0	<RL	<RL	<RL
Sulfadimethoxine	Yes	10.0	<RL	<RL	<RL
Sulfamethazine	Yes	5.0	<RL	<RL	<RL
Tetracycline	Yes	25.0	<RL	<RL	<RL
Tiamulin	No	5.0	<RL	<RL	<RL
Tilmicosin	Yes	25.0	<RL	<RL	<RL
Tulathromycin	Yes	10.0	<RL	<RL	<RL
Tylosin	Yes	10.0	<RL	<RL	<RL
Valnemulin	No	5.0	<RL	<RL	<RL
Virginiamycin	No	5.0	<RL	<RL	<RL
Zilpaterol	No	10.0	<RL	<RL	<RL

[1]Veterinary drug residue screening panel analyzed at Trilogy Laboratories (Washington, MO).

[2]Drugs judiciously used by Foote Cattle Company in accordance with our veterinary feed directive and following label directions and withdrawal requirements.

[3]Foote Grain-Finished beef were ribeye steaks sourced from each of the five Foote feedyards; Grass-fed beef were ribeye steaks and purchased from Walmart and labeled as "Marketside Grass Fed & Finished - No antibiotics or hormones EVER"; Conventional-grain finished beef were ribeye steaks and purchased from Walmart and labeled as "USDA choice angus beef." Five samples from each treatment were submitted for individual analysis

Table 4. Hormone and beta-agonist residue testing in grass- or grain-finished beef.

Item[1]	Foote Grain-Finished Beef[2]	Grass-Fed & Finished Beef[2]	Conventional Grain-Finished Beef[2]
Hormone			
Estrogens, µg/kg			
17-alpha-ethinylestradiol	<50	<50	<50
17alpha-estradiol	<20	<20	<20
17beta-estradiol	<20	<20	<20
Dienestrol	<5	<5	<5
Diethylstilbestrol	<10	<10	<10
Estriol	NA	NA	NA
Estrone	<5	<5	<5
Hexestrol	<5	<5	<5
Alpha-zearalanol	<5	<5	<5
Beta-zearalanol	<5	<5	<5
Androgens, µg/kg			
Testosterone	<5	<5	<5
Epitestosterone	<10	<10	<10
Methytestosterone	<10	<10	<10
Testosterone propionate[3]	NR	NR	NR
Boldenone	<5	<5	<5
17alpha-Boldenone	<5	<5	<5
Methyl-Boldenone (Dianabol)	<10	<10	<10
Trenbolone	NA	NA	NA
Stanozolol[3]	NR	NR	NR
Nandrolone	<10	<10	<10
Trenbolone acetate	<10	<10	<10
Beta Agonist, ppb			
Lubabegron	<3	<3	<3
Ractopamine	<10	<10	<10

[1]Hormone and lubabegron residue testing completed at Eurofins Nutrition Analysis Center (Des Moines, IA); Ractopamine testing as part of the complete veterinary drug residue screening at Triology Laboratories (Washington, MO).
[2]One composite sample of 5 total samples per treatment submitted for hormone and beta-agonist analysis
[3]NR - no analyte recovery

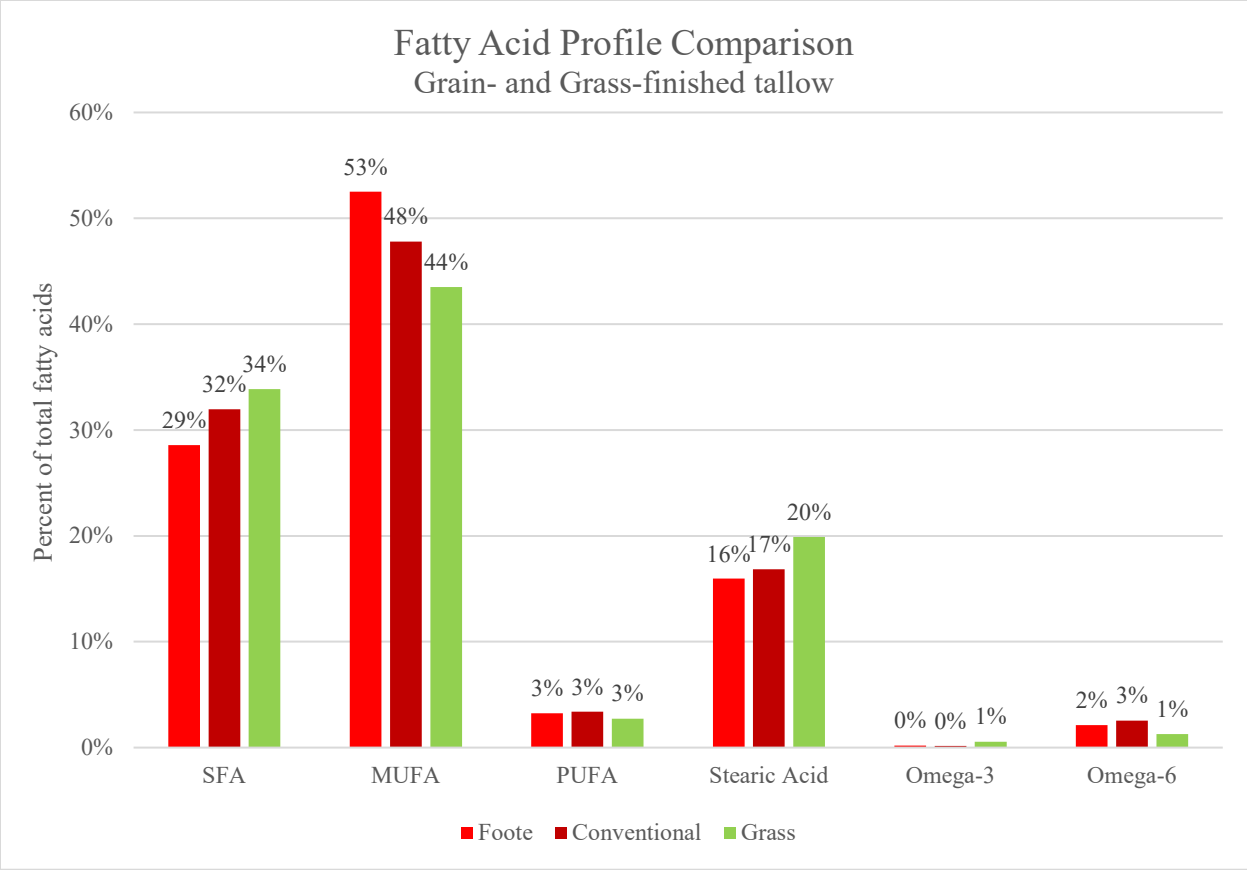


Figure 3. Percent of total fatty acid comparing grain-finished tallow ("Foote" and Conventional") and grass-fed and finished tallow ("Grass"). Saturated Fatty Acids (SFA, minus stearic acid); Monounsaturated Fatty Acids (MUFA); Polyunsaturated Fatty Acids (PUFA; includes Omega-3 and Omega-6).

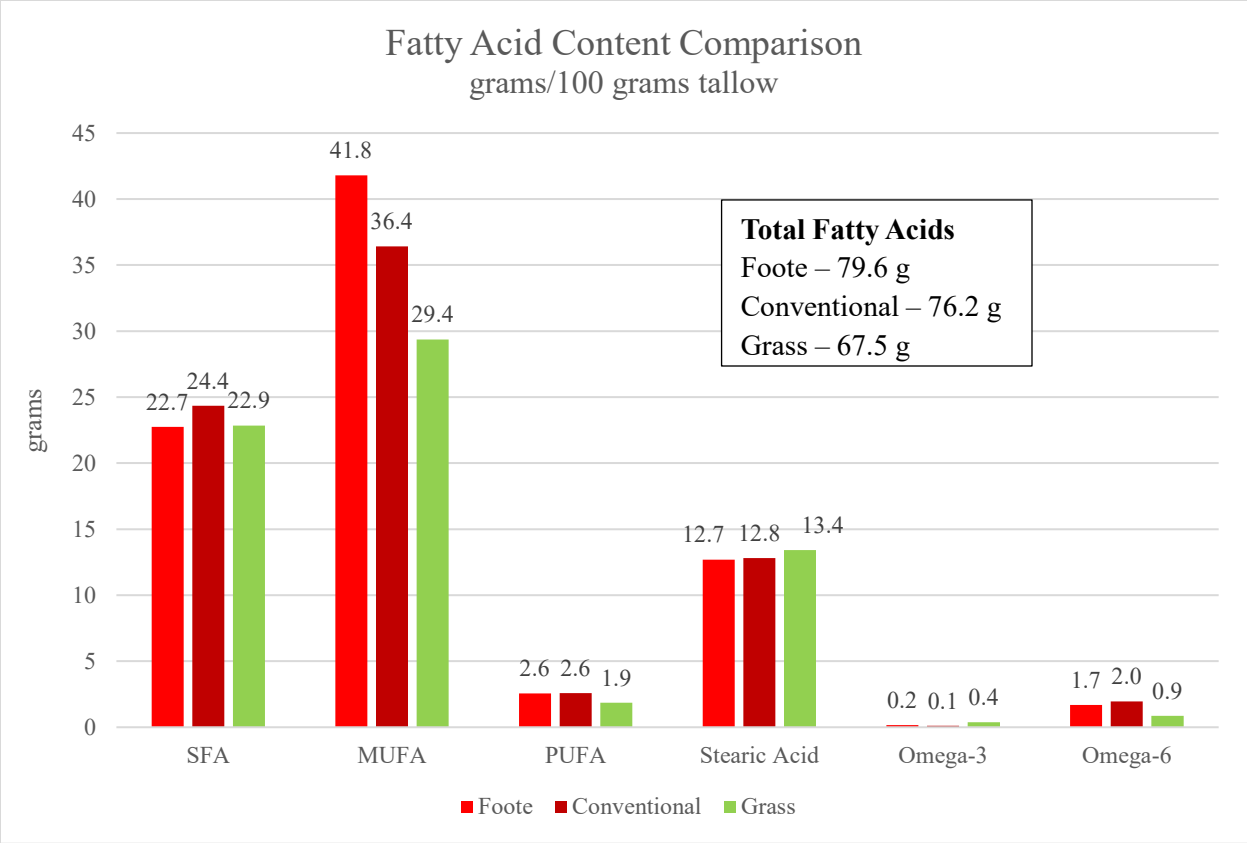


Figure 4. Fatty acid content comparison of grain-finished tallow ("Foote" and Conventional") and grass-fed and finished tallow ("Grass"). Saturated Fatty Acids (SFA, minus stearic acid); Monounsaturated Fatty Acids (MUFA); Polyunsaturated Fatty Acids (PUFA; includes Omega-3 and Omega-6).

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FOOTE CATTLE COMPANY

THE POWER OF BEEF

HIGH IN PROTEIN, IRON, B12, ZINC & MORE

CONTAINS HEALTHY FATS (MUFA)

ALL BEEF IS SAFE!

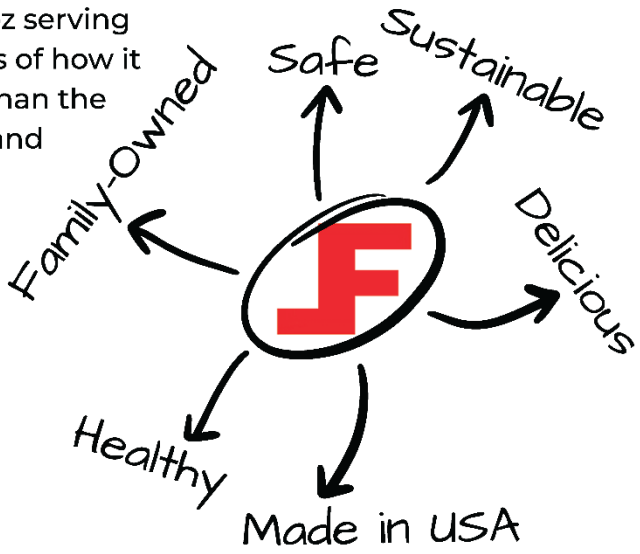
No detected hormone or antibiotic residues regardless of how it was raised.

ZERO HEAVY METALS DETECTED

Our research supports similar nutrient composition for most nutrients in grain-finished or grass-fed beef. Total fat and monounsaturated fatty acids (MUFA; healthy fats) were greater in Foote grain-finished and other conventionally raised grain-finished beef. Grass-fed beef had slightly greater Omega 3s and Vitamin A & D compared to grain-finished beef, however, it only made up <5% of recommended daily allowance for adults in one 4 oz serving of beef. All beef analyzed, regardless of how it was raised, resulted in testing less than the limit of detection for all antibiotics and hormone residues.

BEEF is BEEF

All beef is a safe and healthy source of high-quality protein, healthy fats, zinc, iron, B12 and other nutrients.



SCIENCE-BACKED BEEF NUTRITION

Items	Recommended Dietary Allowence[1]	Foote Grain Finished Beef		Grass Fed Finished Beef		Conventional Grain Finished Beef	
		Amt. per 4oz[2]	% of RDA	Amt. per 4oz[2]	% of RDA	Amt. per 4oz[2]	% of RDA
Macronutrients, g							
Carbohydrates	200	4.53	2%	2.44	1%	2.96	1%
Protein	150	25.14	17%	25.57	17%	23.8	16%
Fat	67	11.1	17%	8.05	12%	13.39	20%
Vitamins							
Vit A, IU	2,664	<30	0%	65.54	2%	<30	0%
Vit D, IU	600	<4	0%	7.32	1%	<4	0%
Vit E, mg	15	0.2	1%	0.93	6%	0.12	1%
B12, mcg	2.4	1.98	83%	1.66	69%	2.08	87%
Riboflavin, mg	1.2	0.19	16%	0.17	15%	0.18	15%
Minerals, mg							
Zn	9.5	6.76	71%	6.1	64%	6.08	64%
Fe	13	4.16	32%	3.01	23%	2.46	19%
Ca	1,000	10.1	1%	10.94	1%	9.74	1%
Mg	370	30.01	8%	30.1	8%	29.27	8%
P	700	228.4	33%	228.5	33%	218.9	31%
K	4,700	402.9	9%	426.4	9%	402.2	9%
Na	2,300	68.34	3%	65.68	3%	66.2	3%

[1]RDA; Per adult per day following a 2,000 calorie diet and 40% carbohydrate, 30% protein, 30% fat macronutrient ratio

[2]Amount of nutrient per 4 oz serving (113 g) of beef as received basis

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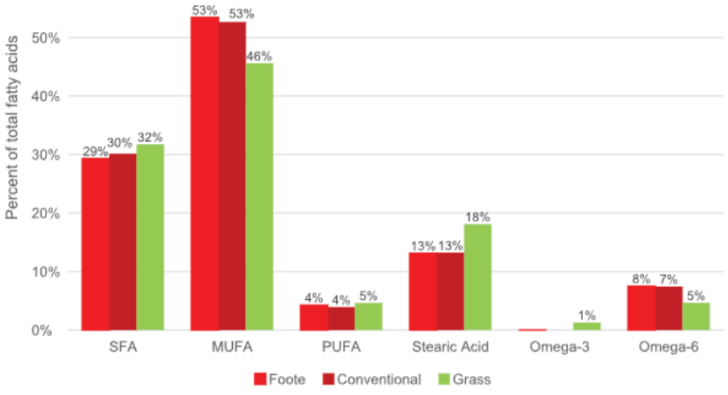
FATTY ACID BREAKDOWN



- As a percent of total fatty acids, grass-fed beef had lower MUFA (healthier fats) compared to grain-finished beef.
- Grass-finished beef had 2-3% greater SFA (unhealthy fats) as a percent of total fatty acids compared to grain finished.
- PUFA levels were similar across all sources of beef.

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BEEF THAT FEEDS FAMILIES. **BACKED BY FACTS.**