



Beef Lipids in Perspective

Introduction

Dietary fats are important components of a nutritionally balanced diet. Besides adding flavor, appetite appeal and satiety to foods, fats provide essential fatty acids and aid in the absorption of fat-soluble vitamins A, D, E, and K and carotenoids. In addition, fats are a concentrated source of energy, providing 9 calories per gram compared to 4 calories per gram for protein and carbohydrates.¹

Classes of Dietary Fats

Dietary fat consists primarily of triglycerides with smaller amounts of phospholipids and sterols.¹ Because triglycerides and phospholipids are comprised primarily of fatty acids attached to a glycerol molecule, the overall fatty acid profile and composition is the focus of any discussion about lipids in meat such as beef.

All fats and oils from animal and plant sources contain mixtures of both saturated and unsaturated fatty acids.¹ Saturated fatty acids (SFAs) contain only single carbon-to-carbon bonds, are quite stable, and are the least reactive chemically. Unsaturated fatty acids contain one (monounsaturated fatty acids [MUFAs]) or more (polyunsaturated fatty acids [PUFAs]) carbon-to-carbon double bonds in the *cis* configuration. The chemical reactivity increases as the number of double bonds increase. *Trans* fatty acids

are unsaturated fatty acids that contain at least one double bond in the *trans* configuration.

The ratio of SFAs, MUFAs, and PUFAs and the position of specific fatty acids on the glycerol molecule of the triglyceride contribute to specific physical and physiological properties of fats and oils. In general, animal fats contain larger amounts of SFAs and are solid at room temperature; plant fats (oils) have a higher content of unsaturated fatty acids and are liquid at room temperature. All fatty acids, regardless of the type (saturated or unsaturated) provide the same number of calories per gram when metabolized for energy.¹

Changes in the Supply of Dietary Fat

Between 1909 and 2010, total fat available in the U.S. food supply increased by 60%, from an average of 119 g/capita/day to 190 g/capita/day (**Table 1**).² Types of fat available during this period also changed. Specifically, a trend toward the increased availability of unsaturated fats relative to SFAs occurred. Between 1909 and 2010, the availability of MUFAs and PUFAs increased by 71% and 238%, respectively, while the availability of SFAs increased more modestly by 18%.² The increase in PUFAs reflects increases in soybean and corn oils and nuts, whereas the increase in MUFAs reflects increases in olive, sunflower, and canola oils.³ In contrast to total fat, the availability of cholesterol in the food supply remained relatively consistent between 1909 and 2010.²

Table 1. Change in Fat and Cholesterol Availability Per Capita Per Day, 1909 and 2010.²

	1909	2010	% Change
Total Fat, g	119	190	60
Saturated Fat, g	50	59	18
Monounsaturated Fat, g	45	77	71
Polyunsaturated Fat, g	13	44	238
Cholesterol, mg	440	460	5

The increase in fat availability is due largely to fat from plant sources, while fat availability from animal sources decreased during this same period (**Figure 1**).² After peaking at 136.1 pounds per capita (boneless, edible basis) in 1971, red meat availability (i.e., beef, pork, veal, lamb, and mutton) significantly declined to 95.4 pounds per capita in 2014, a 30 percent drop. More specifically,

Profile of Beef Fats

Like most other foods containing fat, meat products such as beef are composed of a variety of fatty acids (**Table 2**).

Despite the common reference to animal fats as “saturated,” less than half of all fatty acids in beef fat are saturated.⁷ Lean beef typically contains more MUFAs than SFAs and a small amount of PUFAs (**Table 3**). MUFAs and PUFAs may be beneficial in reducing the risk of heart disease when substituted for SFAs.⁸ A 3-oz serving of cooked beef (NDB 13364, composite of trimmed retail cuts, separable lean only, trimmed to 0” fat, all grades) contains 6.44 g of total fatty acids, of which 42.9% is saturated, 51.6% is monounsaturated, and 5.5% is polyunsaturated.⁷ Also, approximately one-third of beef’s total saturated fat is stearic acid.⁷ Unlike other long-chain SFAs,⁷ Unlike

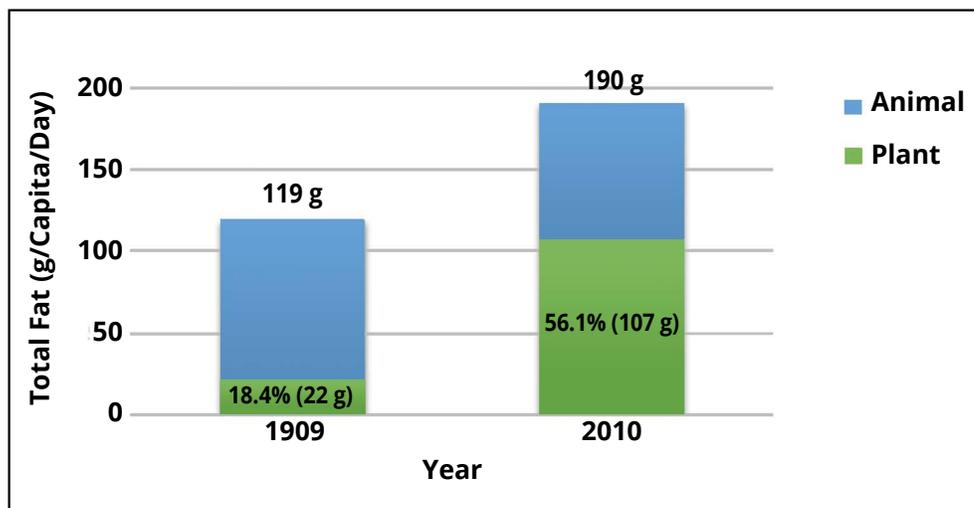


Figure 1. Type and Amount of Fat in the U.S. Food Supply²

beef availability peaked at 88.8 pounds per capita (boneless, edible basis) in 1976, and dropped 35 percent between 1970 and 2014.⁴ With decreased red meat availability, the proportion of total fat available in the U.S. food supply contributed by red meat fell from 32.7% in 1909 to 18.2% in 2010.² Similarly, the proportion of saturated fat contributed by red meat decreased from 30.0% to 23.0% during this time period.²

This decrease in the proportion of total fat and saturated fat available from animal sources in the U.S. food supply is attributed in part to the production of leaner animals through changes in livestock feeding and fat-trimming practices at processor and retail levels, which has contributed to the availability of leaner meats, including beef.⁵ For example, retail data shows that sales of 90%-100% lean ground beef increased by 25% between 2008 and 2013.⁵ The U.S. Department of Agriculture’s (USDA) Agriculture Handbook 8, released in 1963, reported data for the nutrient content of ground beef containing 10% or more.⁶ Today, with the increased availability of leaner beef, the USDA provides nutrient information for ground beef products containing 3% or more fat.⁷

Table 2. Fatty Acid Composition of Cooked Beef.⁷

Fatty Acids	Amount per 3 oz. (85g) Serving (g)
Fatty Acids, Total Saturated	2.76
4:0 (butyric)	0.00
6:0 (caproic)	0.00
8:0 (caprylic)	0.00
10:0 (capric)	0.00
12:0 (lauric)	0.01
14:0 (myristic)	0.18
16:0 (palmitic)	1.58
18:0 (stearic)	0.90
Fatty Acids, Total Monounsaturated	3.32
16:1 undifferentiated (palmitoleic)	0.24
18:1 undifferentiated (oleic)	3.00
Fatty Acids, Total Polyunsaturated	0.36
18:2 undifferentiated (linoleic)	0.28
18:3 undifferentiated (linolenic)	0.01
20:4 undifferentiated (arachidonic)	0.04
Total Fatty Acids	6.44

Data from USDA National Nutrient Database for Standard Ref, Release 28, 2016: Beef, composite of trimmed retail cuts, separable lean, 0” trim, all grades, cooked, 3oz (NDB 13364)

Table 3. Relative Proportion of Types of Fatty Acids and Other Lipids.⁷

	% of Total Fat			
	SFA	MUFA	PUFA	Other Lipids
Beef, composite, lean, cooked	38.8	46.7	5.0	9.4
Pork, composite, lean, cooked	35.4	44.7	7.5	12.4
Lamb, composite, lean, cooked	35.7	43.8	6.5	14.0
Veal, composite, lean, cooked	28.0	35.7	9.0	27.4
Chicken, broiler, meat only, roasted	27.5	35.9	22.8	13.8
Tuna, light, canned in water	28.5	19.4	41.1	11.0
Salmon, pink, cooked	18.5	30.8	18.5	32.2
<i>Cooking Fats/Spreads</i>				
Butter, unsalted	62.2	28.9	3.7	5.2
Corn oil	14.3	28.6	57.1	0.0
Olive oil	14.3	71.4	10.7	3.6

Data from USDA National Nutrient Database for Standard Ref, Release 28, 2016: Beef, composite of trimmed retail cuts, separable lean, 0" trim, all grades, cooked (NDB 13364); Pork, fresh, composite of trimmed retail cuts (loin and shoulder blade), separable lean only, cooked (NDB 10229); Lamb, domestic, composite of trimmed retail cuts, separable lean only, trimmed to 1/4" fat, choice, cooked (NDB 17004); Veal, composite of trimmed retail cuts, separable lean only, cooked (NDB 17091); Chicken, broilers or fryers, meat only, roasted (NDB 05013); Fish, tuna, light, canned in water, without salt, drained solids (NDB 15184); Fish, salmon, pink, cooked, dry heat (NDB 15212); Butter, without salt, (NDB 01145); Pure Corn Oil (NDB 45083607); Texas Hill Country Olive Company, Olive Oil (NDB 45176881).

other long-chain SFAs, stearic acid has been shown to be neutral in its effects on blood cholesterol levels in humans.^{9,10}

The consumption of *trans* fatty acids has been associated with an unfavorable blood lipid profile and consequently an increased risk of heart disease.^{11,12} Most *trans* fatty acids are industrially produced by the partial hydrogenation of fat and oils and found in hydrogenated vegetable oils and products made from or containing these oils (stick margarine, vegetable shortenings).¹¹ However, naturally occurring *trans* fats produced by ruminant animals are present in small quantities in dairy products and meats, including beef.^{11,13} The predominant *trans* fatty acids in beef are vaccenic acid and conjugated linoleic acid (CLA) which differ from the "man-made" *trans* fat, elaidic acid, found in partially hydrogenated vegetable oils.^{11,13,14} CLA is a collective term for a group of geometric and positional isomers of linoleic acid, an essential fatty acid.¹⁵ To date, research has not documented consistent significant associations between either intake or biomarkers of ruminant *trans* fatty acids and increased heart disease risk.¹⁶⁻¹⁹ The 2015 *Dietary Guidelines for Americans* does not recommend eliminating these foods from the diet

as they can be important sources of nutrients.¹¹

The fat content and composition of beef are influenced by genetic factors and cattle feeding practices. For example, in the United States, grass-finished cattle have been shown to produce leaner beef with higher levels of some nutrients: antioxidants, some vitamins, CLA and long-chain omega-3 fatty acids compared to grain-finished beef.^{20, 21} A literature review compared the fatty acid profile of beef from grass/forage-finished cattle to that of beef from grain-finished cattle in the United States on a mg/100 g of meat basis.²¹ Grass-finished beef appears to be leaner (up to 4 g/100g less total beef fat) than grain-finished beef but largely at the expense of MUFA (up to 1.8 g/100g less).²¹ In the context of a 100 g serving and the total diet, both U.S. grass-fed and grain-finished beef contribute similar long-chain omega-3 fatty acid content, predominately in the form of linolenic acid.²¹ Lean beef

from either grass-fed or grain-finished cattle, makes a modest impact to n-3 long chain PUFA intake goals while contributing a limited amount of total fat to the diet. Regardless of feeding regime, evidence from U.S. studies suggests that beef from both grass-fed and grain-finished cattle contributes a wide variety of important nutrients to the U.S. diet, and consumption of either can be compatible with efforts to improve the overall diet quality of Americans.²¹

Beef Fat in Perspective

Due to its popularity in many diets, beef is a prominent source of dietary fat, however beef's contribution may not be as high as often perceived. According to a survey of dietary sources of nutrients among U.S. adults (19 years and older), beef provides approximately 7.9% (92.1% from other food sources) of total fat in the diet, yet supplies only 5% of total calories.²² Beef is the number two source of MUFAs, contributing 9.2% of total intake; the number two source of SFAs, contributing 9.1%; and the third major source of cholesterol at 12.7%, following eggs and poultry.¹⁹ Between 1989-91 and 2003-2006, the contribution of beef total fat, SFAs,

MUFAs, PUFAs and cholesterol to the total levels of these fats in the diet decreased (**Table 4**).²²⁻²⁴

Table 4. Contribution of Dietary Fat from Beef.

	1989-91 ^a	1994-1996 ^b	2003-06 ^c
Total Fat	11.1%	10.1%	7.9%
Saturated Fat	12.4%	11.7%	9.1%
Monounsaturated Fat	12.9%	11.4%	9.2%
Polyunsaturated Fat	2.2%	<2.0%	Not reported in top sources
Cholesterol	16.0%	16.1%	12.7%

^a Data from USDA's 1989-91 Continuing Survey of Food Intakes by Individuals (CSFII)

^b Data from USDA's 1994 to 1996 Continuing Survey of Food Intakes by Individuals (CSFII)

^c Data from USDA's National Health and Nutrition Examination Survey (NHANES) 2003-2006

For individuals concerned about fat in their diet, a variety of lean cuts of beef are available. USDA's Food Safety Inspection Service (FSIS) defines an individual food as "lean" when it contains less than 10 g of total fat, 4.5 g or less of saturated fat, and less than 95 mg of cholesterol per 100 g.²⁵

Changes in cattle breeding and management along with trimming practices of processors, retailers and foodservice operators resulted in an estimated 44% reduction in available total fat (from 13% to 7%) and a 29% reduction in saturated fat per capita (from 13% to 9%) in U.S. beef over the past three decades, as calculated from food disappearance data.⁶ For example, the total fat content for a completely trimmed Sirloin Steak declined 34% from 1963 to 2010, and the saturated fat content declined 17% between 1990 and 2010.^{5, 26}

Today, approximately two-thirds of beef cuts sold at retail meet government standards for lean, when cooked with visible fat trimmed, including 15 of the 20 most popular cuts sold at retail. Among those cuts are perennially popular and widely consumed beef products like Sirloin Steak and Tenderloin.²⁷ In addition

to selecting lean beef cuts, fat intake can be further reduced by choosing low-fat cooking methods and eating moderate portion sizes.

Dietary Recommendations Regarding Fat Intake and the Role of Beef

To meet the body's daily energy and nutritional needs while minimizing the risk of chronic disease, dietary recommendations issued by the Institute of Medicine and the 2015 *Dietary Guidelines for Americans* advise a range of total fat intake of 20% to 35% of calories (i.e., no more than

44 g to 78 g on a 2,000-calorie diet) for all Americans age 18 years and over.¹¹ This range of fat intake, as opposed to more restrictive limits, enables individuals to be flexible in their food choices. The *Dietary Guidelines* also recommend less than 10% of calories from saturated fat (i.e., 22 g on a 2,000-calorie diet), and intake of *trans* fatty acids as low as possible.¹¹

To meet these guidelines, individuals are counseled to choose lean meats such as lean beef.^{11,28,29} A 3-ounce serving of lean beef falls well within the guidelines of a diet that contains 20% to 35% of calories from fat with no more than 7% to 10% of its calories from saturated fat.⁷ On average, cuts of cooked lean beef have 5.7 g total fat and 2.1 g of saturated fat per 3-ounce serving (**Table 5**).⁷ The

Table 5. Fat and Cholesterol Content per 3-Ounce Cooked Servings of Popular Lean* Beef Cuts (visible fat trimmed).⁷

	Total (g)	Saturated Fat (g)	Cholesterol (mg)
Eye Round Roast and Steak**	4.0	1.4	53
Sirloin Tip Side Steak	4.1	1.6	68
Top Round Roast and Steak**	4.6	1.6	61
Bottom Round Roast and Steak**	4.9	1.7	64
Top Sirloin Steak	4.9	1.9	49
Sirloin Tip Center Roast and Steak**	5.8	2.1	65
Top Loin (Strip) Steak	6.0	2.3	56
Flank Steak	6.3	2.6	42
Shoulder Center (Ranch) Steak	6.5	2.4	65
Tri-Tip Roast and Steak**	7.1	2.6	61
Tenderloin Roast and Steak**	7.1	2.7	67

*Lean: Less than 10g of total fat, 4.5g or less of saturated fat, and less than 95mg of cholesterol per serving and per 100 grams.

**Cuts combined.

amount of *trans* fatty acids in lean beef is small (i.e., less than 0.5 g per serving) and as previously noted, the potential physiological impact of these fatty acids differs from that of the cholesterol-raising *trans* fatty acids in the industrial-formulated partially hydrogenated vegetable fats. Furthermore, studies have shown that lean beef can be included in heart-healthy dietary patterns and can be just as effective as poultry or fish in achieving desirable blood lipid profiles.³⁰⁻³³ In their report on the role of beef in the American diet, the American Council on Science and Health concludes, “lean beef, in moderate servings, fits well in a heart-healthy diet”.³⁴

Additionally, eight fresh beef cuts are certified to display the Heart-Check mark, signifying they meet the American Heart Association’s requirements for heart-healthy foods as part of an overall healthy eating pattern. These cuts include USDA Select quality grade Top Sirloin (Petite Roast, Steak, Strips, Filet, and Kabobs), Sirloin Tip Steak, Bottom Round Steak, as well as Extra Lean Ground Beef (96% Lean, 4% Fat).³⁵

Summary

A moderate amount of fat consumed within a nutritionally balanced diet meeting energy needs is recommended by government and health professional organizations. Fat intake from animal sources has decreased in recent decades, in part because of the increased availability of lean meats such as lean beef. Accumulating clinical evidence indicates that the fat in beef is less cholesterol-raising than reflected by its fatty acid composition, due to its stearic acid (a saturated fatty acid) and monounsaturated fatty acid content. Lean beef cuts are available to help consumers achieve current dietary recommendations. In 1989, the USDA Agriculture Handbook No. 8 identified six beef cuts as meeting the government definition for lean; by the USDA’s release of SR 26 in 2013, 38 cuts of beef met that same criteria.⁶ Consumers are encouraged to select naturally nutrient-rich foods to get more nutrients with fewer calories. Focusing on the total nutritional package of foods, rather than on just fat or calories, helps people understand the nutritional value of a food. Lean beef is a nutrient-dense food providing substantial amounts of vitamins and minerals, most notably protein, iron, zinc, and vitamin B12, and relatively few calories.⁸

References

1. Food and Nutrition Board, Institute of Medicine of the National Academies. Dietary Reference Intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington, D.C.: The National Academies Press; 2005.
2. U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. Nutrient content of the U.S. food supply, 1909-2010. Data last updated May 15, 2014. Available at <https://www.cnpp.usda.gov/USFoodSupply-1909-2010>
3. Hiza HAB, Bente L. U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. Nutrient content of the U.S. food supply, 1909-2004: A summary report. Home Economics Research Report No. 57, 2007. Available at https://www.cnpp.usda.gov/sites/default/files/nutrient_content_of_the_us_food_supply/FoodSupply1909-2004Report.pdf
4. Bentley J. U.S. Department of Agriculture, Economic Research Service. U.S. trends in food availability and a dietary assessment of loss-adjusted food availability, 1970-2014. EIB-166, 2017.
5. National Cattlemen’s Beef Association, a Contractor to the Beef Checkoff Program. Lean Matters: Chronicling Beef’s Change from Gate to Plate. 2014. Available at http://www.beefresearch.org/CMDocs/BeefResearch/Nutrition/LeanMatters_Web.pdf
6. Watt BK, Merrill AL. Composition of foods raw, processed, prepared. US Department of Agriculture, Agriculture Handbook 8, 1963.
7. U.S. Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory. USDA Nutrient Database for Standard Reference, Release 28. Version Current: September 2015, slightly revised May 2016.
8. Kris-Etherton PM, Fleming JA. Emerging nutrition science on fatty acids and cardiovascular disease: nutritionists’ perspectives. *Adv Nutr* 2015;6(3):326S-375.
9. Hunter JE, et al. Cardiovascular disease risk of dietary stearic acid compared with *trans*, other saturated, and unsaturated fatty acids: a systematic review. *Am J Clin Nutr* 2010;91:46-63.
10. Denke MA. Role of beef and beef tallow, an enriched source of stearic acid, in a cholesterol-lowering diet. *Am J Clin Nutr* 1994;60:1044S-9S.
11. U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015–2020 *Dietary Guidelines for Americans*. 8th Edition. December 2015. Available at <http://health.gov/dietaryguidelines/2015/guidelines/>
12. Vesper HW, et al. Plasma *trans*-fatty acid concentrations in fasting adults declined from NHANES 1999-2000 to 2009-2010. *Am J Clin Nutr* 2017;105(5):1063-9.

13. Mozaffarian D, et al. Health effects of *trans*-fatty acids: experimental and observational evidence. *Eur J Clin Nutr* 2009;63:S5-21.
14. Jakobsen M, et al. Intake of ruminant *trans* fatty acids and risk of coronary heart disease. *Int J Epidemiol* 2008;37:173-82.
15. Chin SF, et al. Dietary sources of conjugated dienoic isomers of linoleic acid, a newly recognized class of anticarcinogens. *J Food Compos Anal* 1992;5:185-97.
16. Huth PJ. Do ruminant *trans* fatty acids impact coronary heart disease risk? *Lipid Technol* 2007;19:59-62.
17. Bendtsen NT, et al. Consumption of industrial and ruminant *trans* fatty acids and risk of coronary heart disease: a systematic review and meta-analysis of cohort studies. *Eur J Clin Nutr* 2011;65:773-83.
18. Gebauer SK, et al. Effects of ruminant *trans* fatty acids on cardiovascular disease and cancer: a comprehensive review of epidemiological, clinical, and mechanistic studies. *Adv Nutr* 2011;2:332-54.
19. Wang DD, Hu FB. Dietary fat and risk of cardiovascular disease: Recent controversies and advances. *Annu Rev Nutr* 2017; 37:423-46.
20. Daley CA, et al. A review of fatty acid profiles and antioxidant content in grass-fed and grain-fed beef. *Nutr J* 2010;9:10.
21. Van Elswyk ME, McNeill SH. Impact of grass/forage feeding versus grain finishing on beef nutrients and sensory quality: The U.S. experience. *Meat Sci* 2014;96:535-40.
22. O'Neil CE, et al. Food sources of energy and nutrients among adults in the US: NHANES 2003-2006. *Nutrients* 2012;4:2097-120.
23. Subar AF, et al. Dietary sources of nutrients among US adults, 1989 to 1991. *J Am Diet Assoc* 1998;98:537-47.
24. Cotton PA, et al. Dietary sources of nutrients among US adults, 1994 to 1996. *J Am Diet Assoc* 2004;104:921-30.
25. U.S. Department of Agriculture, Food Safety and Inspection Service. A guide to federal food labeling requirements for meat, poultry, and egg products. 2007. Available at https://www.fsis.usda.gov/shared/PDF/Labeling_Requirements_Guide.pdf
26. McNeill SH, et al. The evolution of lean beef: identifying lean beef in today's U.S. marketplace. *Meat Sci* 2012;90:1-8.
27. IRI/Freshlook, Total U.S. Multi Outlet (MULO), 52 weeks ending 8/27/17; Categorized by VMMeat System.
28. Eckel RH, et al. 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol* 2014;63:2960-84.
29. Van Horn L, et al. Recommended dietary pattern to achieve adherence to the American Heart Association/American College of Cardiology (AHA/ACC) Guidelines: A scientific statement From the American Heart Association. *Circulation* 2016;134:e505-29.
30. Roussell MA, et al. Beef in an Optimal Lean Diet study: effects on lipids, lipoproteins, and apolipoproteins. *Am J Clin Nutr* 2012;95:9-16.
31. Roussell MA, et al. Effects of a DASH-like diet containing lean beef on vascular health. *J Hum Hypertens* 2014;28:600-5.
32. Maki KC, et al. A meta-analysis of randomized controlled trials that compare the lipid effects of beef versus poultry and/or fish consumption. *J Clin Lipidol* 2012;6:352-61.
33. Sayer RD, et al. Equivalent reductions in body weight during the Beef WISE Study: beef's role in weight improvement, satisfaction and energy. *Obes Sci Pract* 2017;3:298-310.
34. Meister K. The role of beef in the American diet. New York: American Council on Science and Health, 2003.
35. American Heart Association. Heart-Check Certified Product List. Last updated December 15, 2017. Available at: http://www.heart.org/idc/groups/heart-public/@wcm/@fc/documents/downloadable/ucm_474830.pdf. (Accessed January 4, 2018).

For more information, contact:

National Cattlemen's Beef Association
 Contractor to the Beef Checkoff Program
 9110 East Nichols Avenue
 Centennial, CO 80112
 303.694.0305

Copyright© 2018 Cattlemen's Beef Board and National Cattlemen's Beef Association.
 All rights reserved.



BeefResearch.org



303.694.0305



Funded by Beef Farmers and Ranchers