

BEEF LIPIDS IN PERSPECTIVE

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 (1,2).

Changes in the Supply of Dietary Fat

Between 1909-19 and 2004, total fat available in the U.S. food supply increased by 49%, from an average of 120 g/capita/day to 179 g/capita/day (3, Table 1). Types of fat available during this period also changed. Specifically, a trend toward the increased availability of unsaturated fats relative to saturated fats occurred. Between 1909-19 and 2004, the availability of monounsaturated and polyunsaturated fats increased by 68% and 185%, respectively (3). The increase in polyunsaturated fats reflects increases in soybean and corn oils and nuts, whereas the increase in monounsaturated fats reflects increases in olive, sunflower, and canola oils. In contrast to total fat, the availability of cholesterol in the food supply slightly declined between 1909-19 and 2004 (3).

The increase in fat availability between 1909-19 and 2004 is due largely to fat from vegetable sources, which has more than tripled (3, Figure 1). During this same period, fat availability from animal sources decreased (3). The proportion of total fat available in the U.S. food supply contributed by meat fell from 32.3% in 1909-19 to 13.2% in 2004 (3).

Similarly, the proportion of saturated fat contributed by meat decreased from 30.3% to 16.1% during this time period (3). Between 1909 and 2004, the proportion of available total fat and saturated fat contributed by beef dropped by 43% (from 12.3% to 7.0%) and 27% (from 12.4% to 9.0%), respectively (3).

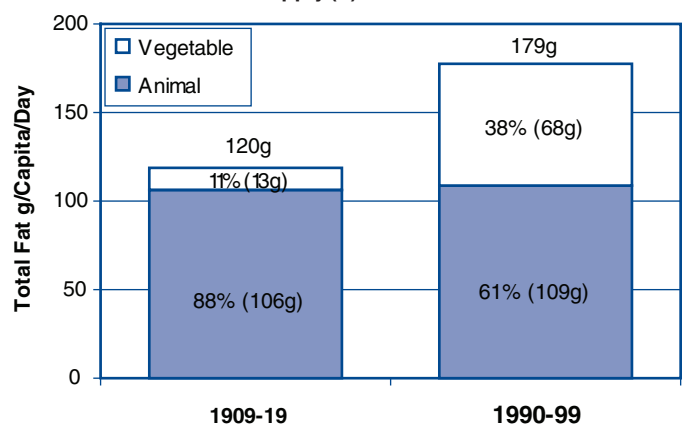
This decrease in the proportion of total fat and saturated fat available from animal sources in the U.S. food supply is attributed in part to the production of leaner animals through changes in livestock feeding and fat-trimming practices at processor and retail levels, which has contributed to the availability of leaner meats, including beef (4). For example, the amount of fat in ground beef at retail has decreased over the years (4,5). In the late 1980s, the U.S. Department of Agriculture (USDA) reported data for the nutrient content of ground

beef containing 17% fat and above. Today, the USDA provides nutrient information for ground beef products containing 5% fat and above (5).

Table 1. Change in Fat and Cholesterol Availability Per Capita Per Day, 1909-1919 and 2004 (3)

| | 1909-19 | 2004 | % Change |
|-------------------------|---------|------|----------|
| Total Fat, g | 120 | 179 | 49 |
| Saturated Fat, mg | 50 | 56 | 12 |
| Monounsaturated Fat, mg | 47 | 79 | 68 |
| Polyunsaturated Fat, mg | 13 | 37 | 185 |
| Cholesterol, mg | 440 | 430 | -2 |

Figure 1. Type and Amount of Fat in the U.S. Food Supply (3)



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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 vegetable 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. Conjugated linoleic acid (CLA), a *trans* fatty acid found in beef, is a collective term for a group of geometric and positional isomers of linoleic acid, an essential fatty acid. All fatty acids, regardless of the type (saturated or unsaturated) provide the same number of calories per gram when metabolized for energy (1).

Profile of Beef Fats

Like most other foods containing fat, meat products such as beef are composed of a variety of fatty acids (5, Table 2). Despite the common reference to animal fats as “saturated,” less than half of all fatty acids in meat fat are saturated (5). Lean beef typically contains more MUFAs than SFAs and a small amount of PUFAs (5, Table 3). MUFAs and PUFAs may be beneficial in reducing the risk of heart disease when substituted for SFAs (2). A 3-oz serving of cooked lean beef (i.e., composite of trimmed retail cuts, all grades, 0” trim, separable lean only) contains 6.60 g of total fatty acids, of which 45.6% is saturated, 50.1% is monounsaturated, and 4.1% is polyunsaturated (5). Also, approximately one-third of beef’s total saturated fat is stearic acid (5). Unlike other long-chain SFAs, stearic acid has been shown to be neutral in its effects on blood cholesterol levels in humans (6,7).

Trans fatty acids are found naturally in very low amounts in meats such as beef (0.01-0.21 g/serving or less than 5% of beef fat) (8,9). Most *trans* fatty acids are formed during the partial hydrogenation of fat and oils and are

Table 2. Fatty Acid Composition of Lean Cooked Beef (5)

| Fatty Acids | Amount per 3 oz Serving (g) |
|-------------------------------------|-----------------------------|
| Fatty Acids, total saturated | 3.01 |
| 4:0 (butyric) | 0.00 |
| 6:0 (caproic) | 0.00 |
| 8:0 (caprylic) | 0.00 |
| 10:0 (capric) | 0.01 |
| 12:0 (lauric) | 0.01 |
| 14:0 (myristic) | 0.22 |
| 16:0 (palmitic) | 1.79 |
| 18:0 (stearic) | 0.97 |
| Fatty acids, total monounsaturated | 3.31 |
| 16:1 undifferentiated (palmitoleic) | 0.28 |
| 18:1 undifferentiated (oleic) | 3.02 |
| Fatty acids, total polyunsaturated | 0.27 |
| 18:2 undifferentiated (linoleic) | 0.21 |
| 18:3 undifferentiated (linolenic) | 0.02 |
| 20:4 undifferentiated (arachidonic) | 0.03 |

Table 3. Relative Proportion of Types of Fatty Acids and Other Lipids (5)

| | % of Total Fat | | | Other Lipids |
|---------------------------------------|----------------|------|------|--------------|
| | SFA | MUFA | PUFA | |
| Beef, composite, lean, cooked | 38.1 | 42.0 | 3.4 | 16.5 |
| Pork, composite, lean, cooked | 35.2 | 45.5 | 7.8 | 11.5 |
| Lamb, composite, lean, cooked | 35.7 | 43.8 | 6.5 | 14.0 |
| Veal, composite, lean, cooked | 28.0 | 35.7 | 9.0 | 27.3 |
| Chicken, broiler, flesh only, roasted | 28.3 | 34.7 | 21.6 | 15.4 |
| Tuna, light, canned in water | 28.5 | 19.4 | 41.1 | 11.0 |
| Salmon, pink, cooked | 16.2 | 27.1 | 39.2 | 17.5 |
| Cooking Fats/Spreads | | | | |
| Butter | 62.8 | 25.7 | 3.7 | 7.8 |
| Corn Oil | 12.9 | 27.6 | 54.7 | 4.8 |
| Olive Oil | 13.8 | 73.0 | 10.5 | 2.7 |

found in hydrogenated vegetable oils and products made from or containing these oils (stick margarine, vegetable shortenings) (8). Not only does meat such as beef have a low amount of *trans* fatty acids, but its predominant *trans* fatty acid (vaccenic acid) differs from the “man made” *trans* fat (elaidic acid) in partially hydrogenated vegetable oils (10,11). *Trans* elaidic acid is associated with an increased risk of coronary heart disease (12), whereas preliminary evidence indicates that ruminant-derived *trans* vaccenic acid may not be associated with an increased risk and, because of its conversion in the body to CLA, may have health benefits (10,11).

Because man-made *trans* fatty acids, like some SFAs, are associated with an unfavorable blood lipid profile and therefore increased risk of coronary heart disease, the U.S. Food and Drug Administration (FDA) issued a regulation requiring food manufacturers to list the amount of *trans* fatty acids on the Nutrition Facts Panel of most food products (13). CLA is excluded from this regulation (13). Under this regulation, manufacturers are allowed to label certain foods as “*trans* fat free” (i.e., less than 0.5 g per serving) (13). The U.S. Food Safety Inspection Service, not FDA, governs meat labeling. Nevertheless, virtually all lean beef products fall below FDA’s minimal level and thus can be listed as “zero” *trans* fat on nutrition labels. The 2005 *Dietary Guidelines for Americans* recommend that the intake of *trans* fat be as low as possible, recognizing that some *trans* fats are naturally occurring and often present in nutrient-dense foods such as animal products (2).

Meat such as beef is an important source of CLA, which has been shown in experimental animal and *in vitro* studies, and limited human investigations, to have several potential health benefits, including reduced risk of some cancers and coronary heart disease (14,15). The average CLA content of meat products of ruminant origin (e.g., beef) is 0.46% of fat (range of 0.12 to 1.20%) (16). When the CLA intake of U.S. adults was estimated by 3-day dietary records, beef provided 32% of total CLA intake (17).

Beef Fat in Perspective

While beef is a prominent contributor to dietary fat intake, due to its popularity in many diets, it may not be as high as is often perceived. There are numerous sources of dietary fat in the typical American diet. According to a study of dietary sources of nutrients among U.S. adults, beef provides approximately 10.1% (90% from other food sources) of total fat in the diet, yet supplies only 6.2% of total calories (18). Beef is the number one source of MUFAs, contributing 11.4% of total intake; the number two source of SFAs, contributing 11.7%; the number ten source of PUFAs at less than 2.0%; and the second major source of cholesterol at 16.1% (18). Between 1989-91 and 1994-96, the contribution of beef total fat, SFAs, MUFAs, and PUFAs to the total levels of these fats in the diet decreased, while cholesterol remained unchanged (18).

For individuals concerned about fat in their diet, a variety of lean cuts of meat including beef are available. The 1990 Nutrition Labeling and Education Act defined lean cuts of meat as those containing 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 (19). The 29 cuts of beef listed in Table 4 meet the requirements for lean meat (5,19). Interestingly, a 3-oz serving of any one of these beef cuts provides less total fat than a similar size serving of a skinless chicken thigh (9.2 g fat) and nearly all of these beef cuts contain less saturated fat than a skinless chicken thigh (2.6 g saturated fat) (5). In

Table 4. Fat and Cholesterol Content Per 3-Ounce Serving of 29 Cuts of Lean* Beef (5)

| | Total Fat (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 |
| Brisket, Flat Half | 5.1 | 1.9 | 49 |
| 95% Lean Ground Beef | 5.1 | 2.4 | 65 |
| Round Tip Roast and Steak** | 5.3 | 1.9 | 75 |
| Round Steak | 5.3 | 1.9 | 66 |
| Shank Cross Cuts | 5.4 | 1.9 | 66 |
| Chuck Shoulder Pot Roast | 5.7 | 1.8 | 60 |
| Sirloin Tip Center Roast and Steak** | 5.8 | 2.1 | 65 |
| Chuck Shoulder Steak | 6.0 | 1.9 | 80 |
| Bottom Round (Western Griller) Steak | 6.0 | 2.2 | 65 |
| Top Loin (Strip) Steak | 6.0 | 2.3 | 56 |
| Shoulder Petite Tender and Medallions** | 6.1 | 2.4 | 66 |
| 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 |
| T-Bone Steak | 8.2 | 3.0 | 48 |

* 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.

addition to selecting lean meats, fat intake from meat can be further reduced by trimming any visible fat from retail cuts, choosing lowfat cooking methods, and eating moderate portion sizes.

The fat content and composition of meat are influenced by genetic factors and feeding practices. For example, forage finished cattle has been shown to produce beef with more CLA and omega-3 fatty acids compared to grain finished beef (20,21). In some studies grass-fed beef has been found to have a lower concentration of MUFAs and a higher concentration of SFAs than grain-fed beef (20,22), although the opposite finding was observed in another investigation

(21). The effects of the lipid differences between grass-fed and conventional raised beef, on human health, remains to be investigated. While lean beef has consistently been shown to be beneficial in a cholesterol lowering diet it is still questionable whether or not grass-fed beef would have similar benefits.

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 (1) and the *2005 Dietary Guidelines for Americans* (2) 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. 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), less than 300 mg/day of cholesterol, and intake of *trans* fatty acids as low as possible (2). For adults at risk of heart disease, the Guidelines recommend less than 7% of calories from saturated fat (i.e., 16 g or less on a 2,000 calorie diet) and less than 200 mg/day of cholesterol (2). In its Diet and Lifestyle recommendations, the American Heart Association recommends a total fat intake of 25% to 35%, less than 7% of calories from saturated fat, less than 1% of energy from *trans* fat, and less than 300 mg cholesterol/day (23).

To meet these guidelines, individuals are counseled to choose lean meats such as lean beef (2,23). A 3-ounce serving of lean beef falls well within the guidelines of a diet that contains 20% to 30% of calories from fat, no more than 7% to 10% of its calories from saturated fat, and less than 300 mg cholesterol. The 29 cuts of lean beef contribute

an average of 5.7 g total fat, 2.1 g of saturated fat, and 62 mg cholesterol per 3-ounce serving (5, Table 4). Also, the amount of *trans* fatty acids in beef is small (i.e., less than 0.5 g per serving) and the potential physiological impact of these fatty acids differs from that of the cholesterol-raising *trans* fatty acids in hydrogenated vegetable fats. Furthermore, studies have shown that lean beef can be included in lowfat diet plans and can be just as effective as poultry or fish in achieving desirable blood lipid profiles (24-27). In its 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" (28).

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 and it contains potential health-promoting components such as CLA.

Twenty-nine cuts of lean beef are available to help consumers achieve current dietary recommendations such as the *Dietary Guidelines for Americans* (2) and *MyPyramid* (29). Consumers are being encouraged to select naturally nutrient-rich foods to get more nutrients from 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 (5).

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