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Original research article

Fatty acid, cholesterol, vitamin, and mineral content of cooked beef cuts from a national study

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ABSTRACT

A comprehensive beef study was initiated to obtain and compare representative retail beef nutrient data to include leaner and newly merchandised cuts available in the marketplace. A statistically based sampling plan was used to obtain 72 beef carcasses with nationally representative characteristics, conducted in three phases. Retail cuts were fabricated and cooked. Validated laboratories determined nutrient values using quality assurance protocols. Cooked cuts of chuck eye, ribeye, tenderloin, shoulder and top loin were compared for nutrient differences. Total fat levels ranged from 6.9 to 24.2 g, saturated fat was 2.9 to 10.5 g, and cholesterol was 80 to 98 mg (per 100 g). Nutrient content differed among three grilled cuts ($p < 0.05$), and among three roasted cuts ($p < 0.05$), indicating higher total fat and fatty acid concentrations (saturated, monounsaturated, polyunsaturated, trans) in ribeye cuts compared to tenderloin cuts ($p < 0.05$). Concentrations of cholesterol and fatty acids were similar between roasted and grilled paired cuts, for most pairs ($p > 0.05$). Vitamin and mineral differences in paired cut comparisons were insignificant for most pairs ($p > 0.05$). The results confirmed and extended previous nutrient data, using up-to-date representative beef cuts to generate and compare data for a range of cuts for several cooking methods.

1. Introduction

Beef, as a recognized contributor of vital nutrients to the diet including high quality protein, zinc, highly bioavailable iron, and B-vitamins, especially B-6 and B-12, offers important health benefits (Geay et al., 2001; Nicklas et al., 2012). Cholesterol and fatty acids, which are often correlated with cardiovascular disease (CVD) risk, are also found in beef (Daley et al., 2010). Meat intake, including its total fat and fatty acids, has been extensively studied, with mixed conclusions as related to health (Daley et al., 2010; Klurfeld, 2015; Micha et al., 2017; Sinha et al., 2009). Positive effects of beef and overall red meat intake on health indicators are supported by studies that have addressed questions about the possible relationship of intake to chronic disease (McNeill et al., 2012). For example, heart-healthy diets in which lean beef (113 or 153 g/day) was the major protein had positive effects on risk of cardiovascular disease (CVD), as shown in the Beef in an Optimal Lean Diet study (Roussell et al., 2012, 2014). Furthermore, specific fatty acids have unique effects on biological function (Vannice and Rasmussen, 2014). For example, stearic acid, a prominent saturated fatty acid in beef, has a neutral effect on serum cholesterol, thus having a more favorable impact on health than many other saturated fatty acids (Daley et al., 2010; Vannice and Rasmussen, 2014). The role of

Abbreviations: USDA, United States Department of Agriculture; NDL, Nutrient Data Laboratory; NDI, Nutrient Database Improvement; QC, quality control; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; TFA, *trans* fatty acids; CVD, cardiovascular disease

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trans fatty acids naturally found in beef and other foods from ruminant animals also deserves mention. Studies examining individual ruminant-sourced *trans* fatty acids consumed in typical amounts suggest neutral or inverse associations with CVD risk factors, although further research is needed (Gebauer et al., 2011).

Red meat consumption was not associated with coronary heart disease, diabetes mellitus, or stroke in a *meta*-analysis of 20 studies (Micha et al., 2010). Lean red meat in moderate amounts in a balanced diet provided valuable contributions to essential nutrient intake and was deemed unlikely to increase CVD or colon cancer risks (McAfee et al., 2010). In another multi-study assessment, which was a *meta*-analysis of 945 studies, consuming over 35 g cooked (1/2 serving) red meat per day had no influence on relevant CVD risk measures (O'Connor et al., 2017). Thus, in light of current scientific information, beef contributes nutritive value within a balanced diet.

Although data on nutrient contents of beef are reported in the scientific literature, most of those data were collected to answer specific research questions, such as the effects of experimental cattle diets on nutrients in beef measured in one specific raw cut. Because those types of nutrient data results are not derived from beef obtained through sources that are representative of beef typically consumed, they have limited use as food composition data. Furthermore, published literature have lacked nutrient data comparisons for specific beef cuts prepared using different cooking methods.

To assist scientists and consumers in identifying nutrient contributions of current retail cuts of beef, this report provides statistically compared data from a comprehensive three-phase research study in which nationally representative samples were obtained and analyzed. Results for selected cuts from all three phases are reported. The twelve cuts being compared are from three different primals of the beef carcass. Four are from the chuck primal (chuck eye steak, chuck eye roast, shoulder steak, shoulder roast), four are from the rib primal (ribeye lip-on boneless steak, ribeye lip-on boneless roast, ribeye lip-on bone-in steak, ribeye lip-on bone-in roast), and four are from the loin primal (tenderloin steak, tenderloin roast, top loin steak with 0.32 cm trim, top loin steak with no trim).

This report presents nutrient comparisons based on these research objectives: a) did nutrient differences exist among retail cuts using the same cooking method; and b) did nutrients vary among pairs of cuts when cooked with two different methods. For these investigations, first, cholesterol and fatty acid content were compared among cooked beef cuts from the chuck, rib, and loin primals of the carcass. Nutrient values for steak cuts from these three primals, which were grilled, were compared to corresponding roasts from the three primals (Table 1). In addition, to address the second research objective, paired comparisons were made for cholesterol, fatty acids, vitamins, and minerals from six pairs of cuts including chuck eye steak vs roast, shoulder steak vs roast, tenderloin steak vs roast, ribeye boneless steak vs roast, ribeye bone-in steak vs roast, and top loin steak with 0.32 cm trim vs 0 trim (Tables 1–4). Most of these pairs involved nutrient comparisons between cooking methods; the effects of alternative fabrications on nutrient content for several pairs were also examined. The ultimate objective of this report is to compare amounts of cholesterol, fatty acids, vitamins, and minerals in specific beef cuts typically consumed and to potentiate future analyses based on implications and applications to nutrition science. These nutrient comparisons of cooking methods and cut characteristics provide a framework for understanding how cooking methods, cut fabrications, and cut locations within the carcass affect the composition of consumed beef.

2. Materials and methods

2.1. Study procedures

An in-depth collaborative research project was developed by scientists at the United States Department of Agriculture (USDA)'s

Table 1
Effects of cut and cooking method on fat, cholesterol, and fatty acid concentrations (per 100 g) in comparable beef retail cuts[1].

Cut	Cooking Method	Fat Trim (cm)	N/N[2]	Fat g(SEM)	Cholesterol mg(SEM)	Saturated Fat g(SEM)	Monounsaturated Fat g(SEM)	Polyunsaturated Fat g(SEM)	*Trans* Fat g(SEM)
Chuck eye roast, boneless	roasted[3]	0.0	35/6	15.4^{b}(0.64)	83^{a}(2.2)	6.4^{b}(0.50)	7.2^{b}(0.49)	0.66^{b}(0.041)	0.89^{b}(0.086)
Chuck eye steak, boneless	grilled[4]	0.0	71/6	**19.7**^{b}(0.60)	87^{a}(2.2)	**8.7**^{a}(0.50)	**9.5**^{a}(0.49)	**0.81**^{b}(0.041)	**1.29**^{a}(0.086)
p values <				0.001	0.197	0.004	0.005	0.02	0.004
Ribeye lip-on roast, boneless	roasted	0.32	36/6	21.5^{a}(0.85)	81^{a}(2.2)	9.3^{a}(0.50)	10.3^{a}(0.49)	1.07^{a}(0.041)	1.42^{a}(0.086)
Ribeye lip-on steak, boneless	grilled	0.32	36/6	21.8^{a}(0.45)	80^{b}(2.2)	9.6^{a}(0.50)	10.5^{a}(0.49)	1.00^{a}(0.041)	1.46^{a}(0.086)
p values <				0.7	0.739	0.38	0.525	0.09	0.384
Tenderloin roast, boneless	roasted	0.0	36/6	8.0^{c}(0.40)	84^{a}(2.2)	3.2^{c}(0.50)	3.6^{c}(0.49)	0.59^{b}(0.041)	0.45^{c}(0.086)
Tenderloin steak, boneless	grilled	0.0	36/6	**8.8**^{c}(0.45)	**93**^{a}(2.2)	3.5^{b}(0.50)	3.9^{b}(0.49)	0.61^{c}(0.041)	0.48^{b}(0.086)
p values <				0.009	0.001	0.366	0.313	0.574	0.504
Shoulder roast, boneless	braised[5]	0.0	72/6	**9.0**(0.43)	**98**(2.2)	3.1(0.50)	3.9(0.49)	**0.51(0.041)**	0.39(0.086)
Shoulder steak, boneless	grilled	0.0	72/6	6.9(0.48)	81(2.2)	2.9(0.50)	3.5(0.49)	0.41(0.041)	0.39(0.086)
p values <				0.001	0.0001	0.50	0.314	0.017	0.936

[1]Each data profile includes the cut's total lean plus separable fat content after removing external fat trim, unless otherwise noted. SEM indicates standard error of mean.
Nutrient means for roasted cuts followed by the same letter (a, b, or c) are not significantly different ($p < 0.05$). Nutrient means for grilled cuts (excluding shoulder) followed by same letter (a, b, or c) are not significantly different ($p < 0.05$). For paired comparisons of roast vs steak, bold-face value indicates the greater mean ($p < 0.05$).
[2]The first number shows number of analytical values for fat; the second shows number of analytical composites for cholesterol and fatty acids.
[3]Roasted: Cooking temperature 160°C, final internal temperature 60°C.
[4]Grilled: Cooking temperature 195°C, final internal temperature 70°C.
[5]Braised: Cooking temperature 120°C, final internal temperature 85°C.