EBG Capital
Agricultural Investments

Grass-fed vs Grain-fed cattle

Differences in meat and milk quality and their consequences on human health

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Table 1: Differences in meat properties for grass-fed vs. grain fed cattle

Green text: *healthier for human consumption,* ***Red text***: *less healthy for human consumption.*

Meat properties	Grass-fed cattle	Grain-fed cattle
Total fat	Lower	Higher
Cholesterol	Slightly lower	Slightly higher
Saturated fatty acids (SFA)	Lower	Higher
Monounsaturated fatty acids (MUFA)	Lower	Higher
Polyunsaturated fatty acids (PUFA)	Slightly higher	Slightly lower
Omega 3	Higher	Lower
Omega 6	No statistical difference	No statistical difference
Omega 6/Omega 3	Lower	Higher
Conjugated linoleic acid (CLA)	Slightly higher	Slightly lower
Antioxidants (β-carotene)	Higher	Lower
Trace minerals	No statistical difference	No statistical difference
Proteins	No statistical difference	No statistical difference

Table 2: Differences in milk properties for grass-fed vs. grain fed cattle

Green text: *healthier for human consumption,* ***Red text***: *less healthy for human consumption.*

Milk properties	Grass-fed cattle	Grain-fed cattle
Polyunsaturated fatty acids (PUFA)	Higher	Lower
Saturated fatty acids (SFA)	Higher	Lower
Omega 6/Omega 3	Lower	Higher
Omega 3	Higher	Lower
Omega 6	Lower	Higher
Conjugated linoleic acid (CLA)	Higher	Lower
Vitamin E, selenium and β-carotene	Higher	Lower

1. Introduction

Nearly half of Americans suffer from one or more diet-driven chronic conditions including cardiovascular disease (CVD), overweight and obesity. Seven of the 10 leading causes of death in the United States were diet-related in 2013, and none are curable via medical intervention alone.

A radical change in the diet harmful for human health has impacted the ratio of dietary omega-6/omega-3 fatty acids (FAs), that has become historically high in Western diets during the last century, reaching about 15, compared to estimated evolutionary ratios near 1.

Modern agriculture, by changing animal feeds as a result of its emphasis on production, has decreased the omega-3 FAs content and increased intakes of omega-6 FAs in many foods, including animal meats, milk, eggs, and even fish.

The fatty acids profile in meat and milk vary substantially changed by shifting animals from grain- or concentrate-rich rations to diets largely based on grass and legume forages. This shift increases omega-3 FAs and conjugated linoleic acid (CLA) and decreases omega-6 FAs, changes that may help prevent CVD and other chronic conditions. The magnitude of these changes is markedly greater than most of the nutritional differences between organically and conventionally grown plant-based foods.

More studies would be valuable in order to better define the intake of various nutrients to be obtained in a larger variety of cuts from grass/forage-fed beef. Such information will be useful for nutrition professionals counseling clients, consumers making purchasing decisions, and improving the accuracy of nutrient databases.

Important note

Studies of forage and/or grass feeding of cattle versus grain finishing have been conducted in varying regions throughout the world but generalization of the results to beef from one region to another may not be appropriate. For example, the meat nutritional profile resulting from fresh pasture feeding systems in countries with abundant grass growing seasons, such as Brazil, Argentina, Uruguay, Australia and New Zealand is not directly applicable to beef marketed as “grass fed” in the U.S. In particular, heterogeneity exists between countries with regard to pasture type and availability and cattle breeds, all with the potential to influence the nutrient composition of the cattle diet and thus affect meat nutritional and sensory quality.

2. Meat

Red meat, regardless of feeding regimen, is nutrient dense and regarded as an important source of essential amino acids, vitamins A, B3, B6, B12, D, E, and minerals, including iron, zinc and selenium. It also contains high-quality protein and various lesser known nutrients, such as creatine and carnosine, important for muscles and brain. Along with these nutrients, meat consumers also ingest a number of fats which are an important source of energy and facilitate the absorption of fat-soluble vitamins including A, D, E and K.

With respect to lipid profiles and ratios, there are genetic, gender, age and geographic location related differences among the various meat producing species. Also, changes in finishing diets of conventional cattle can alter the lipid profile in such a way as to improve upon this nutritional package. Direct contrasts between grass and grain rations consistently demonstrate significant differences in the overall fatty acid profile, in the antioxidant and vitamins content found in the lipid depots and body tissues.

3. Milk

The nutritional composition of milk is highly complex: it is a rich source of protein (casein and whey proteins), of carbohydrates (in form of lactose), of vitamins and minerals. Milk fat is one of the most complex of natural fats, containing about 400 different types of fatty acids.

Key features of the fatty acid profile of milk fat include its omega-6/omega-3 ratio, its amounts of total omega-3, conjugated linoleic acid, and long-chain omega-3 polyunsaturated fatty acids. For each, grassmilk is markedly different than both organic and conventional milk.

These differences in grassmilk can help restore a historical balance of fatty acids: replacing recommended daily servings of conventional dairy products with grassmilk products and avoiding some foods high in omega-6 could substantially decrease historically high dietary ratios of omega-6/omega-3 ratios from current values of >10 to as low as 3.1. This has many potential health benefits, such as reducing the risk of cardiovascular, metabolic diseases and other chronic conditions.

4. Nutritional content

4.1. Fats and fatty acids

Total fat

Beef fat deposition is highly heritable and as such, total fat content may differ significantly among breeds. Stage of growth is influential on total carcass fat with certain breeds depositing more total fat and particular fatty acids at an early stage of life than other breed types. Therefore, the total fat content of beef reflects not only feeding regime but also genetic variability between cattle breeds, age at harvest, carcass grade, and beef cut.

Evidence regarding the effect of grass feeding or finishing on total carcass fat content suggests that grass/forage feeding significantly lowers total fat compared to grain-finished cattle. When comparing available evidence for lean cuts, this reduction translates to a 2–4 g difference in total fat per 100 g grass-fed vs. grain-finished beef, as consumed.

Cholesterol

Beef's cholesterol content is similar to other meats (beef 73; pork 79; lamb 85; chicken 76; and turkey 83 mg/100 g). Studies have shown that breed, nutrition and sex do not affect the cholesterol concentration of bovine skeletal muscle, rather cholesterol content is highly correlated to IMF (intramuscular fat) concentrations. As IMF levels rise, so goes cholesterol concentrations per gram of tissue. Because pasture raised beef is lower in overall fat, it would seem to follow that grass-finished beef would be lower in overall cholesterol content although the data is very limited.

Saturated fatty acids (SFA)

When reported on a percentage of total fatty acid basis, studies have consistently reported increases in total saturated fat deposition in response to grass feeding and finishing. However, due to the lower total fat content of beef from grass-fed cattle, this percentage increase does not translate to an increased intake of total SFA from grass-fed beef. In fact, g/100 g beef data suggest that because of its lower total fat content, U.S. grass-fed beef contains up to 1.4 g less total saturated fat per 100 g in various steak cuts than beef from grain-finished cattle.

Grassmilk is different than both organic and conventional milk, with total fatty acids levels as 3.585, 3.108, and 3.098 g/100 g milk in grassmilk, organic, and conventional milk.

Monounsaturated fatty acids (MUFA)

Beef is a primary source of MUFA and one of the most common sources of MUFA in the form of oleic acid, that elicits a cholesterol-lowering effect, a reduced risk of stroke and a significant decrease in both systolic and diastolic blood pressure. Oleic acid increases in beef as marbling fat cells differentiate. Grass-fed cattle produce beef with 30–70% less MUFA, compared to beef from grain-finished cattle.

The role of MUFA in cardiovascular health is well documented. Recent expert reports rate the evidence as "convincing/strong" that substitution of dietary MUFA for cholesterol-raising saturated fatty acids reduces LDL and lowers risk of type II diabetes and cardiovascular disease. The higher MUFA content of grain-finished beef may be important for increasing plasma HDL cholesterol among beef consumers and that exclusive grass-feeding could shift the MUFA:SFA ratio of beef in a manner that significantly lowers HDL, increases triglycerides, and increases the density of LDL particles among consumers of grass-fed beef.

Polyunsaturated fatty acids (PUFA) and omega-3/omega-6 FAs

The PUFA content of beef is low only averaging up to 5% of total fatty acids. The omega-6 fatty acid, linoleic acid, is the primary PUFA in both grass/forage-fed and grain-finished beef providing 60–85% of total PUFA.

The percentage PUFA in beef is increased by as much as 25% in response to grass-feeding. Due to the lower total fat content of most grass-fed beef, however, the total estimated amount of PUFA in steak from grass/forage-fed cattle may be up to 75 mg lower per 100 g of beef than that of grain-finished beef, primarily as less linoleic acid.

There is no significant change to the overall concentration of omega-6 FAs between feeding regimens, although grass-fed beef consistently shows a higher concentrations of omega-3 FAs as compared to grain-fed contemporaries, creating a more favorable omega-6:omega-3 ratio. The omega-3 fatty acid reduce inflammation in the body and has been tied to a lower risk of heart disease, stroke and type 2 diabetes.

Grassmilk is markedly different than both organic and conventional milk:

- The omega-6/omega-3 ratios are, respectively, 0.95, 2.28, and 5.77 in grassmilk, organic, and conventional milk,
- total omega-6 levels were 0.052, 0.071, and 0.098 g/100 g milk,
- total omega-3 levels were 0.056, 0.032, and 0.020 g/100 g milk.

Conjugated linoleic acid (CLA)

CLA is a metabolic end product of the rumen biohydrogenation of linoleic acid and thus accumulates in the fat and muscle of ruminant animals. Benefits attributed to mixed CLA isomer intake include reduced markers of atherosclerosis and is linked to protection from colorectal and breast cancers, diabetes and heart disease. Grass/forage feeding significantly increases the percent of CLA, in total fatty acids up to twice that found in grain-finished beef. However, due to the lower total fat content of most grass-fed beef, the total amount of CLA from either grass/forage-fed or grain-finished U.S. beef is essentially identical and either makes only a minor contribution to CLA intake levels found beneficial in clinical trials.

Grassmilk is markedly different than both organic and conventional milk, with total conjugated linoleic acid (CLA) levels as 0.043, 0.023, and 0.019 g/100 g milk in grassmilk, organic, and conventional milk.

4.2. Other nutrients

Antioxidants (β-carotene)

Antioxidants are compounds that have the capability to inhibit oxidative damage at the cellular level in vivo. Two studies reported increases in common antioxidants, α-tocopherol and β-carotene, in beef from cattle grazing pasture in the U.S. Specifically, in response to grass-finishing, the concentration of α-tocopherol nearly tripled and β-carotene content increased up to 10 times as compared to beef from U.S. grain-finished cattle.

Carotenes (mainly β-carotene) are precursors of retinol (Vitamin A), a critical fat-soluble vitamin that is important for normal vision, bone growth, reproduction, cell division, and cell differentiation. Specifically, it is responsible for maintaining the surface lining of the eyes and also the lining of the respiratory, urinary, and intestinal tracts. The overall integrity of skin and mucous membranes is maintained by vitamin A, creating a barrier to bacterial and viral infection. In addition, vitamin A is involved in the regulation of immune function by supporting the production and function of white blood cells.

Pasture-fed steers incorporated significantly higher amounts of beta-carotene into muscle tissues as compared to grain-fed animals: concentrations are 0.45 µg/g and 0.06 µg/g for beef from pasture and grain-fed cattle respectively, demonstrating a 7 fold increase in β-carotene levels for grass-fed beef over the grain-fed contemporaries.

Grassmilk is richer in antioxidants such as vitamin E, selenium and beta-carotene than both organic and conventional milk.

Trace minerals

The trace mineral content of grain-finished vs. grass-finished beef and reported no nutritionally relevant difference between the feeding regimes. The mineral content of grass-fed beef may vary in forage due to the mineral content of the soil in which it is grown. Therefore, whereas the grass species and stage of maturity impact the fatty acid profile of grass-fed beef, the mineral content of the soil, and in particular the sodium content, will impact trace minerals in beef from grass-fed cattle.

Proteins

Animal production factors such as nutrition and genetics have no influence on the protein content or amino acid profile of beef. Only a handful of U.S. studies compared protein content of grass/forage-fed to grain-finished and none reported statistical or practical differences (range 20–23%) in response to feeding regime.

5. Sources

Impact of grass/forage feeding versus grain finishing on beef nutrients and sensory quality: The U.S. experience

Nutritional composition of the meat of Hereford and Braford steers finished on pastures or in a feedlot in southern Brazil

A review of fatty acid profiles and antioxidant content in grass-fed and grain-fed beef.

Enhancing the fatty acid profile of milk through forage-based rations, with nutrition modeling of diet outcomes

An Increase in the Omega-6/Omega-3 Fatty Acid Ratio Increases the Risk for Obesity

Is Grassfed Meat and Dairy Better for Human and Environmental Health%253F