



## CHAPTER 50

# High Forage Diets Improve Quality of Beef for Consumers

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**F**eeding systems for beef cattle have intensified in order to maximise production efficiency and profitability, and to enable year-round feeding in regions that are snowbound for many months each year. Intensification has involved a move away from high forage and pastoral systems to feedlots in which feed contains minimal amounts of forage along with a high proportion of grain for rapid weight gain. Because beef cattle need roughage, some stored forage is included in these diets. The stored feed often consists mainly of whole-crop corn or barley silage with or without small amounts of grass as hay or silage. In contrast, high hay diets are associated with slower growth rate, unless the grass is chopped or, better, ground at very high expense. Also, since production, harvesting and storage of grass silage and hay are weather-dependant, forage quality is uneven and producers are reluctant to use large amounts. Grain has more consistent quality and produces rapid growth and is therefore very popular with the cattle finishing

sector. However, the shift to grain has come with some sacrifices to animal health (modest risk of 'founder' due to higher acidity of high grain diets) and to meat quality (excessive subcutaneous fat, less intramuscular fat, and changes in fatty acid profile of the carcass). This chapter will focus on new observations regarding health and organoleptic aspects as they relate to fat in forage-raised beef.

Many studies conducted in western Canada over the years have demonstrated that beef production systems have an effect on mechanical tenderness of beef. However, the differences tend to be small and preferences may be discernible to expert taste panels but not to consumers. Compared to grain-fed beef, forage-fed beef generally has less fat and hence may be more challenging to prepare. Lower tenderness due to reduced fat can be overcome by aging the beef longer, but this additional step is costly. Alternatively, to overcome the tenderness problem, mature sized animals may be rapidly finished with up to 70% grain and this seems to improve appeal



to consumers. Such feeding systems are beneficial to the cattle compared to conventional grain feeding because the acidity experienced by cattle on 90% grain diets is eliminated. Further, cattle fed lower grain diets with less rumen acidity can approach the feed bunk and consume more regularly, avoiding foot problems associated with the peaks and valleys in acidity in the rumen. Finally, when cattle are fed high levels of grain they need to be provided with antibiotics such as Tylosin phosphate, which mitigate the effects of acidity and reduce the number and severity of liver abscesses. There is concern that administering large amounts of antibiotics prophylactically may contribute to the rise of antibiotic resistant bacteria and to antibiotic contaminated water supplies and there is increasing public pressure to reduce antibiotic use for livestock production.

From the consumer health perspective, beef along with other flesh foods such as fish, poultry, mutton and pork are excellent sources of protein, fat- and water-soluble vitamins, and many minerals. It has been documented that consuming beef helps patients recover from stroke more rapidly with less onset of dementia compared to patients who do not consume beef. While this appears to be true for all beef, the beef from forage-fed cattle has a special fatty acid composition, which can even vary between cattle fed stored hay versus those that graze on pasture.

Despite the challenges of inconsistent nutritional quality of forages due to the effects of weather during growth and harvest, feeding hay appears to have consistent benefits in altering the fatty acid composition of the beef. Depending upon the forage used, there is accumulation of many bio-converted fatty acids which have been recognized to have special health benefits for the consumer. For example, perennial ryegrass is high in linolenic acid (omega 3 fatty acid) while orchardgrass has higher levels of linoleic acid (omega 6 fatty acid), thus the choice of grass species can affect the fatty acid composition of the beef.


The omega-3 and omega-6 fatty acids in grasses are substrates for production of transvaccenic acid (TVA) and conjugated linoleic acid (CLA), while some of the absorbed native linolenic acid molecules are elongated into eicosapentenoic acid (EPA), an important anti-inflammatory agent for humans. The conjugated linoleic acid is formed both by synthesis in the rumen and by desaturation of transvaccenic acid in the animal tissues. However, for the conjugated linoleic acid and transvaccenic acid to be formed, the diets must contain the precursor fatty acids (linoleic and linolenic acid) which encourages the particular bacteria that can participate in the bioconversion, either directly to conjugated linoleic acid or to the intermediary compound transvaccenic acid.

The levels of bio-transformed and elongated fatty acids

(TVA, CLA and EPA) are greater in grazing cattle than confined cattle fed forage because grazing cattle select young succulent parts of forage. The young forage plants have higher levels of fat than mature plants and the fat is comprised largely of the polyunsaturated linolenic and linoleic fatty acids.

When the production of ruminant livestock was less intensive, the feed consumed by the animals was more conducive to synthesis and deposition of transvaccenic acid, conjugated linoleic acid and other bioformed fatty acids. However as livestock production became more intensive, the nature of the feed provided to cattle changed and the content of conjugated linoleic acid in the meat decreased.

Can conjugated linoleic acid content of ruminant products be increased adequately to meet the human requirement from the amount of meat and milk consumed today? The current recommendation that conjugated linoleic acid comprise 1% of diet or that 3.5 g of conjugated linoleic acid be consumed daily was determined by extrapolating values from experiments with rodents. However, there are epidemiological studies which indicate that consuming as little as 55 mg conjugated linoleic acid per day provides enough chemo-protection from carcinogens to reduce incidence of breast cancer. If this threshold is substantiated, then consuming only 100 g (3 oz) of beef with 15mg conjugated linoleic acid/g of lipid will be adequate. Since the conjugated linoleic acid fatty acids are found in the fat marbling of the beef, as the marbling fat increases, the conjugated linoleic acid available to the consumer will also increase.

Our recent research has indicated that the key fatty acids (TVA, CLA and EPA) attach themselves specifically to the central carbon of the three carbons in the fat molecule in beef (Margatek et al. 2012). When beef is consumed, the digestion process retains the fatty acid attached to the central carbon, favouring its use for structural purposes rather than for energy. This feature of the transformed fatty acids may aid in providing the health benefits in a cumulative manner, indicating that efficacy is influenced not only by the content of these fatty acids but also their all-important “location, location, location!” While there is much to learn about the relative efficacy of the different types of forages as sources of fatty acids in promoting the bioconversion to these special fatty acids, current evidence indicates that consumption of grass-fed, and especially pastured beef, may be a tasty and wholesome way to enjoy the benefit from the health-promoting fatty acids. 

**References available online at [www.farmwest.com](http://www.farmwest.com)**

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