Bison - A "Healthy" Red Meat??

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Definitions: Lipids – Scientific term for "fat". Triglycerides – the major component of fat. Fatty acids – Major component of triglycerides. Fatty acids differ from one another not only by the number of carbons in their chain, but by the number of double-bonds between the carbon atoms. Saturated fatty acids are fatty acids with their carbon bonds "hydrogenated". Unsaturated fatty acids are fatty acids that have some hydrogen atoms removed resulting in double bonds. Fatty acids with more than one double bond are called polyunsaturated (PUFA). Cholesterol – Waxy fat circulating in the blood that can lead to deposition in the blood vessel walls contributing to atherosclerosis and cardiovascular disease. Conjugated linoleic acid (CLA) a potentially "healthy" isomer of a less healthy fatty acid, linoleic acid.

Bison (*Bison bison*) consumption in the United States has increased in popularity both due to taste and leanness and is now a commercially available alternative to cattle beef in many grocery locations. According to the National Bison Association, the total number of Bison in the US has increased from a low of 1500 in the mid 1800's to the current estimate of 400,000 today. Bison meat products are becoming mainstream food items in many health conscious American households. Approximately 35, 000 Bison were commercially processed for meat in 2005, a 17% increase over 2004 (www.bisoncentral.com). While still a small percentage of total cattle beef sales, Bison meat provides a healthy alternative for consumers of red meat.

Potential Health Benefits of Bison Meat

Dietary fat, once vilified by one and all, is now regarded as having some potentially healthful properties. We now know that the fat content of the food we consume can be beneficial or harmful depending upon the type of fat the food product contains, particularly the individual fatty acids attached to the triglyceride molecule. Triglycerides are the major form of storage fat in muscle tissue and are deposited in the muscle cell as well as the more obvious external marbling around the meat. The total amount of fat consumed in our daily diet is an important determinant of blood lipid levels; however certain types of fat are less "atherogenic" or not as prone to cause cardiovascular disease than others. Ideally, we would like to consume fats that are less likely to promote high blood cholesterol levels and less likely to be subsequently deposited in arterial plaques that lead to poor cardiovascular health. Generally speaking, saturated fats such as palmitic acid (C-16) are considered more atherogenic than poly-unsaturated fatty acids. Certain C-18 and C-20 polyunsaturated fatty acids are structured to contain their double bonds in a particular order with respect to the position of the first double bond and the positioning of hydrogen atoms around the double bond; this structuring imparts some unique health benefits to these fatty acids. Fatty acids that start expressing their double bonds 3 carbons from the methyl end of the fatty acid (omega 3 fatty acids) are usually not nearly as atherogenic as those which start their double bonds 6 carbons from the methyl end of the fatty acid molecule (omega 6 fatty acids).

What makes Bison a more healthful meat choice?

Bison meat presents both a more "favorable" total fat and fatty acid profile, especially when compared to typical feedlot fed beef cattle (Marchello et al 1989, Marchello et al 1998, Rule et al 2002). A typical cut of Bison meat such as lean broiled top sirloin contains slightly less cholesterol and up to 1/3 less calories from fat

(USDA handbook) per 100g of cooked lean meat. Some nutrient comparisons of several commercial meat products to Bison meat is shown in the following table from the National Bison Association website (www.bisoncentral.com).

Table 1. Nutritional Comparisons of several commercial cooked meats*

NUTRITIONAL COMPARISONS

PER 100 GRAM SERVING – COOKED MEAT – UPDATED DECEMBER 2002

SPECIES	FAT GRAMS	CALORIES KCAL	CHOLESTEROL MG	IRON MG	VITAMIN B-12 MCG
BISON	2.42	143	82	3.42	2.86
Beef *(Choice)*	10.15	219	86	2.99	2.65
Beef *(Select)*	8.09	201	86	2.99	2.64
Pork	9.66	212	86	1.1	0.75
Chicken *(Skinless)*	7.41	190	89	1.21	0.33
Sockeye Salmon	10.97	216	87	0.55	5.80

Bison, separable lean only, cooked, roasted. USDA NDB No. 17157
Beef, composite of trimmed retail cuts, separable lean only trimmed to 0" fat, choice, cooked USDA NDB 13365
Beef, composite of trimmed retail cuts, separable lean only trimmed to 0" fat, select, cooked USDA NDB 13366
Pork, fresh, composite of trimmed retail cuts (leg, loin and shoulder), separable lean only, cooked USDA NDB No. 10093
Chicken, broilers or fryers, meat only, roasted USDA NDB No. 05013
Finfish, salmon, sockeye, cooked, dry heat USDA NDB 15086

* www.bisoncentral.com

Meat products from range fed Bison contain up to 20% of their fatty acids in the form of polyunsaturated fat (PUFA) compared to approximately 6% for feedlot fed beef cattle. The gap narrows when range fed Bison meat is compared to range fed beef, but the advantage in fatty acid profile still favors Bison meat (Table 2).

Table 2. Comparison of the fatty acid composition of uncooked semitendinosus muscle of Bison and Beef*

Fatty Acid (weight %)	Bison	Beef
Saturated Fatty Acids (SFA)	38.1	39.9
Polyunsaturated Fatty Acids (PUFA)	19.9	14.4
Omega-3 Fatty Acids (ω-3)	6.9	4.3
Conjugated Linoleic Acid (CLA)	0.4	0.3
Cholesterol (mg/100 g)	45.8	48.7

* From Rule, DC et al. Comparison of muscle fatty acid profiles and cholesterol concentrations of bison,beef cattle, elk and chicken. J Anim Sci 80:1202-1211, 2002

Since a higher ratio of PUFA to saturated fatty acids (SFA) is associated with a more favorable blood cholesterol profile, the consumption of Bison meat may lead to a more favorable human blood lipid profile than consumption of similar amounts of feedlot fed beef (Cordain et al 2002). Fatty acids in dietary materials consumed by ruminants can in turn influence the fatty acid composition of their meat, affecting both flavor and health benefits for humans. Since Bison are typically range fed, increased grass intake results in an increase in the PUFA:SFA ratio as well as conjugated linoleic acid (CLA) concentration in muscle meats. Ruminants fed

diets high in range grasses tend to have higher concentrations of desirable omega 3 fatty acids (ω-3) and CLA in muscle tissue.

The suggestion that Bison meat presents a healthy alternative to other meat sources seems like a reasonable conclusion based upon what is known of the fat content and composition of Bison meat. However, surprisingly few human clinical trails have been conducted to substantiate the health benefits of Bison meat. Most of the health benefits are "presumed" based upon known the composition of Bison meat and inferences from the literature drawing upon studies utilizing other animal and human models studying the relationships of diet, cardiovascular disease and cancer. The leanness of Bison meat as well as its unique fatty acid profile are important nutritional attributes related to genetic factors as well as the typical foraging ecology of range fed Bison (Fortin et al 2003). In addition to being lower in total fat content compared to beef (Marchello et al 1989, Koch et al 1995), Bison meat also differs in its content of certain fatty acids and other nutrients that may lend special nutritional benefits to this nutrient dense food (Driskell et al 1997, Wilson et al 2000, Marchello 2001, Cordain et al 2002).

Does Bison meat possess anticancer nutrients?

Based upon the lipid analysis of range fed Bison meat, we might predict that it might have favorable cardiovascular benefits compared to other types of meat products. Other attributes of Bison meat related to other chronic disease conditions may also exist. Cancer has recently "dethroned" heart disease as the top killer among Americans under the age of 85. If Bison meat is more "heart healthy" than other red meats, could it also possess anti-carcinogenic properties? Although this is largely conjecture since experimental evidence is lacking, there may be additional health related benefits related to the compodition of Bison meat. Could the fatty acid profile of Bison (and perhaps other wild ruminant species) contribute to a reduced risk against certain types of cancer? The increased content omega 3-fatty acids and of certain beneficial C-18 unsaturated fatty acids such as conjugated linoleic acid (CLA isomers, 18:2 *cis*-9, *trans*-11 and 18:2 *cis*-12, *trans*-10) as well as the reduced content of potentially carcinogenic fatty acids such as linoleic acid (C-18:2 *cis* 9,12) may contribute to important nutritional properties of Bison meat (Cordain et al 2002, Rule et al 2002) . CLA is believed to be a "beneficial" fatty acid, with anti-inflammatory and <u>possibly</u> anti-carcinogenic properties. Range fed Bison meat has approximately 28% more CLA than feedlot fed beef (Rule et al 2002) and even has slightly more CLA when range fed Bison is compared to range fed beef. Research on the health benefits of CLA has shown that this particular fatty acid is involved with a number of positive health related outcomes (Table 3). Of particular interest is the suggestion that CLA may be anti-carcinogenic (Belury, 2002). Although it is unlikely that enough CLA could be ingested from any one dietary source to strongly influence the outcomes listed in Table 3, meat source CLA could make a significant contribution to the total dietary CLA intake. This possibility has been noted in a recent review of feeding practices and meat composition and their potential to favorably influence human health published by the Union of Concerned Scientists (www.ucsusa.org).

Table 3. Suggested Health Benefits of Conjugated Linoleic Acid*

- **Increases metabolic rate**
- **Decreases abdominal fat**
- **Enhances muscle growth**
- **Lowers blood cholesterol and triglycerides**
- **Lowers insulin resistance**
- **Enhances immune system function**
- **Possibly anti-carcinogenic**

*Belury, MA. Inhibition of carcinogenesis by conjugated linoleic acid: potential mechanisms of action. J Nutr 132: 2995-2998, 2002

The report "Greener Pastures: How grass fed beef and milk contribute to healthy eating" concluded that increased ruminant grass intake results in an increase in the PUFA:SFA ratio and CLA concentration in muscle meats. This report concluded that the fatty acid composition of beef can be improved from a human health perspective by inclusion of grass in the diet. Although this report was not specifically about Bison, it concluded that pasture fed (a common Bison feeding practice) ruminants have a statistically significant difference in both total fat and specific beneficial fatty acids such as certain omega-3 fatty acids and CLA . The report also concluded that human clinical trails demonstrating beneficial effects of meat products from pasture fed ruminants would be very useful to industry marketing of meat products. Although the Union of Concerned Scientists' review focused upon pasture fed beef cattle, it is a logical extension of these findings and recommendations to Bison meat, a ruminant product that has all the positive attributes of pasture fed beef and more.

Conjugated Linoleic Acid and Cancer: Is there a connection?

Although human clinical trials of the influence of Bison meat consumption on the response of cancer related biomarkers in humans are lacking, our knowledge of the cardioprotective and antimutagenic activity of conjugated linoleic acid in lower vertebrate models and cell culture studies suggests that this fatty acid, found in relatively high concentrations in range fed bison muscle and adipose tissue, may be a potent naturally occurring anti-carcinogen in the human diet (Devery et al 2001, Kritchevsky 2000). CLA is believed to enrich the membranes of biological tissues. When consumed and deposited in cell membranes, CLA may produce a cytotoxic effect upon cancer cells (Wahle and Heys 2002, Devery et al 2001). CLA also is believed to be anti-inflammatory (Pariza 2004) and inflammation is the first step toward undesirable chronic disease outcomes. CLA can delay or reduce the onset of chemically induced tumors in various sites of rats and mice, including skin, mammary glands, and stomach. Proposed mechanisms of CLA and its anti-carcinogenic activities include a reduction in cell tumor proliferation which may be secondary to reduced chronic inflammation. It is well accepted that inflammation plays a key role in cardiovascular disease (Libby 2006). Chronic inflammation is also associated with processes that contribute to the onset or progression of cancer (Il'yasova et al 2005) leading to the induction of rapid cell division, which

statistically increases the possibility for replication error and ineffective DNA repair and subsequent mutations (Modugno et al 2005). Repeated insults lead to chronic tissue damage and resultant chronic inflammation which in turn leads to an imbalance of pro and anti-inflammatory cytokines which are believed to increase the risk of cancer. The beef and dairy products industry has been quick to recognize the health related benefits of increasing CLA in commercially available meat, milk and cheese products and are working toward ways to increase CLA in their meat and dairy products. (Bauman and Griinari 2003, Clancy 2006). Canadian researchers have reportedly been able to increase CLA in cow's milk 10 fold by manipulating the CLA sources in the animal's diet (www.foodnavigator.com/news/news-NG.asp?id=44315).

The consumption of red meat and cancer risk

Although controversial, an association has been made between the consumption of red meat and cancer and cardiovascular risk (Williamson et. al. 2005). This may be due to a multitude of complex dietary factor interactions such as the linoleic acid (C-18:2 *cis* 9,11) content of conventional feed lot beef. Linoleic acid (C-18:2 *cis* 9,11) consumption is related to increased cancer risk (Devery et. al. 2001, Godley et. al. 1996) whereas the C 18:2 isomers of linoleic acid , CLA (18:2 *cis*-9, *trans*-11 and 18:2 *cis*-12, *trans*-10), are believed to be a potent inhibitor of carcinogenesis (Kritchevsky 2000, Devery et al 2001, Belury 2002, Wale and Heys 2002), and presumably related to decreased cancer risk. Although the exact mechanism is not well understood, dietary CLA has been shown to influence body composition and metabolism (DeLany and West 2000) and to reduce tumorigenicity and atherosclerosis at relatively low concentrations (Kritchevsky 2000). This is encouraging news and emphasizes the potential health benefits of ingesting increasing amounts of this fatty acid via the diet. Most of the animal and cell culture studies studying CLA to date have been with relatively large pharmacological doses. Human studies investigating cancer related outcomes with CLA as a dietary variable are lacking and are warranted to evaluate the benefits of CLA for humans (Bretillon et al 2003). The scientific evidence for the health benefits of CLA is strong enough to warrant investigating potential positive health outcomes resulting from the consumption of food products such as range fed Bison meat as part of a healthy balanced diet. It is unlikely that the total amount of CLA form any one food source would be great enough to exert the effects seen in these carefully controlled animal studies, but it certainly can be argued that multiple sources of CLA from the diet might lead to a significant overall dietary effect.

Can fat actually be "good for our health?

David Kritchevsky, an International expert in lipid metabolism (2000) observed that "Animal fat, which has been maligned for so long, may actually prove to contribute a potent therapeutic component to our diet". It is tempting to speculate that Bison meat, by virtue of its inherent leanness and unique fatty acid profile, may prove to be a potentially "therapeutic" component of a healthy diet.

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