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Meat Colour Stability and Fatty Acid Profile in Commercial Bison and Beef

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Abstract

Commercial bison meat has been found to discolour more rapidly than beef in retail display. The influence of fat content, fat composition and vitamin E on the colour stability of commercially produced bison and beef were examined. *Longissimus* samples from grain-fed beef (n = 20) and grass-fed bison (n = 14) were analyzed for fat content, fatty acid composition, vitamin E levels, pigments, TBARS and retail stability. Intramuscular fat content was lower and richer in PUFA in bison ($P < 0.01$) compared to beef. Pigment and TBARS levels in bison were significantly higher ($P < 0.01$), leading to higher ($P < 0.01$) metmyoglobin levels. Regression analysis results showed that differences in total fat content and fatty acid composition were the most responsible factors for early discolouration of commercial bison meat compared to commercial beef. In conclusion, total fat and fatty acid composition can be manipulated to improve the colour stability of bison meat.

Keywords: *Bison bison*, myoglobin, lipid, retail, tocopherol

1. Introduction

Bison (*Bison bison*) are raised in North America for their meat and other products. In 2012, in the Canadian Province of Alberta, over 12,000 bison were slaughtered in inspected abattoirs (Steenbergen, 2013). Bison meat composition has been found to be nutrient dense, with high proportion of protein (Galbraith et al., 2006; Marchello & Driskell, 2001). Bison meat is sold as both frozen and fresh product and can be found increasingly at mainstream grocery chains. Bison meat has been reported to discolour more rapidly than beef (Dhanda et al., 2002; Janz et al., 2000; Pietrasik et al., 2006) and the reason for this has not been determined. Meat colour is important because it is used by consumers as an indicator of freshness and wholesomeness (Mancini & Hunt, 2005). Structurally, beef and bison have identical myoglobin which displays no difference in primary structure, kinetics of oxidation, and thermostability (Joseph et al., 2010). Therefore, the differing rate of discolouration of bison cannot be attributed to differences in the structure and biochemistry of myoglobin. Early browning in bison meat was also not attributable to a difference in microflora, but rather pigment oxidation (Janz et al., 2001). In Canada, commercial beef is usually grain-fed, while a large proportion of Canadian bison is grass-fed. Thus, a combination of inter-species intrinsic differences, production system and dietary factors may be responsible for the different discolouration rates observed between commercially produced beef and bison meat.

Polyunsaturated fatty acids (PUFA) in phospholipid membranes are susceptible to oxidative breakdown resulting in changes to the colour, smell and taste of the meat (Wood et al., 2008). Differences in susceptibility of meat to oxidation have been linked to the heme iron content (Rhee et al., 1996). Heme iron has been proposed as an initiator and promoter of lipid oxidation in raw meats and H2O2-activated metmyoglobin has been seen to promote lipid oxidation in model systems (Decker et al., 2000). High levels of iron have been found in raw bison meat compared to those typically found in beef (Galbraith et al., 2006; Marchello & Driskell, 2001). The

relatively rapid deterioration of colour quality of bison muscle compared with beef may be related to the significantly higher content of both total PUFA's (Rule et al., 2002) and total iron. These characteristics may make bison meat more susceptible to a reduction in display life because of oxidation-related changes in appearance. Additionally, feeding vitamin E to steers has been found to increase lipid and oxymyoglobin stability in several muscles (Chan et al., 1996).

The purpose of this study was thus to examine the influence of fatty acid profile, vitamin E levels and pigment on the oxidative and colour stability of fresh commercial grain-fed beef and grass-fed bison in a retail display environment in order to understand the origin of the different rate of discolouration observed in these two types of meat.

2. Method and Methods

2.1 Animals and Slaughter

A total of 20 feedlot British×Continental composite steers were fed a commercial diet containing approximately 8% grass hay and up to 80% steam-rolled barley. Animals were finished to a target backfat depth of 8-9 mm. Fourteen intact male bison from three commercial farms were also slaughtered at the AAFC Lacombe Meat Research Centre abattoir. Bison were grass finished on native grass pasture. All animals were stunned and exsanguinated in accordance with the principles and guidelines established by the Canadian Council on Animal Care (CCAC, 1993).

The average carcass weight of beef was 328 ± 5.44 whereas the average carcass weight of bison was 208 ± 8.83 Kg. Following the overnight chill, at approximately 24 h *post-mortem*, pH was measured as described by Juárez et al. (2011) and carcasses were knife-ribbed at the grade site (between the 12^{th} and 13^{th} rib for beef and between the 11^{th} and 12^{th} rib for bison). After being exposed to atmospheric oxygen for 20 min, carcasses were assessed for grade by certified graders (CFIA, 2003). The left *longissimus* muscle (grade site) was pulled from the carcasses, labelled and trimmed. One steak was removed for subsequent fatty acid and α-tocopherol determination. The remainder of the muscle was labelled, bagged and aged until 7 d *post-mortem* in a cooler at 2^oC.

Following the 6 d ageing period, the stored loin muscle was removed from the cooler and two steaks (25 mm thick) were collected closest to the grade site. The first steak was placed into a polystyrene tray with a dri-loc pad, over-wrapped with oxygen permeable film (8000 ml m^{-2} 24 h^{-1} vitafilm choice wrap; Goodyear Canada Inc., Toronto, ON, Canada) and put into a retail display case (Hill Refrigeration of Canada Ltd., Barrie, ON, Canada) at 1°C for retail evaluation at 0, 1, 2 and 3 d under fluorescent room lighting (GE deluxe cool white), supplemented with incandescent lighting directly above the display case (GE clear cool beam 150 W/120 V spaced 91.5 cm apart) to provide an intensity of 1076 lux at the meat surface for 12 h per day. The second steak was cut in half and one half was immediately prepared for determination of thiobarbituric reactive (TBAR) substances (0 d in retail), as described by Nielsen et al. (1997). The remaining half was placed on pre-labelled polystyrene tray with a dri-loc pad, over-wrapped with oxygen permeable film and put into the retail display case for an additional 3 d, before determining final TBAR values.

2.2 Lipid Analyses

Lipid extraction was performed using 2:1 chloroform: methanol and with the same solvent to sample ratio as reported by Folch et al. (1957). Lipids were methylated using 1.5 N methanolic hydrochloric acid as described by Kramer et al. (1997). Fatty acid methyl esters (FAMEs) thus obtained were dissolved and purified using Supelclean LC-Si solid phase extraction tubes (Supelco, Bellefonte, PA, USA). The sample was then analyzed using a Varian CP-3800 GC (Varian Chromatography Systems, Walnut Creek, CA, USA) with Model 1079 injector and a flame ionization detector (25 psi and hydrogen as carrier gas) and a Varian CP-Sil88 – 100 m column. The temperature program used included an initial temperature of 45^oC held for 4 min, to 175^oC at 13^oC / min and held for 27 min, to 215^oC at 4^oC / min and held for 35 min as outlined by Cruz-Hernandez et al. (2004). Fatty acid concentrations were reported individually or by lipid class as percentage of the total fatty acids identified.

2.3 Pigment Content

Pigment was determined in duplicate using a modified procedure from Trout (1991) and evaluated using a spectrophotometer (Pharmacia Ultraspec 3000 Model 80-2106-20; McKinley Scientific, Sparta, NJ, USA) at wavelengths of 730 nm and 409 nm.

2.4 Tocopherol Levels

Muscle tissue levels of tocopherol were determined using normal phase HPLC with tocopherol acetate as an internal standard as described by Katsanidis and Addis (1999), using am isocratic high performance method and avoiding saponification (in order to protect sensitive homologs) and adapted for fluorescence detection by Hewavitharana et al. (2004).

2.5 Retail Stability

Treatment samples were placed into the retail display case controlling for known temperature gradients within the retail case. On each specific day in retail objective colour measurements (CIE L^*[brightness], a^*[red-green axis], b^*[yellow-blue axis] values; (CIE 1978) were collected, and converted to hue (H_{ab}=arctan[b^*/a^*]) and chroma ($C_{ab}=[a^{*2}+b^{*2}]^{0.5}$), in triplicate across the face of each steak using a Minolta CR-300 with Spectra QC-300 Software (Minolta Canada Inc., Mississauga, ON, Canada). Spectral reflectance readings were also collected at the same time to calculate the relative contents of MetMb, Mb and MbO_2 as described by Krzywicki (1979). Following the objective colour measurements, steaks were subjectively evaluated for retail appearance, lean colour score, percent surface discolouration, colour of discolouration, amount of marbling and marbling colour by five trained raters using an 8-point hedonic (1=extremely undesirable and 8=extremely desirable), 8-point descriptive (1=white and 8=extremely dark red), 7-point descriptive (1=0% and 7=100% discolouration), 7-point descriptive (1=no browning and 7=black), 6-point descriptive (1=devoid and 6=abundant) and 5-point descriptive (1=white and 5=red) scales, respectively.

2.6 Retail Stability

Differences between species (bison and beef) were determined for retail evaluation data on day 0, 1, 2 and 3 using a repeated measures design with PROC MIXED (SAS 2003). The fixed effects were species, day and their interaction and the experimental unit was the individual animal (species). The model of best fit was determined using the Bayesian Information Criterion (BIC) where the lower BIC indicated a better fit (Wang and Goonewardene 2004).

A comparison of bison to beef for tocopherol, pigment and all fatty acids using PROC MIXED LS means and standard errors for the dependant variable were determined.

PROC STEPWISE was used (SAS 2003) to examine the effect of inherent tissue levels of total fat, omega-3 (n-3), omega-6 (n-6), the n-6:n-3 ratio, saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), PUFA, pigments and vitamin E on the change in the percent of surface discolouration and MetMb content between d 0 and d 3 in retail display. When a factor was significant (P<0.15) it was included in the model contributing to the overall model R^2 value.

3. Results and Discussion

3.1 Fatty Acid Composition

No differences were observed for pH values among groups at 24 h (5.71; P>0.05; data not shown) Intramuscular fat content (Table 1) was much lower in meat from commercial bison than in meat from commercial beef (P<0.01). Fat content in commercial Canadian bison cuts has been reported to range between 0.31 and 1.08 % (Galbraith et al. 2006). On the other hand, Marchello et al. (1998) reported higher values in meat from bison fed concentrate diets (1.6-2.4 %). Total fat content influences the fatty acid composition of meat, as low concentrations of total lipids in muscle lead to a relative increase in the proportion of membrane phospholipids, which have higher proportions of PUFA (Wood et al. 2008).

The percentages of all the individual fatty acids and indices were also different (P<0.01) between commercial beef and bison (Table 1). Significant differences were observed for SFA, MUFA, PUFA, n-3, and n-6 fatty acids. Overall, SFA was lower in bison due to lower amounts (P<0.01) of 16:0 and 14:0. The long chain SFA 18:0 was significantly higher in bison (18.40 mg / 100 mg fat compared to 12.52 mg / 100 mg fat in beef; P<0.01). Furthermore, α-linolenic (18:3n-3) levels were more than 7 times higher in bison than beef (Table 1). It is well known that diet can alter the fatty acid composition in bison (Rule et al. 2002) and beef (Laborde et al. 2002; Nuernberg et al. 2008). However, changes to diet have less of an effect in a ruminant animal compared to a monogastric, due to bio-hydrogenation of dietary fatty acids in the rumen (Scollan et al. 2006).

The fatty acid composition of muscle affects its oxidative stability during retail display. The PUFA's in phospholipids are susceptible to oxidative breakdown at this stage (Wood et al. 2008). PUFA levels were over three times higher in commercial bison than commercial beef (Table 1). In a previous study, *longissimus* muscle samples from bison contained more PUFA than either Hereford or Brahman cattle (26.2, 20.8, and 21.1 mg / 100

mg fat, respectively; Larick et al. 1989). Authors also attributed an increased off-flavour and aftertaste in bison to the increased levels of PUFA. In the present study, commercial beef n-3, n-6 and n-6:n-3 were 0.94 mg / 100 mg fat, 4.21 mg / 100 mg fat and 4.52 whereas commercial bison n-3, n-6 and n-6:n-3 were 6.16 mg / 100 mg fat, 13.25 mg / 100 mg fat and 2.11, respectively (Table 1). Thus, such differences among the different production systems may account for the differences in oxidative stability of the bison meat and beef during retail display.

Table 1. Fatty acid content of *longissimus thoracis* muscle of entire male bison and beef steers

	Beef	Bison	SEM	*P* value
Number of animals	20	14		
Total Fat, %	5.56	1.00	0.39	<0.01
Fatty Acids, mg·100 mg fat^{-1}				
14:0	2.68	1.27	0.17	<0.01
16:0	27.2	18.9	0.70	<0.01
*c*9-16:1	3.92	1.43	0.16	<0.01
17:0	1.12	1.41	0.07	<0.01
18:0	12.5	18.4	0.47	<0.01
Σtrans 18:1	3.50	2.95	0.55	0.03
*c*9-18:1	37.5	30.2	0.94	<0.01
18:2n-6	3.00	9.54	0.80	<0.01
*Σ*CLA	0.59	0.78	0.05	<0.01
18:3 n-3	0.38	2.90	0.11	<0.01
20:3 n-6	0.28	0.38	0.04	0.04
20:4 n-6	0.80	3.17	0.31	<0.01
20:5 n-3	0.14	1.15	0.09	<0.01
22:4 n-6	0.13	0.16	0.02	0.04
22:5 n-3	0.35	1.72	0.11	<0.01
22:6 n-3	0.07	0.41	0.03	<0.01
SFA	44.0	40.6	1.00	<0.01
MUFA	49.5	38.3	0.97	<0.01
PUFA	6.43	21.11	1.44	<0.01
n-3	0.94	6.16	0.32	<0.01
n-6	4.21	13.25	1.14	<0.01
n-6:n-3	4.52	2.11	0.18	<0.01

[a- b] Least squares means in the same row with different letters differ (P<0.05).

3.2 Pigment

Mb is the principle protein responsible for meat colour, and is the predominant meat pigment (Mancini & Hunt, 2005). Oxygenation occurs when Mb is exposed to oxygen and is characterized by the development of a bright cherry-red colour. The loss of oxygen from oxymyoglobin and an electron from ferrous ion producing the MetMb, are the changes that occur to alter the absorption properties and the complementary colour which turns from bright red to dark-red and further to brown (Kanner, 1994). Pigment levels in grass-fed bison can be seen to be significantly higher (P < 0.01) than in grain-fed beef (Figure 1). The iron atom in the centre of the heme ring (in Mb) can form six bonds, the sixth of which can reversibly bind to ligands which dictate muscle colour (Mancini & Hunt, 2005). While structure of Mb between bison and beef have been found to be identical (Joseph et al., 2010), the increased levels of pigment found in commercial bison compared to commercial beef in the present study combined with high levels of iron found in bison muscle tissue in previous studies (Galbraith et al., 2006) could contribute to poor colour stability in fresh bison meat during retail display.

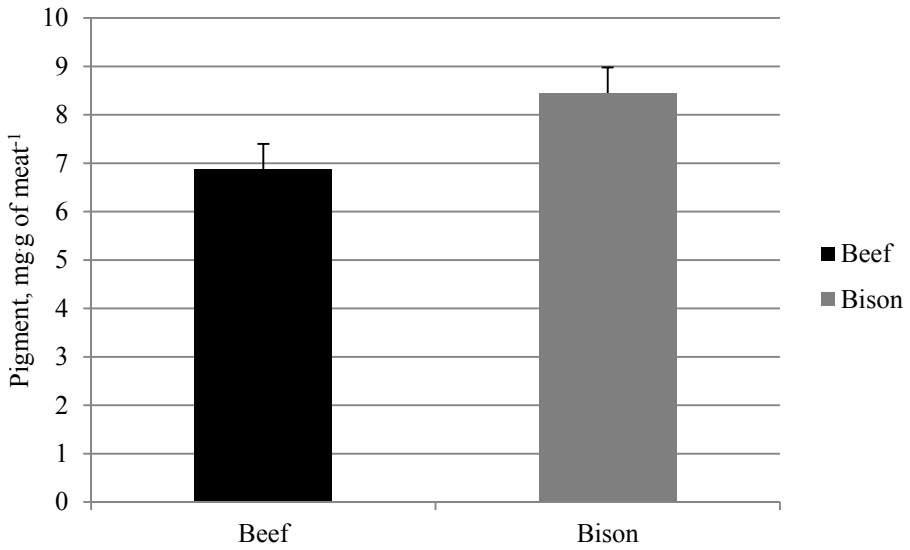

Figure 1. Pigment levels (mg/g meat) in bison and beef tissue

3.3 Retail Evaluation

Metmyoglobin levels in commercial bison were significantly higher than commercial beef on all retail display days (Table 2) confirming the early browning in bison reported previously (Dhanda et al., 2002; Janz et al., 2000; Pietrasik et al., 2006). Commercial beef MetMb level on day 3 was equivalent to the level in commercial bison on day 0 and, by day 3, the levels in bison were twice that of beef. Over the same time, MbO_2 decreased (P <0.01) slightly in commercial beef (0.78 to 0.71) and substantially in the commercial bison (0.70 to 0.49) (Table 2). Hence, it appears that colour stability of commercial bison was already compromised on entry into the retail case after 6 d of ageing.

Table 2. Retail performance for beef (n=20) and bison (n=14) steaks (*P value for interaction)*

	Beef (n=20)				SEM	Bison (n=14)				SEM	*P* value		
	0	1	2	3		0	1	2	3		Species(S)	Retail(R)	S×R
Objective Retail Measurements													
*L**	42.2^{a}	41.2^{b}	41.3^{b}	41.4^{b}	0.43	37.1^{c}	35.2^{d}	34.5^{d}	36.4^{d}	0.52	<0.01	0.03	0.03
Chroma	23.9^{a}	23.3^{a}	23.14^{a}	22.9^{a}	0.45	18.6^{b}	17.5^{c}	15.2^{d}	14.1^{e}	0.54	<0.01	<0.01	<0.01
Hue	36.2^{f}	36.1^{f}	36.6^{cef}	37.2^{bce}	0.66	32.4^{d}	35.9^{cf}	39.0^{b}	42.2^{a}	0.79	<0.01	<0.01	<0.01
Metmyoglobin	0.15^{f}	0.18^{e}	0.19^{de}	0.20^{d}	0.01	0.21^{d}	0.28^{c}	0.34^{b}	0.40^{a}	0.01	<0.01	<0.01	<0.01
Myoglobin	0.07^{d}	0.08^{b}	0.08^{b}	0.09^{b}	0.00	0.10^{bc}	0.09^{b}	0.11^{ac}	0.11^{a}	0.01	<0.01	<0.01	0.05
Oxymyoglobin	0.78^{a}	0.74^{b}	0.73^{bc}	0.71^{c}	0.01	0.70^{c}	0.63^{d}	0.55^{e}	0.49^{f}	0.01	<0.01	<0.01	<0.01
Subjective Retail Measurements													
Retail Appearance	7.66^{a}	7.01^{b}	6.69^{c}	6.01^{d}	0.17	7.40^{ab}	5.26^{e}	3.96^{f}	3.26^{g}	0.20	<0.01	<0.01	<0.01
Lean Colour Score	5.01^{e}	4.95^{e}	5.02^{e}	5.04^{e}	0.07	6.00^{d}	6.49^{c}	6.93^{b}	7.19^{a}	0.09	<0.01	<0.01	<0.01
% Surface Discolouration	1.02^{f}	1.33^{ef}	1.63^{de}	2.03^{d}	0.19	1.26^{ef}	3.59^{c}	4.77^{b}	5.33^{a}	0.23	<0.01	<0.01	<0.01
Colour of Discolouration	1.04^{e}	1.16^{de}	1.45^{ed}	1.72^{c}	0.11	1.11^{e}	2.13^{b}	2.70^{a}	2.83^{a}	0.13	<0.01	<0.01	<0.01
Marbling Score	3.59	3.73	3.80	3.78	0.09	2.29	2.34	2.40	2.43	0.10	<0.01	0.088	0.57
Marbling Colour	1.00^{b}	1.00^{b}	1.00^{b}	1.00^{b}	0.04	1.23^{a}	1.17^{a}	1.00^{b}	1.00^{b}	0.04	<0.01	0.022	<0.01

$^{a\text{-}f}$ Least squares means in the same row with different letters differ (P<0.05).

There was a significant interaction for objective colour measurements (P<0.05) over time in retail (Table 2). By day 1, the subjective retail measurements were showing commercial bison to be less resilient in the retail environment. Retail appearance, lean colour score, and percent surface discolouration were significantly different for commercial bison than commercial beef, with bison scoring less favourably on all of these measurements (Table 2).

3.4 Vitamin E

Vitamin E is a term that encompasses a number of tocopherols and trienols that have antioxidant properties (Brigelius-Flohé & Traber, 1999). The efficacy with which they exert their biological action is very low in the case of the tocotrienols, whereas tocopherols, and in particular α-tocopherol, are much more active and potent and account for almost all the vitamin E activity of living tissues (Berges, 1999). Tocopherols constitute a series of benzopyranols that occur in plant tissues and vegetable oils and are powerful lipid-soluble antioxidants (Christie, 2010). In the current study, vitamin E was significantly higher in grass-fed bison meat (P<0.01) than in grain-fed beef (3.47 µg / g meat compared to 2.20 µg / g meat; Figure 2). However, levels of α-tocotrienols were higher (P<0.01) in beef than in bison. Elevated tissue levels of antioxidants have been reported to have a stabilizing effect on meat colour. Larraín et al. (2008) reported beef fed a corn diet were found to have α-tocopherol of 188 µg / 100 g meat, which is also lower than the levels reported for both commercial bison and beef in the present study. Arnold et al. (1992) reported a vitamin E supplementation (500 IU / head / d) could extend display life of beef by 2.5 days based on a threshold value of 15% MetMb, which corresponded to first detection of discolouration. In the present study, MetMb levels started in the display case at d 0 at 15 % for commercial beef and 21% for commercial bison (Table 2).

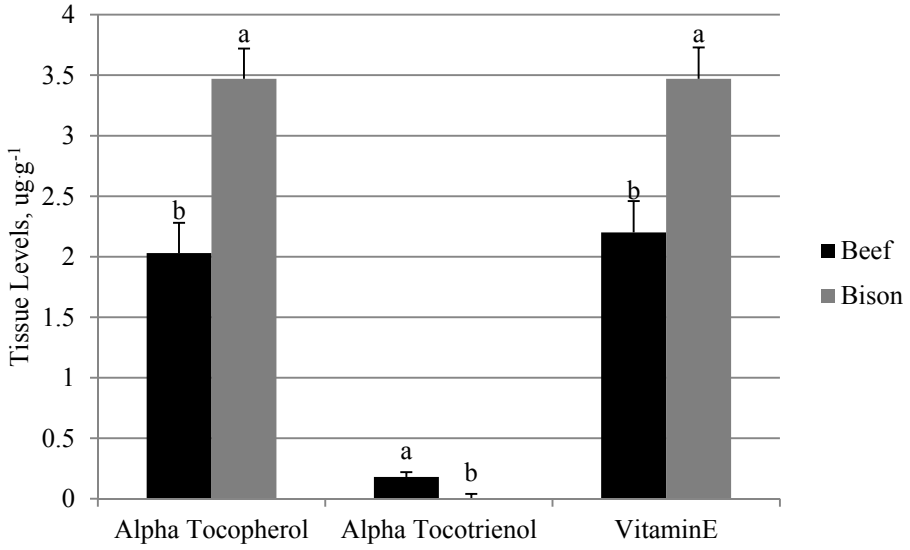

Figure 2. Tissue levels (µg/g meat) of α-tocopherol, α-tocotrienol and total vitamin E in beef and bison

3.5 TBARS

Lipid oxidation in muscle tissues can promote Mb oxidation causing discolouration and rancid odours and flavours (Scollan et al., 2006). TBAR values above about 0.5 mg malonaldehyde / kg meat are considered critical since at this level lipid oxidation products, which produce a rancid odour and taste, detectable to consumers, are present (Wood et al., 2008). In the present study (Figure 3), both commercial beef and bison had TBAR values exceeded this critical level by day 3 of retail display (0.54 and 0.73, respectively). Despite a numerically higher value after 3 d of retail display in the commercial bison compared to commercial beef, there was no significant differences (P = 0.28) due to the large range in values. In a study where TBAR values were measured under different packaging regimes, bison meat was found to form higher TBAR values during storage compared to beef (Pietrasik et al., 2006). In this study, authors used storage intervals of 1 d, 1 wk and 2 wks, which were longer than the current study. Thus, had the current study extended the time in retail, significant differences in TBAR levels between commercial bison and beef would likely have emerged.

In a previous study, a positive correlation was found between metmyoglobin accumulation and the production of lipid oxidation products (Faustman & Cassens, 1990). Basically, the rate of discolouration of meat is related to the effectiveness of oxidation processes and enzymatic reducing systems in controlling metmyoglobin levels in meat (Faustman & Cassens, 1990).

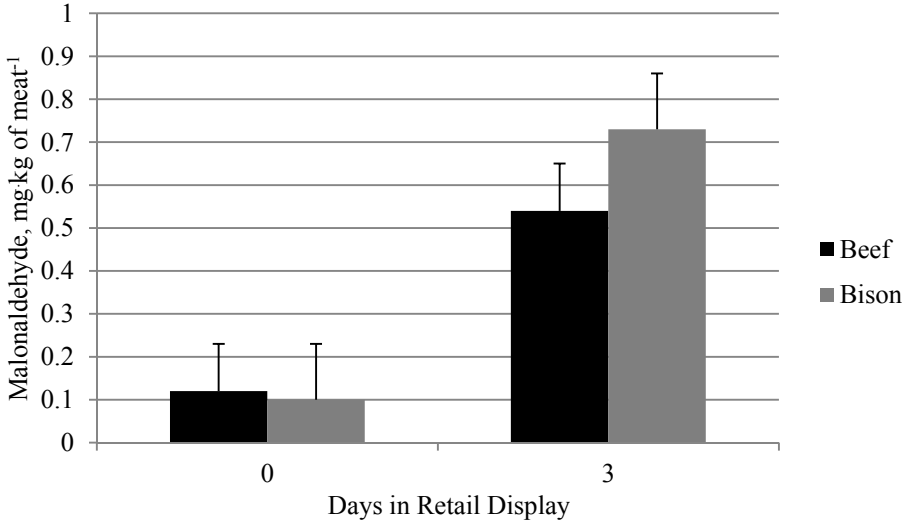

Figure 3. Tissue levels of malonaldehyde in bison and beef after 0 and 3 days retail display

3.6 Changes to Appearance Traits

The current study shows that inherent traits in the muscle tissue of bison influence the lack of retail colour stability. Prolonged *ante-mortem* stress in bison has been related to preharvest depletion of glycogen, with both pH and lactate levels indicating a more rapid glycolysis while carcass temperatures are still high (Galbraith et al., 2009). These metabolic processes may lead to higher drip loss and lower colour stability. In all retail display days commercial bison had higher (P<0.01) MetMb (Table 2), and on display days 1, 2 and 3 it had a higher (P<0.01) percentage of discolouration than the commercially produced beef steaks. Retail appearance was also rated as less desirable (P<0.01) in bison for retail d 1, 2 and 3 (Table 2).

3.7 Regression Analysis

As pointed-out in section 1, the reason for a rapid discolouration of meat bison compared to beef has not been clear. These types of meat have identical structure and biochemistry of myoglobin. Additionally, commercially produced bison meat is grass-fed whereas commercially produced beef is grain-fed in Canada. The main purpose of this study was, therefore, to identify the parameters that are important for the different rate of discolouration of the commercially produced bison meat and beef. For this reason, a regression analysis was performed to estimate the contribution of different factors. The results indicated that the change (Δ) in the percentage of surface discolouration from d 0 to d 3 in retail was most influenced by the inherent n-3 levels in the tissue, followed by the n-6 and the n-6:n-3 ratio (R^2 = 0.72). This shows that 72% of the explained variability was due to the differences in the fatty acid composition. Using the *b* values and the intercept, an equation to describe the influence that the independent variables were having on the dependant variables was derived. For instance, the equation for changes in percentage of surface discolouration from d 0 to d 3 in retail was derived as follows:

$$\Delta \text{ \% discolouration} = - 0.271 - 1.029(\text{n-3}) + 0.217(\text{n-6}) - 0.159(\text{n-6:n-3}) \quad (P<0.05)$$

In addition to this, the following equation was also derived for changes in MetMb (R^2 = 0.56):

$$\Delta \text{ MetMb} = - 0.230 + 0.017(\text{total fat}) - 0.021(\text{n-3}) + 0.010(\text{n-6}) + 0.013(\text{n-6:n-3}) \quad (P< 0.05)$$

This relationship showed that as levels of total fat increase and levels of n-3 and n-6 decrease, an increased change in MetMb content will occur between d 0 and d 3. Although included in the statistical analyses, the levels of vitamin E or pigment content, as well as SFA, MUFA and PUFA levels, were not included in any of the stepwise regression models.

These equations show the inherent tissue traits of commercial bison were strongly linked to undesirable changes in fresh meat colour in a retail display environment. Commercial bison had lower total fat, lower n-6 and n-6:n-3 levels and higher n-3 levels than beef and, consequently, showed a higher change in the percentage of surface discolouration and MetMb content between d 0 and d 3 in retail. Based on these results, it could be suggested that feeding bison with grain during finishing can help to stabilize the colour of bison meat by increasing the n:6 and decreasing n:3. A recent study (Tuner et al., 2014) revealed that bison meat from grain-fed bison had a lower proportion of n:3 compared to grass-fed bison. Of course, while an increase in n:6 and a decrease in n:3 in grain-fed bison can improve the colour stability of bison meat, this strategy will have a negative impact on the health of consumers. As previously mentioned, PUFA are susceptible to oxidative breakdown resulting in changes to the colour (Wood et al., 2008) and these differences have been linked to the heme iron content (Rhee et al., 1996). Rule et at. (2002) hypothesized that the rapid deterioration of colour quality of bison could be linked to its higher PUFA content. The results of the present study seem to corroborate this idea. However, further research is required to determine the appropriate proportion of n:6 and n:3 in order to improve the colour stability of commercially produced bison meat without affecting the human health and fat quality. Furthermore, specific packaging strategies should be evaluated in order to extend the shelf-life of bison meat.

4. Conclusions

The expected differences in colour stability between commercial beef and commercial bison meat were evident in the present study. Further analyses revealed that the differences in total fat content and lipid composition (n-3, n-6 and n-6:n-3 levels) between the two types of meat were among the main reasons for the early deterioration of bison meat, compared to beef. Vitamin E levels, although higher in bison, did not protect against this process. Summing up, this study revealed that there are factors that are inherent within the two commercially produced types of meat that impact meat colour, but there are also factors that can be manipulated in order to improve the colour stability of bison meat.

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