

Gastrointestinal parasites in farmed bison

Prevalence in Western Canada



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Research Project Utrecht University, Faculty of Veterinary Medicine

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Prefatory Note

As a part of the Master in Veterinary Medicine at the University of Utrecht, students have to complete a research project. This paper is the final report on the project conducted by T.B. Oostenbrug at the Department of Production Animal Health of the University of Calgary, Faculty of Veterinary Medicine.

This research investigates the prevalence of gastrointestinal parasites in farmed bison as well as the difference in prevalence of various parasite species among operation types (feedlot versus pasture) throughout western Canada. All data and methods of obtaining this data can be found in this report.

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Abstract

The Canadian bison industry has grown considerably in the last two decades. This is due to the nutritional value of bison meat as well as consumer demand for products that do not contain hormones or antibiotics. As an industry grows, the relevance of science to provide better management recommendations becomes even more important. It is, therefore, important to conduct more research in such a growing industry. A prevalence study was conducted using 249 faecal samples from 16 herds across the four western provinces of Canada. These samples were either collected on farm during animal handling or at a slaughterhouse. The faecal samples were examined via 3-chambered McMaster under a microscope for the presence of eggs of eight different gastrointestinal parasite species. These parasites and the prevalence of positive samples were: *Capillaria* spp. 5.8%, *Eimeria* spp. 83%, *Moniezia* spp. 5.2%, *Nematodirus* spp. 0.8%, *Strongyloides papillosus* 2.8%, *Toxocara vitulorum* 0.0%, *Trichostrongylus* spp. 54% and *Trichuris* spp. 0.8%. The percentage of positive herds was 25, 94, 31, 13, 31, 0, 94 and 13% respectively. This research project also examined the difference in faecal egg counts for each parasite in bison housed in feedlots or on pasture. Egg counts for *Capillaria* spp., *Moniezia* spp. and *Trichostrongylus* spp. were significantly higher in bison on pasture than those in a feedlot. The egg counts for these parasites were higher in pastured bison than feedlot bison. *Toxocara vitulorum* was not found in any of the samples. For the remaining four parasite species, no significant difference in faecal egg counts was detected between the two operation types. Overall, some differences in egg counts between the two differently farmed bison populations were found. The majority however, did not show any difference.

Introduction

An increasing demand for bison meat has occurred over the past few years (Firmage-O'Brien 2015), primarily due to its perceived nutritional value. Because of this growth it is important to both determine and understand the diseases that can affect bison and the bison industry as a whole (Janardhan, Hays et al. 2010).

One condition that is considered to be important in farmed bison is gastrointestinal parasitism. A few studies have been done in various parts of Canada to determine the prevalence of gastrointestinal parasites in cattle, predominately by faecal examination (Polley, Bickis 1987, Fréchette, Gibbs 1971, Slocombe 1973), most of which were done more than 30 years ago. These studies found prevalences between herds varying from 13 to 64% for *Capillaria* spp., 55 to 72% for *Moniezia* spp., 13 to 50% for *Nematodirus* spp., 0 to 9% for *Strongyloides*, 5 to 41% for *Trichuris* spp and 100% for *Trichostrongylus* spp (Tessaro 1989, Knapp, Marley et al. 1993, Woodbury, Wagner et al. 2014). One study found that the prevalence of gastrointestinal parasites was not different between cattle and farmed bison and that the parasite species were also similar (Dies, Coupland 2001). This does not confirm though that the clinical and production impacts are the same for cattle and bison when encountering the same gastrointestinal parasite burden, because cattle and bison are not the same species and management practices do differ between these industries.

Bison (*Bison bison*)

North America had 30 to 70 million bison before the European settlers came to the New World that ranged from the north of Mexico to Alaska and from New England to the West Coast. These bison were the only survivors of a bigger family of bison that roamed the North American plains, some of their ancestors being 40 percent larger than the bison that exist today. Due to intensive hunting and a growing demand for hides and other bison products, only 1,500 bison were left at the end of the “great slaughter” (Hedrick 2009), which selectively killed the largest animals and the most robust bulls, thereby affecting the herd genetics as a whole. Using conservative estimates, the entire bison herd was reduced to 1/2000th of its former size in about 100 years. This of course begs the question whether the modern day bison is similar to its ancestors of 400 to 500 years ago.

Today, the total herd size in the United States and Canada is estimated to be just over 500,000, with 90% of the animals being managed as farmed bison. The average US bison operation has about 50 animals, while the average Canadian operation has approximately 100 animals. In Canada, 95% of the farmed bison herd is raised in the four western provinces of Manitoba, Saskatchewan, Alberta and British Columbia (Kremeniuk, Carter et al. 2010). The wild population is distributed over several national parks and reservations across the United States and Canada.

The bison industry has a unique niche within the North American livestock sector. While 72,267 bison were processed in the United States in 2008, this number is nearly insignificant compared with the beef cattle industry that processes roughly 125,000 cattle on average a day. Similarly, the Canadian meat sector processes 25,990 bison a year and approximately 15,000 beef cattle daily. However, this does not mean that the bison industry is insignificant within the livestock sector. The bison industry is one of the few industries that was not greatly affected by the economic depression of the past years (Kremeniuk, Carter et al. 2010).

Operation types

Feedlot

Feedlots or feedyards are an intensive method of housing and feeding animals where they are kept in pens and receive special feed. They typically consist of a dirt floor with a central straw bedding pack, surrounded by wind fence on 2 to 3 sides. Feed is delivered to a concrete or wooden feedbunk and water provided in automated water troughs. Thus, there is no grazing in feedlots.

Pasture

Bison farmed on pasture are extensively managed on a large land base and obtain forages by grazing at least part of the year (Kremeniuk, Carter et al. 2010). Supplemental feed must be delivered during much of the year in the northern climate. Water sources may be natural or automated. Because animals have opportunity to graze, there exists greater opportunity for exposure to parasites.

Clinical Signs of Parasitism

In cattle, the clinical signs associated with gastrointestinal parasites are weight loss, anorexia, and diarrhoea with or without blood, while some infections can be asymptomatic. Dairy cattle have a decrease in milk yield. In severe cases, the animals develop enteritis and diarrhoea. If an animal has a heavy infection, dysentery with tenesmus can occur. This can result in an animal that is pyrexemic, dehydrated, and weak. If such an animal is left untreated, it may die (Taylor, Coop et al. 2007). The symptoms mentioned above are seen in cattle infected with gastrointestinal parasites; however, it is not prudent to extrapolate this knowledge to bison without appropriate evidence.

Parasites

Capillaria spp. are species of nematodes that are found in the bovine small intestines. Its life cycle is direct. Infections occur when the embryonated infective stage is ingested. The prepatent period is 3-4 weeks and there are no clinical signs attributed to infection with this parasite in cattle (Taylor, Coop et al. 2007).

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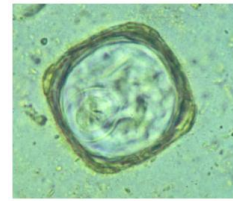
Eimeria spp. is clinically known as bovine coccidiosis. There are at least 13 different species known to infect cattle. *Eimeria* in bison include: *Eimeria bovis*, *E. canadensis*, *E. zuernii*, *E. ellipsoidalis*, *E. auburnensis* and *E. brasiliensis* (Ryff, Bergstrom 1975, Penzhorn, Knapp et al. 1994). They are small sporozoasides (protozoa) that are usually found in the lower small intestine, caecum, and colon. The life cycle is typical of coccidia, in that it is largely intracellular. Infection occurs when sporozoites are ingested. The life cycle takes between 1-4 weeks depending on the type of *Eimeria*. Coccidiosis is usually a disease in younger animals but can occur in animals older than one year. Clinical signs in cattle include anorexia, weight loss and diarrhoea that is often bloody (Taylor, Coop et al. 2007).

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Moniezia spp. are species of cestodes that are found in the small intestine. Adult tapeworms can grow to a length of 2 metres or more. Its life cycle is indirect: mature eggs are passed in the faeces onto the pasture where they are ingested by forage mites and infection of the final host occurs when these mites are ingested during grazing. The prepatent period is approximately 6 weeks. This parasite is usually seen in younger animals during their first year of life and it is less common in adult animals. There are no clinical signs attributed to *Moniezia* spp. in cattle (Taylor, Coop et al. 2007).

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Nematodirus spp. are species of nematodes that are found in the small intestine. Adult females are usually larger than adult males. The life cycle is direct and its development to the L3 is almost unique in that it takes place within the egg shell. This means that larvae can be found on pasture within 2-3 weeks after the eggs are excreted. Infection occurs when these larvae are ingested during grazing. The prepatent period is approximately 3 weeks. Only severe infections result into clinical signs in cattle that can cause diarrhoea and dehydration (Taylor, Coop et al. 2007).

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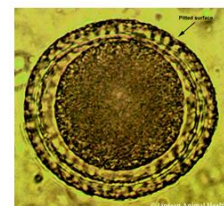
Strongyloides papillosus is a species of nematode that is found in the small intestine. Only females are parasitic and they produce larvated eggs. Its life cycle is unique in that it is capable of both parasitic and free-living reproductive cycles. L3 stages on pasture can become parasitic and infection can occur via skin penetration, ingestion or via maternal milk. The prepatent period is 8-14 days. The common clinical signs in ruminants are diarrhoea, anorexia, dullness, loss of weight and reduced growth (Taylor, Coop et al. 2007).

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Toxocara vitulorum is a species of nematode that is found in the small intestine. It is a large white nematode, up to 30cm in length. The life cycle is direct. The primary route of infection is trans-mammary. Milk can contain larvae for up to 3-4 weeks after parturition. Ingestion of larvated eggs by animals older than 6 months will seldom result in infection. The prepatent period is 3-4 weeks. In ruminants, heavy infections can result in diarrhoea, condition loss, and may cause death (Taylor, Coop et al. 2007).

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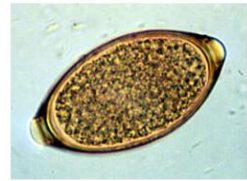
Trichostrongylus spp. are species of nematodes found in the duodenum and small intestines. The life cycle is direct with eggs developing to the infective L3 in 7-10 days under optimal condition. Infection occurs when the infective L3 are ingested during grazing. The prepatent period is 2-3 weeks. Clinical signs in cattle associated with heavy infections are rapid loss of weight, dark coloured diarrhoea, and death rates can be high. This parasite is possibly zoonotic (Taylor, Coop et al. 2007).

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Trichuris spp. are species of nematodes that are found in the large intestine. Its life cycle is direct. The infective stage is the L₁ within an egg. Under optimal conditions, these larvated eggs may survive and stay viable for several years. Infection occurs via ingestion. The prepatent period is approximately 7-10 weeks. The clinical significance of this parasite in ruminants is negligible (Taylor, Coop et al. 2007).

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Project Outline

This project will investigate the prevalence of a number of different gastrointestinal parasite species in farmed bison. These parasites include *Capillaria* spp., *Eimeria* spp., *Moniezia* spp., *Nematodirus* spp., *Strongyloides papillosus*, *Toxocara vitulorum*, *Trichostrongylus* spp. and *Trichuris* spp. From each farm, a maximum of 20 faecal samples were collected from animals one year of age and older. Faecal samples were obtained from 16 bison herds throughout the western Canadian provinces of Manitoba, Saskatchewan, Alberta and British Columbia that participate in a research project investigating *Mycoplasma bovis* infection. Samples were examined using the McMaster technique in the laboratory at the University of Calgary. Data will be used to estimate the prevalence of these gastrointestinal parasite species in bison and comparisons will be made between the two operation types, feedlot and pasture.

Hypothesis

Taking in consideration that for most parasites the route of infection is ingestion during grazing, and that only pastured bison have the opportunity to graze, the hypothesis of this research was that parasite egg counts will be higher in pastured bison faeces than in faeces of bison in feedlots.

Materials and Methods

Sample Collection

Samples were collected via rectal sampling during bison handling, for pregnancy diagnosis, vaccination/deworming or weaning, or at the slaughterhouse by emptying the rectum by hand. Samples were contained in vacuum-sealed plastic bags or rectal gloves with the air manually evacuated, then stored in a cooler until processing within 15 hours to 21 days. It was not possible to collect the planned 320 samples because of the dangerous temperament of some animals, thus only 249 were obtained. All farms deworm annually, usually when handling the animals.

Faecal Egg Counts

A 30ml glass solution cup was filled with 28ml of Fecasol ®: Sodium Nitrate solution. The faecal sample was homogenised inside the bag or glove using a wooden tongue depressor, then 2ml of faeces were added to the solution cup, making the contents in the cup 30ml in total. The solution in the cup was then homogenised. The 3-chambered McMaster slide was filled using a syringe to remove the top part of the solution content from the cup.

The slide was then examined under a microscope at 10x magnification. Counting of the number of parasite eggs found within the grids of the McMaster slide was performed and recorded. Every grid of the 3-chambered McMaster slide contained 0.33cc solution, making a total of 0.90cc for the entire 3-chambered slide. For the total number of eggs found in 1 sample examined in a 3-chambered McMaster slide, a multiplication factor of 17 was used to calculate the eggs per gram (EPG) count. A sample was positive when at least one egg of the described parasite was found.

However, there was one exception, *Eimeria* spp. oocyst numbers were denoted with '+' as a scoring of their egg counts. These '+' were given a numerical value and this number was then used in further results and calculations.

Table 1. Manually recorded *Eimeria* spp. results, transcribed to digital database

<i>Eimeria</i> spp.	Range in EPG	Shown in results as
+	0-850	425
++	850-1700	1275
+++	1700-2550	2125
++++	2250-3400	2975
+++++	3400 +	3825

Statistical Analyses

Statistical data analysis was done using Excel 2010® (Microsoft, United States of America) and SPSS version 22® (IBM, Chicago, United States of America). Excel 2010® was used for calculating medians, percentages and the interquartile range. SPSS version 22® was used for transforming the results by \log_{10} prior to using independent sample t-testing to determine significant differences (p -value > 0.05) in each parasite species faecal egg counts between feedlots and pastures.

Results

In Table 2 the percentage and number of positives samples is presented. Interpretation of the results (Table 2) clearly shows that the difference in parasite prevalence between farms can be quite substantial. Some parasites range from 0 to 100% between farms, with the only exception being *Toxocara vitulorum* with a prevalence of 0% for all farms. The bottom row (Table 2) presents the number and percentages of positive samples of the total of 249 samples. *Eimeria* spp. and *Trichostrongylus* spp. were the most prevalent parasite species. For nearly every herd these two parasite species had the highest number of positive samples.

Table 2. Number and percentage of 249 bison faecal samples positive for various species of gastrointestinal parasites by farm

Farm		<i>Trichostrongylus</i>	<i>Trichuris</i>	<i>Nematodirus</i>	<i>Eimeria</i>	<i>Moniezia</i>	<i>Capillaria</i>	<i>Toxocara</i>	<i>Strongyloides</i>
AB7 (n=20)	%	10 (50%)	0 (0%)	0 (0%)	18 (90%)	5 (25%)	0 (0%)	0 (0%)	0 (0%)
	+								
AB15 (n=19)	%	6 (31.6%)	1 (5.3%)	0 (0%)	7 (36.7%)	4 (21.1%)	0 (0%)	0 (0%)	0 (0%)
	+								
AB33 (n=21)	%	5 (23.8%)	0 (0%)	0 (0%)	20 (95.2%)	0 (0%)	2 (9.5%)	0 (0%)	0 (0%)
	+								
AB40 (n=21)	%	14 (66.7%)	0 (0%)	0 (0%)	19 (90.5%)	0 (0%)	1 (4.8%)	0 (0%)	0 (0%)
	+								
AB42 (n=10)	%	1 (10%)	0 (0%)	0 (0%)	10 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	+								
AB52 (n=20)	%	12 (60%)	0 (0%)	0 (0%)	12 (60%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	+								
AB79 (n=13)	%	7 (53.8%)	0 (0%)	0 (0%)	9 (69.2%)	2 (15.4%)	0 (0%)	0 (0%)	1 (7.7%)
	+								
AB13 3 (n=4)	%	4 (100%)	0 (0%)	0 (0%)	3 (75%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	+								
AB14 2 (n=21)	%	14 (66.7%)	0 (0%)	0 (0%)	21 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (4.8%)
	+								
AB19 8 (n=21)	%	11 (52.4%)	0 (0%)	1 (4.8%)	19 (90.5%)	1 (4.8%)	0 (0%)	0 (0%)	1 (4.8%)
	+								
AB20 5 (n=2)	%	1 (50%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	+								
BC21 3 (n=2)	%	0 (0%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	+								
MB24 4 (n=20)	%	17 (85%)	1 (5%)	0 (0%)	18 (90%)	0 (0%)	8 (40%)	0 (0%)	2 (10%)
	+								
SK423 (n=20)	%	8 (40%)	0 (0%)	0 (0%)	15 (75%)	1 (5%)	0 (0%)	0 (0%)	0 (0%)
	+								
SK473 (n=20)	%	9 (45%)	0 (0%)	0 (0%)	19 (95%)	0 (0%)	1 (5%)	0 (0%)	2 (10%)
	+								
SK528 (n=15)	%	15 (100%)	0 (0%)	1 (6.7%)	15 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	+								
Total (n=249)	%	134 (53.8%)	2 (0.8%)	2 (0.8%)	207 (83.1%)	13 (5.2%)	12 (4.8%)	0 (0%)	7 (2.8%)
	+								

Table 3 presents the median number of eggs for every herd by parasite. *Eimeria* spp. had the highest egg per gram counts followed by *Trichostrongylus* spp. These are the only two parasite species that did not have a zero as their median in every herd. The high amount of zeroes as a median for egg counts is explained by the low number of positive samples for the remaining six parasite species.

Table 3. Median number of eggs per gram of bison faeces of various species of gastrointestinal parasite by farm

Farm	<i>Trichostrongylus</i>	<i>Trichuris</i>	<i>Nematodirus</i>	<i>Eimeria</i>	<i>Moniezia</i>	<i>Capillaria</i>	<i>Toxocara</i>	<i>Strongyloides</i>
AB7	8.5	0	0	425	0	0	0	0
AB15	0	0	0	0	0	0	0	0
AB33	0	0	0	1275	0	0	0	0
AB40	17	0	0	425	0	0	0	0
AB42	0	0	0	425	0	0	0	0
AB52	17	0	0	425	0	0	0	0
AB79	17	0	0	425	0	0	0	0
AB133	0	0	0	0	0	0	0	0
AB142	17	0	0	425	0	0	0	0
AB198	17	0	0	425	0	0	0	0
AB205	76.5	0	0	0	0	0	0	0
BC213	0	0	0	425	0	0	0	0
MB244	102	0	0	425	0	0	0	0
SK423	0	0	0	425	0	0	0	0
SK473	0	0	0	425	0	0	0	0
SK528	119	0	0	2125	0	0	0	0

In Table 4 the median, range of and interquartile range of the egg counts per parasite of all samples is presented. Overall, the highest egg counts were found for *Eimeria* spp. and *Trichostrongylus* spp. (Table 4) *Moniezia* spp. and *Capillaria* spp. had positive samples with fairly high egg counts but these were rare and therefore, did not have an influence on the median egg count. In contrast, the interquartile range shows that for *Eimeria* spp. more than 75% of samples had an egg count of 425 eggs or greater. For *Trichostrongylus* spp., there was a greater distribution with 50% of the samples having an egg count over 17 eggs and 75% of the samples remained relatively low, only 3 times more.

Table 4. Median, Range and Interquartile range of eggs per gram counts per parasite

Parasite	Median	IQR 25%	IQR 75%	Range
<i>Trichostrongylus</i>	17	0	51	0-952
<i>Trichuris</i>	0	0	0	0-17
<i>Nematodirus</i>	0	0	0	0-17
<i>Eimeria</i>	425	425	425	0-3825
<i>Moniezia</i>	0	0	0	0-731
<i>Capillaria</i>	0	0	0	0-323
<i>Toxocara vitulorum</i>	0	0	0	0
<i>Strongyloides</i>	0	0	0	0-34

Feedlot versus Pasture

Table 5. Independent sample t-test results by parasite

	<i>Capillaria</i>	<i>Eimeria</i>	<i>Moniezia</i>	<i>Nematodirus</i>	<i>Strongyloides</i>	<i>Toxocara</i>	<i>Trichostrongylus</i>	<i>Trichuris</i>
N (feedlot)	85	85	85	85	85	85	85	85
Mean (feedlot)	0.80	735.00	0.20	0.00	0.60	0.00	29.20	0.00
N (pasture)	164	164	164	164	164	164	164	164
Mean (pasture)	6.84	746.34	20.84	0.21	0.73	0.00	81.16	0.21
p-value	0.05	0.93	0.01	0.16	0.83	-	0.00	0.16
Std. Err. Diff.	3.02	129.66	7.28	0.15	0.57	-	14.69	0.15

In Table 5 the results of the statistical comparison between feedlot bison and bison on pasture is presented. Mean eggs per gram count was for every parasite species higher in pastured bison than in feedlot bison, except for *Toxocara vitulorum* (Table 5). However, faecal egg count was only significantly different for *Capillaria* spp., *Moniezia* spp. and *Trichostrongylus* spp., which were higher in pastured bison than in feedlot bison. Sample size differed between feedlot bison and pastured bison, with 85 and 164 samples collected, respectively. Because no positive samples were found for *Toxocara vitulorum*, independent sample t-testing could not be performed.

Discussion

Sample Collection

It was not always possible to obtain the desired 20 samples per herd. In some instances, this was due to the danger associated with certain individual bison. This was also due to reliance on some producers or their veterinarians for sample collection on some herds from the provinces of British Columbia, Manitoba and, Saskatchewan.

This gives rise to the challenge of comparing herds with unequal sample sizes. A single positive sample in a herd with only two samples would result in a within herd prevalence of 50%, while a single positive sample in a herd with 20 samples would have a within herd prevalence of 5%. However, it seems that these smaller sampled herds do not contribute to the less frequently seen parasites. As is the case for 'AB205' and 'BC213' which had 4 samples together in total with only two positive samples for *Eimeria* spp. and one positive sample for *Trichostrongylus* spp.

Comparing to other studies

In Tables 6 and 7, the overall prevalence of the parasite species at the bison level (Table 5) and at the herd level (Table 6) of our study is compared with other studies. Furthermore, these tables show the prevalence of several of the parasite species in other mammals, both domesticated and wild.

Table 6. Overall bison-level prevalence of various gastrointestinal parasite species compared with other mammals from different studies

	This Study Bison:		(Fréchette, Gibbs 1971) Beef Cattle:	(Slocome 1973) Dairy Cattle:	(Uhazy, Holmes 1971) Rocky Mountain Bighorn Sheep:	(Dies, Coupland 2001) Bison:	(Karbowiak, Demiaszki et al. 2014) Wisent:	
	Mean (Median)	%	%	%	Median	%	Mean	%
<i>Capillaria</i>	4.8 (0.0)	4.8%	1.9%	-	2.0	4.0%	0.4	-
<i>Eimeria</i>	742.5 (425.0)	83.1%	-	3.6%	-	-	-	23.3%
<i>Moniezia</i>	13.8 (0.0)	5.2%	0.9%	1.7%	3.0	12.0%	3.5	41.0%
<i>Nematodirus</i>	0.1(0.0)	0.8%	0.7%	2.7%	352.0	84.0%	0.5	<10.0%
<i>Strongyloides</i>	0.7 (0.0)	2.8%	2.9%	0.4%	-	-	0.22	-
<i>Toxocara vitulorum</i>	0.0 (0.0)	0.0%	-	-	-	-	-	-
<i>Trichostrongylus</i>	63.4 (17.0)	53.8%	21.0%	-	-	-	16.6	20.0- 50.0%
<i>Trichuris</i>	0.1 (0.0)	0.8%	-	0.4%	20.0	68.0%	0.6	-

Table 7. Overall herd-level prevalence of various gastrointestinal parasite species compared with other bison herd from different studies

	This Study Bison:	(Dies, Coupland 2001) Bison:	(Woodbury, Wagner et al. 2014) Bison:
<i>Capillaria</i>	25.0%	63.6%	13.0%
<i>Eimeria</i>	93.8%	-	95.0%
<i>Moniezia</i>	31.3%	54.6%	72.0%
<i>Nematodirus</i>	12.5%	50.0%	13.0%
<i>Strongyloides</i>	31.3%	9.1%	0.0%
<i>Toxocara vitulorum</i>	0.0%	-	4.0%
<i>Trichostrongylus</i>	93.8%	100.0%	100.0%
<i>Trichuris</i>	12.5%	40.9%	5.0%

Table 6 shows some interesting differences in prevalence of some of the parasites in other mammals. Beef cattle parasite prevalence shows more similarities with bison than those in dairy cattle. This is probably due to the fact that operation types for beef cattle and bison are similar, whereas dairy cattle is managed very differently. The prevalence in Rocky Mountain Bighorn Sheep does not show that many similarities with the prevalence in bison, the only parasite prevalence which is similar is *Capillaria* spp. Of course, these Bighorn Sheep are less closely related to bison than cattle are, and bison and Rocky Mountain Bighorn Sheep rarely share habitats in the wild: sheep will keep to the higher altitudes and the steeper terrain whereas bison roam the plains. Probably the most closely related species to the bison is the Wisent or European Bison. Even closer to extinction than bison ever where, this species is starting to increase in numbers again. Again prevalence of gastrointestinal parasites in wisent has some similarities with bison especially for *Trichostrongylus* spp. However, this comparison can be quite difficult to interpret because both species of mammal live on a different continent and the wisent studied are a wild population and not domesticated like the studied bison population. Only one study done in bison showed an individual egg count for several gastrointestinal parasites. That study gave the opportunity to compare the mean egg per gram counts for individual samples. Mean egg per gram counts were similar for *Trichostrongylus* spp. and *Nematodirus* spp. However, that study was conducted 14 years ago and looked at a different population (Dies, Coupland 2001).

Table 7 shows the percentages of positives herds compared with those from two other studies done in bison. The results found in this study are in range with the results found in the two other studies, except for *Strongyloides papillosus* which was considerably more prevalent in herd within the population studied in this project than in the other two conducted studies. Again, studied populations are not completely similar. In the present study, *Moniezia* spp. was found lower in herd level prevalence than in the other studies.

Feedlot versus Pasture

A greater proportion of herds kept their animals on pasture, thus the group of feedlots is not as large as the group of pasture based farms. Nonetheless, it was still possible to perform independent sampled t-test for the individual parasite species between feedlot and pasture farmed bison. Since a pasture is the type of environment more suitable to support a parasite in completing its life-cycle than a feedlot, it was expected that faecal egg counts in pastured bison would be higher than in feedlot bison.

Interpretation of these results (Table 5) shows that the egg counts for *Capillaria* spp, *Moniezia* spp. and *Trichostrongylus* spp. were significantly different between feedlot bison and pastured bison, 0.80 to 6.84, 0.20 to 20.84 and 29.20 to 81.16, respectively. For *Capillaria* spp., this difference is difficult to explain because their life cycle is similar to other examined parasites that showed no significant difference. However, *Moniezia* spp. is the only parasite species examined that has an indirect life cycle. The intermediate host being the forage mite is crucial for its survival. These forage mites are mainly found on pasture, thus likely explaining why egg counts from pastured bison were higher than feedlot bison. *Trichostrongylus* spp. along with *Nematodirus* spp. and *Strongyloides papillosus*, are parasite species in which the L3 stage of the larvae are ingested to create an infection. However, *Trichostrongylus* spp. is the only one of the three species that showed a significant difference in egg count between feedlot farmed bison and pasture farmed bison having a p-value of <0.01, whereas *Nematodirus* spp. and *Strongyloides papillosus* have p-values of 0.16 and 0.83, respectively.

For the remaining five parasite species, no significant difference between feedlots and pastures was found. This only seems plausible for *Strongyloides papillosus* since this is a parasite that is not completely dependent on ingestion to cause an infection. Skin penetration or consumption of infected milk are two other important modes of infection.

Toxocara vitulorum was not found in any of the faecal samples so it is not possible to make comparisons between operation types, as it seems the parasite is just not present in the studied population. *Toxocara vitulorum* is a parasite that is mainly found in younger animals (calves), therefore the results for this parasite are in line with what was expected.

This leaves only three parasite species for which there was no significant difference in the egg counts between feedlot bison and pastured bison. One would assume that for these parasites the prevalence in pastured bison was higher since it represents an environment which is more suitable for a parasite to complete its life-cycle. However, this was not the case. This could be the result of pasture rotation which decreased parasite burden. For *Nematodirus* spp. and *Trichuris* spp. the prevalence is low in either groups, thus creating a bigger chance of not detecting a significant difference. In other words, this low prevalence might result in inadequate power to detect a significant difference. *Eimeria* spp., on the other hand, was found very frequently, so that explanation may not apply for this parasite species. The egg count in both groups is approximately equal. Apparently *Eimeria* spp. does not rely on grazing as a form of ingestion for its survival that much. Maybe it gets ingested when animals groom each other, suggesting that bison have the parasites oocyst on their fur. This explanation however would need further studying to be conclusive. Alternatively, animals in feedlot were likely on pasture prior to arrival and thus, may have already had substantial parasite burden that was not adequately treated with anthelmintics.

Conclusions

This study revealed that every parasite examined except for *Toxocara vitulorum* was present in the studied population, but *Eimeria* spp. and *Trichostrongylus* spp. were the most common. However, to get a more accurate picture of the prevalence of these parasites, a larger sample size representing a greater geographic distribution across Canada would need to be examined.

A significant statistical difference between the egg counts in feedlot farmed bison and pasture farmed bison was found. This difference was found for *Capillaria* spp., *Moniezia* spp. and *Trichostrongylus* spp. The egg counts for these parasites being higher in pastured bison than feedlot bison. One can conclude that for these parasites, feedlots are not ideal for their survival. Therefore, feedlots seem to be effective in keeping the egg count of these parasites low in the herd. However, this is only the case for adult animals since bison will be on grass at some point in their lives, usually when they are weaned (younger than two years).

For the other five examined parasite species no significant statistical difference in egg counts between pasture farmed bison and feedlot farmed bison was found. In that sense, either farming method does not contribute more or less to their survival.

In general, operation type does seem to have an effect on the egg counts of certain parasites within the studied population, with those parasites thriving more in an environment that suits their needs for survival. This is not unexpected since some of these parasites have co-existed and co-evolved on pasture with bison for millions of years.

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Addendum: Faecal Egg Count (eggs per gram)

Farmcode	<i>Trichostrongyle</i> (epg)	<i>Trichuris</i> (epg)	<i>Nematodirus</i> (epg)	<i>Eimeria</i> (Oocysts per gram)	<i>Moniezia</i> (epg)	<i>Capillaria</i> (epg)	<i>Toxocara vitulorum</i> (epg)	<i>Strongyloides</i>
AB7	0	0	0	425	0	0	0	0
AB7	0	0	0	425	0	0	0	0
AB7	0	0	0	425	85	0	0	0
AB7	85	0	0	425	0	0	0	0
AB7	34	0	0	425	17	0	0	0
AB7	0	0	0	425	527	0	0	0
AB7	0	0	0	425	0	0	0	0
AB7	0	0	0	425	0	0	0	0
AB7	17	0	0	0	187	0	0	0
AB7	68	0	0	425	0	0	0	0
AB7	34	0	0	0	731	0	0	0
AB7	34	0	0	425	0	0	0	0
AB7	0	0	0	425	0	0	0	0
AB7	0	0	0	425	0	0	0	0
AB7	0	0	0	425	0	0	0	0
AB7	34	0	0	425	0	0	0	0
AB7	17	0	0	425	0	0	0	0
AB7	17	0	0	425	0	0	0	0
AB7	51	0	0	425	51	0	0	0
AB7	0	0	0	425	0	0	0	0
AB15	0	0	0	0	0	0	0	0
AB15	51	0	0	425	0	0	0	0
AB15	0	0	0	0	0	0	0	0
AB15	0	0	0	0	0	0	0	0
AB15	0	0	0	425	0	0	0	0
AB15	850	0	0	0	0	0	0	0
AB15	0	0	0	425	0	0	0	0
AB15	0	0	0	0	0	0	0	0
AB15	0	0	0	0	442	0	0	0
AB15	0	17	0	425	323	0	0	0
AB15	0	0	0	425	0	0	0	0
AB15	0	0	0	0	0	0	0	0
AB15	0	0	0	425	0	0	0	0
AB15	17	0	0	425	0	0	0	0
AB15	17	0	0	0	476	0	0	0
AB15	0	0	0	0	0	0	0	0
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AB15	850	0	0	0	255	0	0	0
AB15	425	0	0	0	0	0	0	0

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AB33 - feedlot	0	0	0	3825	0	0	0	0
AB33 - feedlot	0	0	0	2125	0	0	0	0
AB33 - feedlot	204	0	0	3825	0	0	0	0
AB33 - feedlot	0	0	0	2125	0	17	0	0
AB33 - feedlot	0	0	0	3825	0	0	0	0
AB33 - feedlot	34	0	0	425	0	0	0	0
AB33 - feedlot	0	0	0	1275	0	0	0	0
AB33 - feedlot	0	0	0	2125	0	0	0	0
AB33 - feedlot	34	0	0	1275	0	0	0	0
AB33 - feedlot	0	0	0	1275	0	0	0	0
AB33 - feedlot	0	0	0	425	0	0	0	0
AB33 - feedlot	0	0	0	1275	0	0	0	0
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AB40	17	0	0	425	0	0	0	0
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AB40	17	0	0	1275	0	0	0	0
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AB40	0	0	0	2125	0	0	0	0
AB40	170	0	0	2975	0	0	0	0
AB40	119	0	0	425	0	17	0	0
AB40	51	0	0	425	0	0	0	0
AB40	51	0	0	425	0	0	0	0
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AB40	17	0	0	425	0	0	0	0
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AB52-feedlot	85	0	0	425	0	0	0	0
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AB52-feedlot	0	0	0	425	0	0	0	0
AB52-feedlot	272	0	0	425	0	0	0	0
AB52-feedlot	51	0	0	425	0	0	0	0
AB52-feedlot	17	0	0	425	0	0	0	0
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AB52-feedlot	17	0	0	0	0	0	0	0
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AB52-feedlot	0	0	0	425	0	0	0	0
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AB52-feedlot	0	0	0	425	0	0	0	0

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AB79	0	0	0	425	0	0	0	34
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AB79	187	0	0	425	0	0	0	0
AB79	0	0	0	0	0	0	0	0
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AB142	238	0	0	3825	0	0	0	0
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AB142	51	0	0	425	0	0	0	0
AB142	85	0	0	1275	0	0	0	0
AB142	34	0	0	425	0	0	0	0
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AB142	0	0	0	425	0	0	0	17
AB142	17	0	0	425	0	0	0	0
AB198	0	0	0	425	0	0	0	0
AB198	51	0	0	425	0	0	0	0

AB198	0	0	0	425	0	0	0	0
AB198	0	0	0	425	0	0	0	0
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AB198	102	0	0	425	0	0	0	0
AB198	34	0	0	1275	0	0	0	0
AB198	34	0	0	425	0	0	0	0
AB198	17	0	0	425	0	0	0	0
AB198	170	0	0	3825	0	0	0	0
AB198	51	0	0	3825	0	0	0	0
AB198	0	0	0	425	0	0	0	0
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AB198	102	0	0	425	136	0	0	0
AB198	204	0	17	425	0	0	0	34
AB198	0	0	0	425	0	0	0	0
AB198	0	0	0	425	0	0	0	0
AB198	0	0	0	0	0	0	0	0
AB198	0	0	0	425	0	0	0	0
AB205	0	0	0	0	0	0	0	0
AB205	153	0	0	0	0	0	0	0
BC213	0	0	0	425	0	0	0	0
BC213	0	0	0	425	0	0	0	0
MB244	0	0	0	425	0	0	0	0
MB244	0	0	0	425	0	0	0	0
MB244	34	0	0	425	0	34	0	0
MB244	952	0	0	425	0	51	0	0
MB244	17	0	0	425	0	0	0	0
MB244	17	0	0	0	0	272	0	0
MB244	34	0	0	425	0	0	0	0
MB244	68	0	0	425	0	323	0	0
MB244	187	0	0	0	0	0	0	0
MB244	629	0	0	425	0	0	0	0
MB244	731	0	0	425	0	51	0	0
MB244	238	0	0	425	0	0	0	0
MB244	255	0	0	425	0	0	0	0
MB244	357	0	0	425	0	0	0	0
MB244	0	0	0	425	0	0	0	0
MB244	170	17	0	2125	0	85	0	17
MB244	408	0	0	425	0	221	0	0
MB244	34	0	0	425	0	0	0	17
MB244	102	0	0	425	0	0	0	0
MB244	102	0	0	425	0	68	0	0
SK423 - feedlot	0	0	0	425	0	0	0	0
SK423 -	0	0	0	425	0	0	0	0

feedlot								
SK423 - feedlot	0	0	0	0	0	0	0	0
SK423 - feedlot	0	0	0	425	0	0	0	0
SK423 - feedlot	0	0	0	425	0	0	0	0
SK423 - feedlot	0	0	0	425	17	0	0	0
SK423 - feedlot	0	0	0	425	0	0	0	0
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SK423 - feedlot	0	0	0	0	0	0	0	0
SK423 - feedlot	68	0	0	0	0	0	0	0
SK423 - feedlot	17	0	0	425	0	0	0	0
SK423 - feedlot	34	0	0	425	0	0	0	0
SK423 - feedlot	0	0	0	0	0	0	0	0
SK423 - feedlot	0	0	0	425	0	0	0	0
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SK423 - feedlot	0	0	0	425	0	0	0	0
SK423 - feedlot	17	0	0	0	0	0	0	0
SK423 - feedlot	51	0	0	425	0	0	0	0
SK423 - feedlot	17	0	0	1275	0	0	0	0
SK423 - feedlot	85	0	0	425	0	0	0	0
SK473 - feedlot	0	0	0	425	0	0	0	17
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SK473 - feedlot	0	0	0	0	0	0	0	0
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SK473 - feedlot	0	0	0	425	0	0	0	0
SK473 - feedlot	51	0	0	425	0	0	0	0
SK473 - feedlot	0	0	0	425	0	0	0	0
SK473 - feedlot	34	0	0	2125	0	0	0	0
SK473 - feedlot	17	0	0	425	0	0	0	0
SK473 - feedlot	34	0	0	425	0	0	0	0

SK473 - feedlot	0	0	0	425	0	0	0	0
SK473 - feedlot	34	0	0	425	0	17	0	0
SK473 - feedlot	0	0	0	425	0	0	0	0
SK473 - feedlot	0	0	0	425	0	0	0	0
SK473 - feedlot	34	0	0	425	0	0	0	0
SK473 - feedlot	17	0	0	425	0	0	0	0
SK473 - feedlot	0	0	0	425	0	0	0	0
SK473 - feedlot	34	0	0	425	0	0	0	0
SK473 - feedlot	0	0	0	425	0	0	0	0
SK528	765	0	0	1275	0	0	0	0
SK528	119	0	0	3825	0	0	0	0
SK528	34	0	17	3825	0	0	0	0
SK528	119	0	0	1275	0	0	0	0
SK528	170	0	0	3825	0	0	0	0
SK528	34	0	0	3825	0	0	0	0
SK528	255	0	0	1275	0	0	0	0
SK528	102	0	0	425	0	0	0	0
SK528	442	0	0	3825	0	0	0	0
SK528	102	0	0	3825	0	0	0	0
SK528	34	0	0	1275	0	0	0	0
SK528	68	0	0	3825	0	0	0	0
SK528	51	0	0	2125	0	0	0	0
SK528	221	0	0	2125	0	0	0	0
SK528	204	0	0	2125	0	0	0	0

