BRIEF COMMUNICATION: Comparison of lameness and hoof horn puncture resistance of New Zealand Friesian and Jersey cross Friesian dairy cattle

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INTRODUCTION

Sole lesions have been found to be one of the most common causes of lameness in both New Zealand (Chesterton, 2004) and the United Kingdom (Logue, 1999). In most studies it was found that these hoof horn lesions develop in postpartum animals and in hind claws (Greenough & Vermunt, 1991) and that these are associated with a significant reduction in the puncture resistance of the hoof (Winkler & Margerison, 2006). There has been some reference to lower levels of lameness occurring in Jersey and Jersey cross bred cattle, compared with Holstein Friesian dairy cattle (Chesterton *et al.*, 1989) and lower hoof wear rates (Logue *et al.,* 1994). However no studies have measured or compared the structural strength of hoof horn in these breeds. The aim of this research was to assess the resistance to puncture of the hoof horn from differing claws and regions of claws of a sample of prepartum New Zealand Friesian and Jersey cross Friesian dairy cows.

MATERIALS AND METHODS

Animals

At 14 weeks of age four male New Zealand Friesian and five Jersey cross New Zealand Friesian cattle, and at 15 months of age 15 New Zealand Friesian and 15 Jersey cross New Zealand Friesian cattle had all their four hooves held and examined and hoof samples collected. All hooves exhibited normal physiological aspects and showed no visible pathological changes to the wall and sole areas. The distal 1 mm surface of the sole horn was removed using a hoof knife. Hoof samples were taken from the clean weight bearing regions of each claw at sites 1 to 5 of the International foot map (Figure 1). The samples were labelled and stored in sealed plastic bags and refrigerated at 4°C until analysis.

Hoof horn samples were analysed for puncture resistance as described by Winkler *et al.* (2002). The maximum punch force, measured in newtons, was obtained from the force-displacement curve, a total of five tests were completed in each of the five defined regions of each claw of each hoof in accordance with Winkler and Margerison (2007). The data collected from each region was recorded separately. The thickness of the sample on the tested area was recorded using callipers with a resolution of 0.01 mm. Each sample was scored for level of pigmentation, using a scale of 0 to 5 (0 = No pigment to 5 = Intense pigment).

Statistical analysis

The puncture resistance data measured in newtons were normalized for analysis by transformation to a $\log_{10}$ scale. The parameters were compared by breed, front or rear claws and International foot map zone adjusting for sample thickness, sex and presence of pigmentation using analysis of variance (ANOVA), general linear modelling command (Minitab, 2006). The comparison of means was completed with a confidence interval of 95% using Tukey's test with Bonferoni correction.

RESULTS AND DISCUSSION

The puncture resistance of hoof tissue from Jersey cross bred cattle was consistently higher than hoof tissue from Friesian dairy cattle at all International foot map zones on both fore and hind claws (Tables 1 and 2). Hoof tissue from the white line region (Zones 1 and 2 on International foot map) had a significantly lower puncture resistance than the sole region (Zones 4 and 5 on International

TABLE 1: Puncture resistance ($\log_{10}$ N) of hoof horn taken from differing regions of the International foot map of the fore claws. SEM = Standard error of mean.

Zone of foot	Breed		SEM	P value
	Friesian	Jersey cross		
1	0.67	0.85	0.02	0.001
2	0.60	0.70	0.02	0.001
3	0.73	0.85	0.02	0.001
4	0.78	0.91	0.02	0.001
5	0.84	0.90	0.02	0.001

FIGURE 1: International foot map (Source: Greenough & Vermut, 1991).

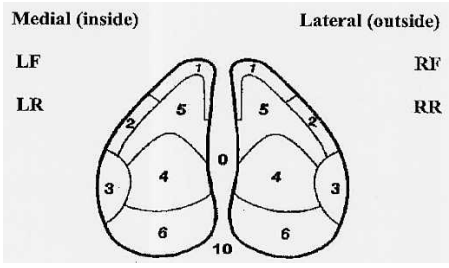

TABLE 2: Puncture resistance (log_{10} N) of hoof horn taken from differing regions of the International foot map of the hind claws. SEM = Standard error of mean.

Zone of foot	Breed		SEM	P value
	Friesian	Jersey cross		
1	0.62	0.76	0.02	0.001
2	0.57	0.64	0.02	0.001
3	0.74	0.86	0.02	0.001
4	0.80	0.94	0.02	0.001
5	0.86	0.93	0.02	0.001

TABLE 3: Puncture resistance (log_{10} N) of hoof horn taken from the white line region (Zones 1 and 2 on International foot map) or sole region (Zones 4 and 5 on International foot map) of the fore and hind claws. SEM = Standard error of mean.

Region of foot	Breed		Claws		SEM	P value		
	Friesian	Jersey X	Fore	Hind		Breed	Claw	B*H
White line	0.63 [b]	0.75 [a]	0.71	0.68	0.01	0.001	0.097	0.185
Sole	0.80 [b]	0.89 [a]	0.84	0.86	0.01	0.001	0.244	0.027

foot map), while there was no significant difference between the puncture resistance of fore and hind claws (Table 3).

This study showed the puncture resistance of hoof tissue from Friesian dairy cattle across all regions of the hoof as mapped in the International foot map (Figure 1) were comparable to those reported in previous studies (Winkler & Margerison, 2006) and beef cattle (Winkler & Margerison, 2007). In contrast the puncture resistance of hoof tissue from Jersey cross bred cattle in this study was consistently higher than the values measured for Friesian dairy cattle. While no other studies have compared the puncture resistance of hoof horn from differing dairy breeds and or cross breeds, this may explain the lower hoof wear rates and subsequent locomotion scores reported for Jersey animals compared to Holstein-Friesians animals reported by Logue *et al.* (1994) and similar reports for Jersey cross breed cattle reported by Chesterton *et al.* (1989).

Hoof horn samples taken from zones 1 and 2 on the International foot map (white line region) had consistently lower puncture resistance compared with zones 4 and 5 (sole region) clearly demonstrating the differences between the physiological structure and functionality of hoof tissue between the white line and sole regions, consistent with previous research (Winkler & Margerison, 2006; 2007). The lower puncture resistance of hoof in the white line region may well explain the high incidence rate of the development of white line lesions (Chesterton *at al.*, 1989) and lameness in pasture based dairy cattle. This is supported by Mulling *et al.* (1994) who found a high negative correlation between hardness and horn structure and in the sites for occurrence of lesions in the ground surface of the hoof. The puncture resistance of fore and hind claws were not significantly different in these groups of male and prepartum cattle. This is consistent with the research that demonstrates that increases in claw lesions (Leach *et al.* 1997) and lower hoof horn puncture resistance (Winkler *et al.,* 2002) in hind claws are associated with parturition (Webster *et al*., 2001). Changes in management and environment at this time may assist in managing cows during first parturition and lactation to reduce the incidence of hoof lesions, deterioration of hoof structural integrity and wear with resultant lameness in these animals.

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