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Indicators for early detection of ecchymosis (bloodsplash) in fallow deer (*Dama dama*) carcasses

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ABSTRACT

Ecchymosis is a haemorrhagic syndrome that appears as small dark spots on the surface of various muscles of a carcass and some organs. It is considered a meat quality defect. In this study eight fallow deer carcasses were completely dissected. Hindquarter muscles showed a significantly higher incidence of ecchymosis compared with forequarter muscles. The most affected muscles were the primal cuts from the hindquarter including the striploin. When this information was applied to a wider study of 963 fallow deer carcasses 23.1% had low to moderate ecchymosis in the left round (*M. vastus lateralis*). In all cases this muscle was a reliable indicator of the presence of ecchymosis in the loins and/or other hind leg primals. In the same carcasses visceral organs such as lung and heart were unreliable indicators of the presence of ecchymosis in skeletal muscles. Castrated bucks were most likely to exhibit ecchymosis followed by does and bucks ($P = 0.02$). An on-line inspection system for fallow deer was recommended which included an *in situ* inspection of the left round as an accurate means of determining ecchymosis incidence in other valuable commercial cuts.

Key words: fallow deer; ecchymosis; blood splash; carcass inspection; abattoir.

INTRODUCTION

Ecchymosis or blood splash, is a haemorrhagic syndrome associated with the slaughter of animals. It has been reported to occur frequently in fallow deer (Mulley & Falepau, 1999). Valuable commercial cuts of meat and sometimes whole carcasses are condemned due to the severity and/or widespread coverage of ecchymosis (Falepau, 1999). Under the inspection regime for export meat carried out by the Australian Quarantine Inspection Service (AQIS), condemnation of venison due to ecchymosis only occurs in the boning room, yet AQIS inspectors often see incidences of high grade ecchymosis in muscles visible during whole carcass inspection on the slaughter floor.

Ecchymosis has been studied in a number of livestock species including, sheep, cattle, and pigs but in those studies the complete anatomical dissection of carcasses was not reported. Those studies concentrated on unravelling the factors associated with ecchymosis incidence. Carcass inspection was confined to muscle surfaces visible on the whole carcass, or commercial cuts into which carcasses of the particular species were commonly broken down (Burson *et al.*, 1983; Pearson *et al.*, 1977; Kirton *et al.*, 1978; Blackmore, 1979; Restall, 1981; Calkins *et al.*, 1981; Kirton & Frazerhurst, 1983; Lambooy & Sybesma, 1988; Smulders *et al.*, 1989). In sheep, which were commercially broken down into hind legs, loin section, and forequarter, few muscles were revealed that could not already be inspected on a whole carcass basis. Accordingly, most

researchers in New Zealand investigating ecchymosis in sheep (Pearson *et al.*, 1977; Kirton *et al.*, 1978; Kirton *et al.*, 1981a, 1981b; Kirton & Frazerhurst, 1983) determined ecchymosis incidence on a whole carcass basis using a grading system developed by the Meat Industry Research Institute of New Zealand (MIRINZ, 1974). This involved a five point scale, with zero indicating no ecchymosis and five indicating severe ecchymosis. Using this grading scale the inspection was based on externally visible muscles such as the intercostals, abdominals, and diaphragm, where the latter was not removed during evisceration.

No work has previously investigated the anatomical distribution of ecchymosis in deer, although a five point grading chart (Grade 1 = Low, Grade 5 = Severe) was developed to facilitate the quantification of the extent and severity of cases of ecchymosis in deer primal cuts (Tuckwell & Hubbard, 1996). The chart was based on the loin (*M. longissimus dorsi*) and round (*M. vastus lateralis*) commercial cuts because these were suggested on the basis of anecdotal evidence, to be the most commonly affected commercial meat cuts in deer.

From a review of the literature, no previous studies have investigated in detail relationships between ecchymosis incidence in different skeletal muscles or organs of the fallow deer. This paper presents data recorded from the complete dissection of a number of fallow deer carcass in order to identify the particular muscles most frequently affected by ecchymosis.

MATERIALS AND METHODS

Fallow deer carcasses affected with ecchymosis were retrieved from four trials conducted at the University of Western Sydney abattoir to determine factors associated with the occurrence of ecchymosis. In each trial the deer were allocated to treatment groups involving electrical stunning at either 150, 200, 300 or 400 volts for a duration of either 1, 2 or 3 seconds. The deer were exsanguinated approximately eight seconds after stunning using the gash cut method.

Carcass dissection

Eight deer carcasses were chilled for at least 24 hours and then split along the spine into 16 halves. Each half was dissected into a 3-rib hindquarter and a 10-rib forequarter, and then into the components muscle, bone, and fat. Dissection of individual muscles was carried out systematically according to the method described by Butterfield and May (1966). Bone and fat were discarded and each muscle was inspected visually for ecchymotic lesions. The score recorded to indicate the extent to which each muscle was affected by ecchymosis was allocated according to the ecchymosis grading chart for deer developed by Tuckwell and Hubbard (1996).

Commercial application of technique

A further 963 fallow deer carcasses were inspected at commercial abattoirs in Australia to validate the inspection technique described in this paper. The carcasses were a mixture of bucks, does and castrated deer.

Statistical analysis

For the distribution of ecchymosis determined by carcass dissection (Table 1 and Table 2), no statistical analysis of the data was required. ANOVA (Minitab, 1995) was used to determine sex type effect on ecchymosis expression.

RESULTS

A comparison of the hindquarter (Table 1) and forequarter (Table 2) ecchymosis scores for the eight animals dissected showed a greater amount of ecchymosis occurring in the hindquarter. Of the total 752 hindquarter muscles inspected, 217 (29%) were affected by ecchymosis. In contrast, only 38 (0.05%) of the 800 forequarter muscles inspected were affected by ecchymosis.

Of the hindquarter muscles, the *M. longissimus dorsi* and *M. vastus lateralis* were affected in all 16 of the carcass sides. The next most frequently affected muscle was the *M. semimembranosus* with 15 muscles affected, followed by the *M. biceps femoris*, *M. gluteus medius*, and *M. rectus femoris* which were affected in 13 of the possible 16 carcass

sides. The *M. adductor femoris* and *M. vastus medialis* were affected in 10 sides, and the *M. semitendinosus* and *M. obliquus internus abdominis* in nine sides. The *M. vastus intermedius* was affected in eight carcass sides. Of the 36 remaining muscles of the hindquarter, 27 of them were affected in at least one of the sides inspected, but in no more than seven of the sides.

Of the forequarter muscles, the *M. supraspinatus* and diaphragm were the most frequently affected. Ecchymosis in these muscles occurred in 11 and seven respectively, out of the 16 carcass sides. The next most frequently affected muscle of the forequarter was the *M. infraspinatus* which was affected in four of the sides, each time recording a score of 1.

When this information was applied to a wider study of 963 fallow deer carcasses from bucks, does and castrates, 23.1% had low to moderate ecchymosis of Grades 1 and 2 in a five grade system, in the left round (*M. vastus lateralis*). In all cases this muscle was a reliable indicator of the presence of ecchymosis in the loins and/or other hind leg primals. In the same carcasses visceral organs such as lung and heart were unreliable indicators of the presence of ecchymosis in skeletal muscles. A significant sex effect ($P = 0.02$) was found in the deer carcasses for ecchymosis incidence in both visceral organs, diaphragm, abdominal and skeletal muscles, with castrates more affected than does and bucks.

DISCUSSION

Although sex type was not thought to be an important factor in this particular study, the results indicated differences in ecchymosis susceptibility attributed to sex type. Reviewing the literature, only two authors had previously referred to sex type and its effect on ecchymosis expression. Burson *et al* (1983) compared the effect of captive bolt and electrical stunning of pigs, and the time between either of these methods and exsanguination, on ecchymosis in barrows (castrates) and gilts (females) and concluded that there was no sex type effect on the expression of ecchymosis. Charles (1960) observed in cattle that ecchymosis was mainly seen in ox (steer) carcasses but very seldom in cow carcasses. From the present results on fallow deer it was concluded that of the three sex types, castrated bucks were most likely to get ecchymosis followed by does and bucks.

TABLE 1: Ecchymosis scores for muscles dissected from the hindquarters of fallow deer carcasses

Name of muscle (Listed in order of dissection)	Ecchymosis scores																Number of muscles affected (Number of carcass affected)
	(Each consecutive pair of columns represents the left and right side of the same carcass. Blank squares indicate a score of 0)																
M. tensor fasciae latae		1															1 (1)
M. biceps femoris	2	2		2	1	1	1	3	3	3	1	3	1			1	13 (8)
M. gluteus medius	3	3	3	2	2	1	2	2	2	4	3	3	1	3			14 (7)
M. vastus lateralis	1	1	2	1	2	1	3	3	2	1	1	2	2	4	3	2	16 (8)
M. gluteus accessorius	1	2	2				3	1				1					6 (4)
M. gluteus profundus	1	1	1				2	1				1					6 (4)
M. rectus femoris	1	3		1	2	1	3	3	1	1	1	1	2	3			13 (7)
M. semitendinosus	1	3	1	1			1	1		1	1	4					9 (5)
M. gracilis					1					1	3	2					4 (3)
M. semimembranosus	1	1	2	2	1	1	2	1	2	1	3	4	1	2		1	15 (8)
M. adductor femoris	1		1				1	1	1	1		1	2	1		1	10 (7)
M. gastrocnemius et m. soleus				1		1			2	1	1	2	2				7 (5)
M. flexor digitorum superficialis (s. plantaris)													1	1			2 (1)
M. pectineus				2			1			1		3	1				5 (5)
M. sartorius							1										1 (1)
M. gemellus												4					1 (1)
M. quadratus femoris			1														1 (1)
Mm. obturatorii externus et internus								1			1	2					3 (3)
M. vastus medialis							1	4				1	4	4	1	2	8 (4)
M. vastus intermedius	1				1	1	4	4				1	3	1	2	1	10 (6)
M. articularis genu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Extensor group**							4	1									2 (1)
M. peroneus longus				1								1					2 (2)
M. extensor digiti quarti propius (pedis)																	*
M. tibialis anterior																	*
M. tibialis posterior***																	*
M. flexor digitorum longus (pedis)***	2	2								1							3 (2)
M. flexor hallucis longus***	2	2			1									1			4 (3)
M. popliteus																	*
M. psoas minor																	*
M. psoas major		1					1		1								3 (3)
M. quadratus lumborum									1								1 (1)
M. iliacus				1													1 (1)
M. latissimus dorsi												2					1 (1)
M. trapezius thoracis																	*
M. serratus dorsalis caudalis																	*
M. iliocostalis (s. longissimus costarum)												1	1		1		3 (2)
M. longissimus dorsi	1	1	2	3	1	1	1	2	2	2	3	2	3	4	2	2	16 (8)
M. spinalis dorsi													1		1	1	3 (2)
Mm. multifidi dorsi										2	3			2	3	1	5 (3)
M. obliquus externus abdominis				1	3	1	1										4 (2)
M. retractor costae					1		1										2 (2)
M. obliquus internus abdominis					3	2		1	2	3	2	2	3	3			9 (5)
M. transversus abdominis						1			2	2	2	2	3	2			7 (4)
M. rectus abdominis		1							1	2							3 (2)
Mm. sacrococcygeal																	*
M. levator ani (s. retractor ani)																	*
Mm. intercostales externi et interni					1	1						1					3 (2)
Mm. levatores costarum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. coccygeus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mm. intertransversarii caudae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. ischiocavernosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. praeputialis caudalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. praeputialis cranialis (s. protractor praeputii)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend for Table 1: * equal to zero, - not scored because muscle was either too small for inspection or only a small fragment remained on the dressed carcass, ** Extensor group muscles comprise; *M. peroneus tertius*, *M. extensor digitorum longus*, *M. extensor digitorum brevis*, *M. extensor digiti tertii propius* (pedis), *** The flexor digitorum profundus (pedis) arises by the heads of these three muscles

TABLE 2: Ecchymosis scores for muscles dissected from the forequarters of fallow deer carcasses

Name of muscle (Listed in order of dissection)	Ecchymosis scores (Each consecutive pair of columns represents the left and right side of the same carcass. Blank squares indicate a score of 0)																Number of muscles affected (Number of carcasses affected)
M. cutaneus trunci et omobranchialis																	*
M. trapezius cervicalis																	*
M. trapezius thoracis																	*
M. deltoideus																	*
M. infraspinatus		1	1			1								1			4 (3)
M. triceps brachii (caput laterale)						1					2						2 (2)
M. teres minor																	*
M. triceps brachii (caput longum)																	*
M. tensor fasciae antibrachii																	*
M. extensor carpi radialis																	*
M. extensor digiti tertii proprius																	*
M. extensor digitorum communis																	*
M. extensor digiti quarti proprius																	*
M. extensor carpi ulnaris (s. ulnaris lateralis)																	*
M. adductor pollicis longus (s. extensor carpi obliquus)																	*
M. omotransversarius																	*
M. rhomboideus																	*
M. serratus ventralis cervicis		1															1 (1)
M. serratus ventralis thoracis		1															1 (1)
M. pectoralis profundus			1														1 (1)
M. pectoralis superficialis		1															1 (1)
M. supraspinatus	1			1	1	2	3	1			1	3	2	2	2		11 (7)
M. biceps brachii																	*
M. teres major																	*
M. coracobrachialis																	*
M. subscapularis							1										1 (1)
M. brachialis							1								1		2 (2)
M. brachiocephalicus													1				1 (1)
M. triceps brachii (caput mediale)																	*
M. flexor carpi radialis																	*
M. flexor carpi ulnaris																	*
M. flexor digitorum sublimis																	*
M. flexor digitorum profundus																	*
M. anconaeus																	*
M. serratus dorsalis cranialis																	*
M. scalenus dorsalis																	*
M. cervicohyoideus (s. omohyoideus)																	*
M. longissimus cervicis						1						1		1			3 (3)
M. splenius															1		1 (1)
M. sternocephalicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. scalenus ventralis																	*
M. longissimus et atlantis																	*
M. intertransversarius longus																	*
M. semispinalis capitis (s. complexus)																	*
M. rectus capitis dorsalis major												1					1 (1)
M. obliquus capitis caudalis														1			1 (1)
M. rectus thoracis (s. transversus costarum)																	*
M. transversus thoracis																	*
M. longus colli																	*
Mm. multifidus cervicis																	*
M. obliquus capitis cranialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. rectus capitis ventralis (s. rectus capitis ventralis minor)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. rectus capitis lateralis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. rectus capitis dorsalis minor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diaphragm				1	1			3	3	3	2				1		7 (4)

Legend Table 2: * equal to zero - not scored because muscle was either too small for inspection or only a small fragment remained on the dressed carcass.

The muscles affected by ecchymosis in the dissected deer carcasses were similar to those which have been observed in badly affected sheep carcasses where ecchymosis was found in the eye muscle, the fillet, leg and shoulder (Kirton & Woods, 1976). However, in less affected sheep carcasses the same authors observed that the diaphragm, the flap and areas of the ribs and loin away from the midline (backbone) were most frequently affected. This was not consistent with the present results on deer where in many cases the diaphragm was not affected by ecchymosis but there was still ecchymosis in the hind leg primals and loin. It is possible that Kirton and Woods (1976) did not find more ecchymosis because of their method of dissection where they sliced the carcasses into 1 cm sections from end to end. As the authors suggested, this technique would not have revealed many ecchymosis haemorrhages which were only on the surface of the muscles and not internal. Using the dissection method of Butterfield and May (1966) in the present study, it is likely that most ecchymosis lesions were found.

Charles (1960) suggested that ecchymosis in cattle was most commonly found in the muscles of the forequarter and that only in extreme cases did it occur throughout the whole carcass. In contrast, the present results on deer demonstrated that ecchymosis particularly affected muscles in the hindquarter (*Mm. longissimus*, *semimembranosus* and *rectus femoris*) and also that it was often wide spread in affected deer carcasses.

During the current study, a number of visits were made to Australian abattoirs which slaughtered deer commercially in order to study the slaughter process in detail. At these abattoirs, whole deer carcasses were inspected to determine the presence of ecchymosis using the left round as an inspection site. The left round was chosen as it was possible to reveal the superficial surface of the *M. vastus lateralis* being one of the muscles of which the round was comprised, by the removal of the *M. tensor fasciae latae*. In the cold and cramped conditions encountered within abattoir chillers, this technique enabled the rapid appraisal of large numbers of carcasses and clearly had the potential to be incorporated in commercial inspection systems. While general observations suggested the round to be a reliable indicator of ecchymosis in other parts of the carcass, no studies of sufficient detail had previously been conducted to support this.

In the current study, data collected from numerous trials conducted to investigate factors associated with ecchymosis were used to determine patterns in the anatomical distribution of ecchymosis in fallow deer. The development of a commercially practicable inspection system was considered imperative to guaranteeing the quality of venison exported from Australia.

REFERENCES

- Blackmore, D.K. 1979: Non-penetrative percussion stunning of sheep and calves. *Veterinary record* **105**: 372-375.
- Burson, D.F.; Hunt, M.C.; Schafer, D.E.; Beckwith, D.; Garrison, J.R. 1983: Effects of stunning method and time interval from stunning to exsanguination on blood splashing in pork. *Journal of animal science* **57**: 918-921.
- Butterfield, R.M.; May, N.D.S. 1966: *Muscles of the Ox*. University of Queensland Press, Australia.
- Calkins, C.R.; Davis, G.W.; Cole, A.B.; Hutsell, D.A. 1981: Incidence of bloodsplashed hams in hogs subjected to certain ante-mortem handling methods. *Journal of animal science* **51**(Supplement 1): 15.
- Charles, D.D. 1960: Ecchymosis in the beef carcass. *Australian veterinary journal*, April, 124-126.
- Falepau, D.F. 1999: Factors associated with the occurrence of ecchymosis (blood splash) in fallow deer (*Dama dama*). Ph D Thesis, University of Western Sydney, Australia.
- Kirton, A.H.; Bishop, W.H.; Mullord, M.M.; Frazerhurst, L.F. 1978: Relationship between time of stunning and time of throat cutting and their effect on blood pressure and blood splash in lambs. *Meat science* **2**: 199-206.
- Kirton, A.H.; Frazerhurst, L.F.; Bishop, W.H.; Winn, G.W. 1981a: A comparison of the effects of electrical, captive bolt or percussion stunning on the incidence of blood splash in lambs. *Meat science* **5**: 407-411.
- Kirton, A.H.; Frazerhurst, L.F.; Woods, E.G.; Chrystall, B.B. 1981b: Effect of electrical stunning method and cardiac arrest on exsanguination efficiency, residual blood and blood splash in lambs. *Meat science* **5**: 347-353.
- Kirton, A.H.; Frazerhurst, L.F. 1983: Effects of normal, light/normal or double stunning on the incidence and severity of blood splash in lambs. *Meat science* **8**: 1-6.
- Kirton, A.H.; Woods, E.G. 1976: Blood splashed carcass cutting trials (and cooking trial). In: *Studies relating to blood splash in lambs and sheep*. Hamilton: Meat Industry Research Institute of New Zealand. (MIRINZ Technical Report; **553**) p. 109-114.
- Lambooy, E.; Sybesma, W. 1988: The effect of environmental factors such as pre-slaughter treatment and electrical stunning on the occurrence of haemorrhages in the shoulder of slaughter pigs. *Proceedings 34th International Congress of Meat Science and Technology*, Brisbane, Australia, p. 20-22.
- Minitab, 1995: *Minitab Student*. Edition 9. Addison-Wesley Publishing, Reading, UK.
- MIRINZ. 1974: Blood splash: Appearance, cause, prevention. Hamilton, Meat Industry Research Institute of New Zealand, (MIRINZ Bulletin no 4). 7 p
- Mulley, R.C.; Falepau, D.F. 1999: Ecchymosis – What Causes It? Rural Industries Research and Development Corporation, Canberra, Australia, Publication Number 99/48.p. 1-150.
- Pearson, A.J.; Kilgour, R.; Langen, D.E.; Payne, E. 1977: Hormonal responses of lambs to trucking, handling and electrical stunning. *Proceedings of the New Zealand Society of Animal Production* **37**: 243-248.
- Restall, D.J. 1981: Blood splash in lambs – A preliminary study using the one stage Prothrombin Time Test. *Meat science* **5**: 125-129.
- Smulders, F.J.M.; Eikelenboom, G.; Lambooy, E.; van Logtestijn, J.G. 1989: Electrical stimulation during exsanguination: Effects on the prevalence of blood splash and on sensory quality characteristics in veal. *Meat science* **26**: 89-99.
- Tuckwell, C.; Hubbard, D. 1996: Development of an ecchymosis grading chart for Deer. Rural Industries Research and Development Corporation, Canberra, Australia. Project report DAS-43A.