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The combined effects of grain supplementation and tenderstretching on alpaca (*Vicugna pacos*) meat quality

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ABSTRACT

This study investigated the effects of feeding a mixed grain supplement and tenderstretching (TS) alpaca carcasses on meat quality. A total of 56 castrated 24 month old alpacas were divided into two treatments (pasture-only, and pasture plus supplementation). Supplemented groups were fed a mixed grain ration in addition to ad lib pasture for 10 weeks. Animals were slaughtered across two kill days (n = 28). One half of each carcass was suspended by the pelvis (TS) prior to chilling, and the other half was Achilles tendon hung (AH). After 24 h, muscles were removed and aged for 10 and 25 d. TS significantly increased sarcomere length and reduced shear force and cooking loss in the *m. semimembranosus*. This trend was not observed in other muscles including the *m. longissimus thoracis et lumborum* (LL) and *m. psoas major*. Ageing period resulted in a marginal improvement in LL tenderness. There is clear evidence that TS improves tenderness in the hindquarter of alpacas.

1. Introduction

Pre and post slaughter practices that promote consistent meat quality, particularly tenderness, lead to improved consumer satisfaction (Ferguson et al., 2001; Koohmaraie, 1996; Maltin, Balcerzak, Tilley, & Delday, 2003; Newbold & Harris, 1972). The diet an animal receives can impact upon glycogen reserves at the time of slaughter, influencing post mortem acidification of the muscle and ultimate pH levels (Ferguson et al., 2001; Gardner, McGilchrist, & Pethick, 2014). It is well accepted that pH levels larger than 5.9 in beef lead to dark firm and dry (DFD) meat, which is associated with inconsistent eating quality (EQ), a darker less appealing colour, lower water holding capacity (WHC) and increased shear force (SF) values (Ferguson et al., 2001). Similarly, post slaughter factors can also influence meat quality (Bouton, Fisher, Harris, & Baxter, 1973a; Dransfield, 1994; Newbold & Harris, 1972; Thompson, 2002).

Alpacas managed under Australian grazing conditions are known to produce lean carcases (Smith, Bush, Thomson, & Hopkins, 2015) and so these are prone to meat quality inconsistencies through normal production processes. However, there is an opportunity to manipulate the pre and post slaughter practices to improve alpaca meat quality. Feeding is an area impacting upon glycogen reserves and ultimately meat quality, yet there is limited information on the effect of supplementation (mixed grain) on alpaca meat quality parameters, under Australian grazing conditions. Supplementation in the form of grain is commonly used to complement the existing pasture base with the aim of improving animal performance and meat quality traits. In alpacas, improving fat coverage is of particular interest as they naturally produce lean carcasses. Although this is desirable for dietary intake, it also predisposes alpaca carcasses to cold induced shortening during chilling, resulting in myofibril shortening, increased toughness and lower EQ scores (Smith, Bush, van de Ven, & Hopkins, 2016).

A processing technique that can be used to prevent shortening is carcass suspension through tenderstretching (TS; Bouton, Harris, Shorthose, & Baxter, 1973b; Hopkins, 2014). TS involves hanging the carcass from the pelvic bone (*obturator foramen*) so that the hind quarter falls into a walking like position, increasing tension on the hind leg muscles the and *m. longissimus thoracis et lumborum* (LL) and physically restricting the muscle from contracting and preventing shortening (Hopkins, 2014; Newbold & Harris, 1972). This hanging method has improved tenderness in the hindquarter and LL muscle in beef (Ahnström, Hunt, & Lundström, 2012; Bouton et al., 1973a; Eikelenboom, Barnier, Hoving-Bolink, Smulders, & Culioli, 1998), lamb (Bouton et al., 1973b; Thompson et al., 2005), pork (Bertram & Aaslyng, 2007) and venison (Hutchison, Mulley, Wiklund, Flesch, & Sims, 2014) with some tenderness values similar to two week aged product. Regardless of these benefits, TS is only adopted by a small percentage of processors due to the additional chilling room required, labour to re-hang carcasses and the increased time required to bone and butcher samples due to the 'stretching' of muscles altering the anatomical shape (Ahnström et al., 2012; Bouton et al., 1973b; Ferguson et al., 2001; Newbold & Harris, 1972).

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Given the improvements in meat quality in other species and the lean nature of alpaca carcasses, making them susceptible to shortening, it is proposed that investigations into the pre and post slaughter effects of feeding a mixed grain supplement and TS alpaca carcasses is warranted. Therefore the aims of this study were to investigate the effects of feeding a grain supplement to grazing alpacas and the use of TS post slaughter to determine the effects on meat quality.

2. Materials and methods

2.1. Experimental design

A total of 56 castrated alpaca males, ranging in age from 23 to 25 months, were randomly divided into two treatment groups (pasture-only and mixed grain supplementation (referred to as supplement or supplementation from this point onwards)), with each treatment having four separate replicates (n = 8 paddocks). Each replicate group consisting of 7 animals was randomly allocated to an individual. Pastures were predominantly kikuyu (*Pennisetum clandestinum*) with an average nutritional value of 22% dry matter, 13% crude protein, 9 MJ/kgDM energy and an average biomass of 3298 kgDM/ha, averaged across paddock and experiment length. Supplemented animals were fed the grain ration for a total of 10 weeks. This included a two week introductory period, to the grain feeding, along with an 8 week period of supplementation (calculated at an average of 300 g/animal/day/supplemented paddock). The 300 g ration consisted of 200 g of commercially available mixed grain feed which included whole oats, rolled barley, cracked lupins, cracked corn, black sunflower seeds plus oil and mineral premix (Knowels Stockfeed and Trading Co, Moss Vale, Australia) and 100 g of cracked lupins. The nutritional content of the as fed ration consisted of 20% crude protein, and 12.3 MJ/kgDM of energy. The rations were fed daily on a paddock basis (to each four supplemented replicate groups) to simulate commercial practice. Animals were slaughtered on two separate days (28 animals per kill), a fortnight apart due to meat processing logistics. To account for any variation between kill days both treatments were equally represented on both kill days. Additionally to ensure the same nutritional feeding duration was maintained, the animals slaughtered on kill day two were inducted into the experiment a fortnight later. Animal ethics approval was granted by The University of Sydney Animal Ethics Committee (ethics number 2014/543 and protocol I.D. 543).

2.2. Slaughter procedure and carcass hanging

The animals were slaughtered at a camelid certified abattoir using a conventional captive bolt system as outlined by Smith et al. (2015). Immediately after exsanguination the animals were immobilised (2000 mA peak current at 500 μs pulse interval and 1000 μs pulse width for 10 s) to prevent excess kicking during carcass dressing and ear tags were collected to confirm carcass identity. Carcass dressing out was then conducted using methods described by Smith et al. (2015).

Once dressed, the neck was removed at the junction of the 5th and 6th cervical vertebrae, prior to the carcass being split in half down the vertebral column using a cattle brisket saw. Prior to entering the chillers the right side of each carcass was suspended by the pelvic bone (*obturator foramen*). This resulted in the typical tenderstretch (TS) pose with the carcass hindquarters hanging at 90° in a walking like position. The left side of each carcass remained conventionally hung by the Achilles tendon (AH).

2.3. pH and temperature decline

Once the carcasses entered the chillers, pH and temperature measurements were taken from the right side of each carcass at the caudal end of the *m. longissimus thoracis et lumborum* (LL) over the lumbar-sacral junction and at the caudal end of the *semitendinosus* (ST) muscle. Measurements were taken at hourly intervals when the temperature was approximately 31 °C through to 15 °C and then again at 24 h. The pH was recorded using meters with temperature compensation (WB-80, TPS Pty Ltd., Brisbane, AUS) and a polypropylene spear-type gel electrode (Ionode IJ 44) calibrated using buffers at pH 4 and pH 6.8, at room temperature prior to use. At 24 h the meter was calibrated at chiller temperature (average temperature 3.9 °C and 90.5% humidity).

2.4. Sample preparation

After 24 h in the chillers the required muscles were removed from the carcasses by an experienced alpaca butcher (average boning room temperature 2.9 °C and 89% humidity). Each carcass side was marked at the 12th/13th rib prior to the removal of the LL (HAM 5101). The LL was cut at the 12th/13th rib mark to produce the eye of rack (HAM 5153) and eye of shortloin (HAM 5150).

From the eye of rack (LL) a 5 g sample was taken from the dorsal edge, from both sides of the carcass, for measuring sarcomere length and frozen at −20 °C. The remaining caudal muscle section was cut into two blocks (cranial and medial), vacuum packed, chilled at 4 °C and aged for 10 and 25 days (ageing duration randomly assigned between cranial and medial positions). At day 10 of ageing (average temperature 2.6 °C) the aged block samples were prepared into approximately a 65 g block for subsequent SF testing and a 5 g sample for particle size (PS) analysis and frozen (−20 °C) until analysis. Similarly at day 25, the aged samples were prepared into approximately a 65 g SF block and 5 g PS sample and frozen (−20 °C).

Fresh colour determination was undertaken on the cranial end of the eye of shortloin (LL), on the cut surface of the 12th/13th rib. A sample block was then cut for purge analysis from both sides of each carcass. Samples were weighed, vacuum packed and chilled (average temperature 0.8 °C and 81% humidity). After 10 days of ageing, the samples were opened, padded dry with paper towel, and re-weighed for purge loss (%) determination. On the left side of each carcass a 5 cm thick retail colour block was taken from the cranial end of the LL for measurement of colour under simulated retail display for 3 days. This sample was vacuum packed and chilled for 5 days (average temperature 1.1 °C and 80% humidity). After retail display the sample was diced and placed into a tube and frozen until analysed for lipid oxidation.

The *m. psoas major* (tenderloin; HAM 5080), and hindquarter muscles (*m. semimembranosus* (SM; HAM 5077); and *m. adductor femoris* (AF)) were removed from both sides of each carcass. The ST muscle was only removed from the right side of each carcass. Each individual muscle was trimmed of any subcutaneous fat and/or epimysium. A 5 g sarcomere length sample was taken from the dorsal edge of the SM muscles, and the caudal end of the TL, and frozen (−20 °C). The remaining portion of each individual tenderloin and SM muscle, and the whole AF and ST muscles, were then vacuum packed and chilled (average temperature 0.8 °C and 81% humidity) for 10 days (with the exception of the AF that was chilled for 5 days). After 5 days a retail display block was prepared from the AF muscle and the remaining muscle sample was re packaged and chilled until day 10. At day 10 a 65 g shear force block and 5 g PS block were collected from the tenderloin and SM muscles and frozen (−20 °C). The chilled AF, ST, and remaining tenderloin and SM samples were also frozen (−20 °C) until ultimate pH analysis.

2.5. Meat quality analysis

2.5.1. Ultimate pH analysis

After 10 days of ageing a 2 g sample was cut from the right side of the LL, AF, SM, ST, and TL muscles, and frozen (−20 °C) until analysis for ultimate pH (pHu). At the time of analysis samples were homogenised and measured using methods outlined by Dransfield, Etherington, and Taylor (1992) using a pH and temperature meter (WP-80, TPS Pty Ltd., Brisbane, Australia) and calibrated using buffers at pH 4 and pH 6.8 at room temperature prior to use.