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Effect of pre-slaughter handling on lamb welfare and meat quality

By

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Background

- Exposure to stress is unavoidable during the pre-slaughter period
  - Transportation, loading , offloading, novel environment, fasting, mixing and handling at the abattoir (Grandin, 2012) e.g improper stunning
- Response to stress differs based on:
  - Intensity, duration and individual susceptibility of the animal to the stressor e.g species, sex and breed (Stempa *et al*., 2016)
- Pre-slaughter stress is closely related to meat quality (Lui *et al.*, 2018)

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Problem Statement

- **Muscle Glycogen**

Weather

Exercise

Mixing of unfamiliar animals

Transportation /handling stress

Water deprivation

Normal meat

DFD meat

- ↑ pHu (5.8-6.0)
- ↑ WHC
- ↑ Microbial spoilage
- Dark colour
- ↓ Tenderness

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Objective and hypothesis

- **Main objective:**
  - To determine the effect of pre-slaughter handling on lamb welfare and meat quality of Merino lambs exposed to different pre-slaughter handling conditions
  - **Null hypothesis**
  - Pre-slaughter handling does not have an effect on lamb welfare and meat quality of Merino lambs

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Materials and Methods

- **Data collection: Ethical considerations** (Certificate number: MUC371SSTE01)
  - 100 eight-month-old female Merino lambs
  - The lambs were transported from the farm to the abattoir over different distances (195.5 km and 288.5 km)
  - On arrival at the abattoir, the lambs were placed at the lairages for different durations; one group was lairised for 8 hours and the other for 12 hours
  - At the lairages, the lambs were given ad-libitum access to water and feed was withdrawn.
  - Humanely slaughtered at a commercial abattoir (Meat safety Act, No. 40 of 2000)

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Materials and Methods

- **Data collection: Ethical considerations** (Certificate number: MUC371SSTE01)
  - Exsanguination blood was collected using 10.0 ml disposable Becton Dickinson vacutainer tubesanticoagulant an (Ethylenediaminetetraacetic acid; EDTA)
    - Creatine kinase and Lactate dehydrogenase
  - Blood tubes were centrifuged (Model 5403 Centrifuge, Gatenbay Eppendorf GmbH, Engelsdorp, Germany) at 21°C for 1000 g for 15 minutes
  - Plasma was transferred into pre-chilled sterile 15 ml Eppendorf tubes and stored at -80°C until analysis.

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- **Plasma samples analysis:**
  - The samples of stored plasma were analysed for CK and LDH using a Model DXC 600 machine (Beckman Coulter, Ireland) with reactive ingredients for SYCHRON Systems (CK 2 x 200 and LD-P 2 x 200)
  - All the ingredients added for quantitative determination of CK and LDH activities of units per litre (U/L) in plasma.

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Data collection:

- Carcass ultimate pH and meat temperature were measured on the right side of each carcass by inserting the piercing probe in the *longissimus* muscle between the 12th and 13th ribs at 45 minutes and 24 hours post-mortem
- Portable pH meter (Hach HQ11d) calibrated in buffers with pH 4.00 and 7.00
- Carcass measurements:
  - warm carcass weight
  - cold carcass weight
  - carcass fatness

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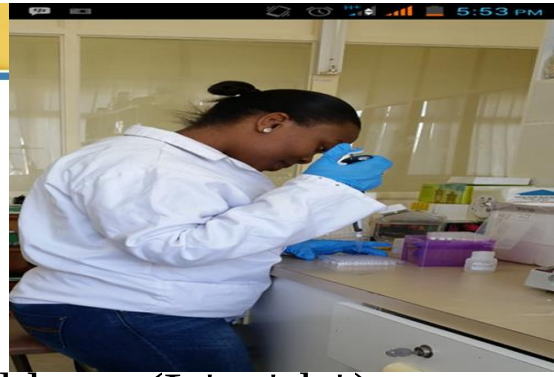

Meat sample harvesting:

- 100 samples (~250 grams & 100 mm thick) were harvested from the *Muscularis longissimus thoracis et lumborum* (LTL) each carcass for meat quality measurements

Meat colour measurements:

- Samples were further processed from 100 mm thick into 20 mm steaks using a band saw (CIE,1979)
- Exposed to air for 30 minutes to facilitate 'blooming'
- Colour variables (L*,a*,b*) were measured using a BYK-Gardner 6692 Colour-guide 45/0 glass sealed, with a 20 mm diameter measurement area and illuminant D65-daylight, 10° observation angle
  - Hue angle = $[\tan^{-1}(b^*) / (a^*)]$
  - Chroma = $(a^2 + b^2)^{0.5}$

(Wyszcecki and Stiles, 1982; Minolta, 1993)

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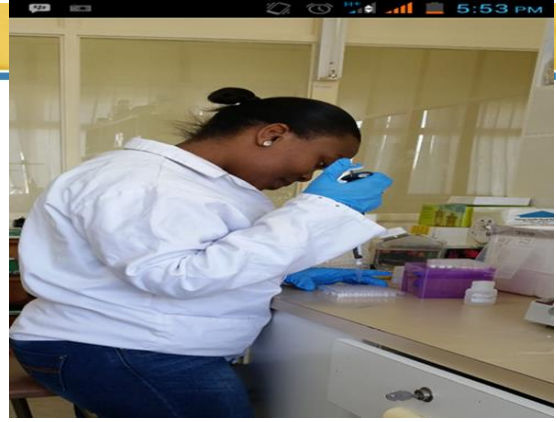

Thawing and cooking loss measurements:

- At day seven the frozen samples were weighed (Nimbus Precision Balance NBL 214i) and allowed to thaw for 10 hours at room temperature, after thawing the samples were reweighed

$$TL\% = \frac{\text{weight from freezer}}{\text{weight before cooking}} \times 100$$

- Samples were cooked in a waterbath (Pura 30) for 45 minutes to a final internal temperature of 72 °C (AMSA, 1995)

$$CL\% = \frac{\text{Wt before cooking} - \text{Wt after cooking}}{\text{Wt before cooking}} \times 100$$

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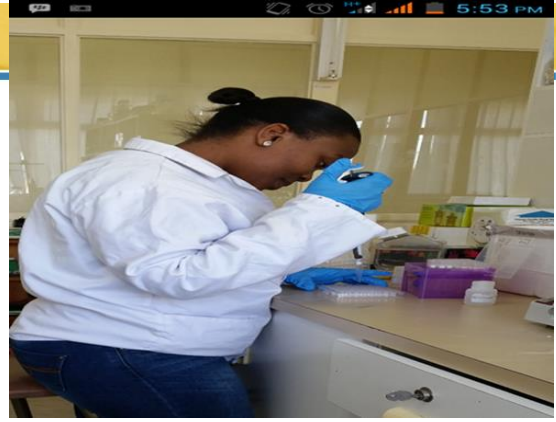

Warner–Bratzler Shear Force measurements:

- From each sample, three subsamples of approximately 12.7 mm core diameter were extracted parallel to the long axis of the muscle fibres (AMSA, 1995)
- Each core was sheared once through the centre at an angle perpendicular to the direction of the fibre using the Warner-Bratzler shear device attached to the Universal Instron apparatus (Model 3344, crosshead speed = 400 mm/min)
- WBSF was measured as the peak force (Newtons) average for three cores per sample

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Statistical analysis

- Statistical analysis was carried out using the Statistical Analysis System (SAS, version 9.0)
- The effect of transportation distance, lairage duration, on CK, LDH, carcass characteristics and technological meat quality attributes using the GLM procedures of SAS (2009)
- Differences between least-square means were compared using the PDIFF procedure of SAS (2000)

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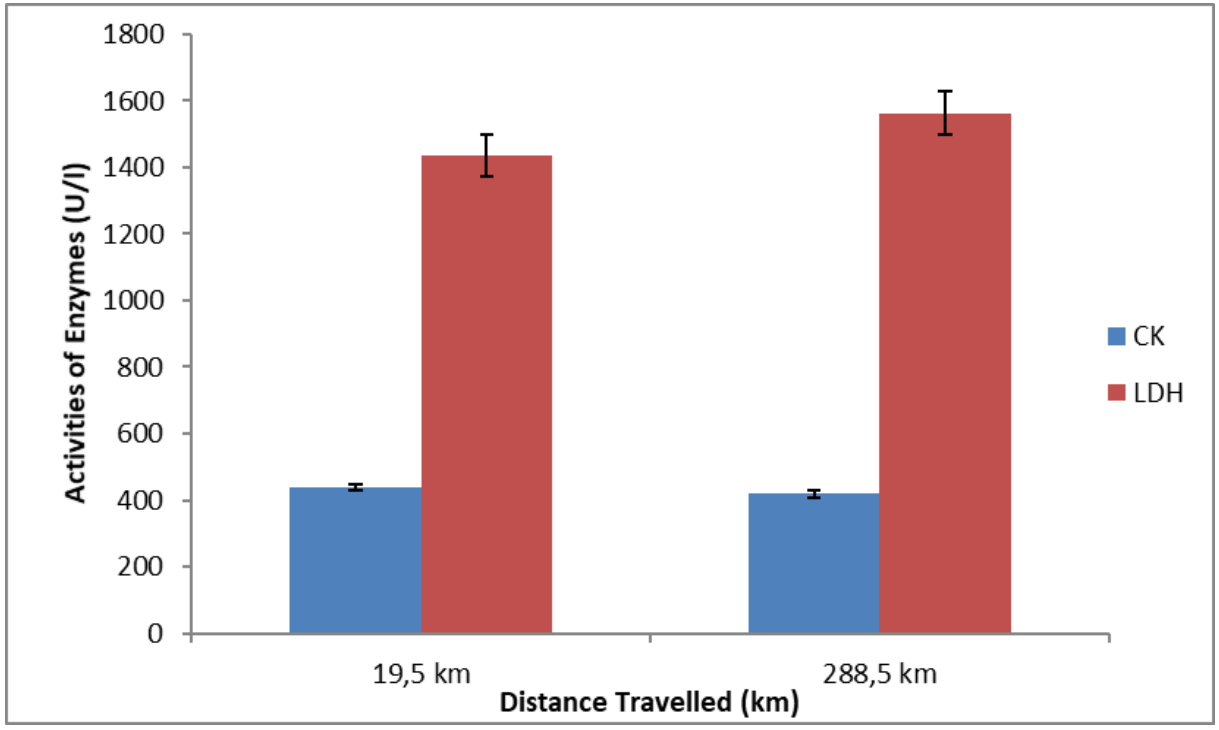
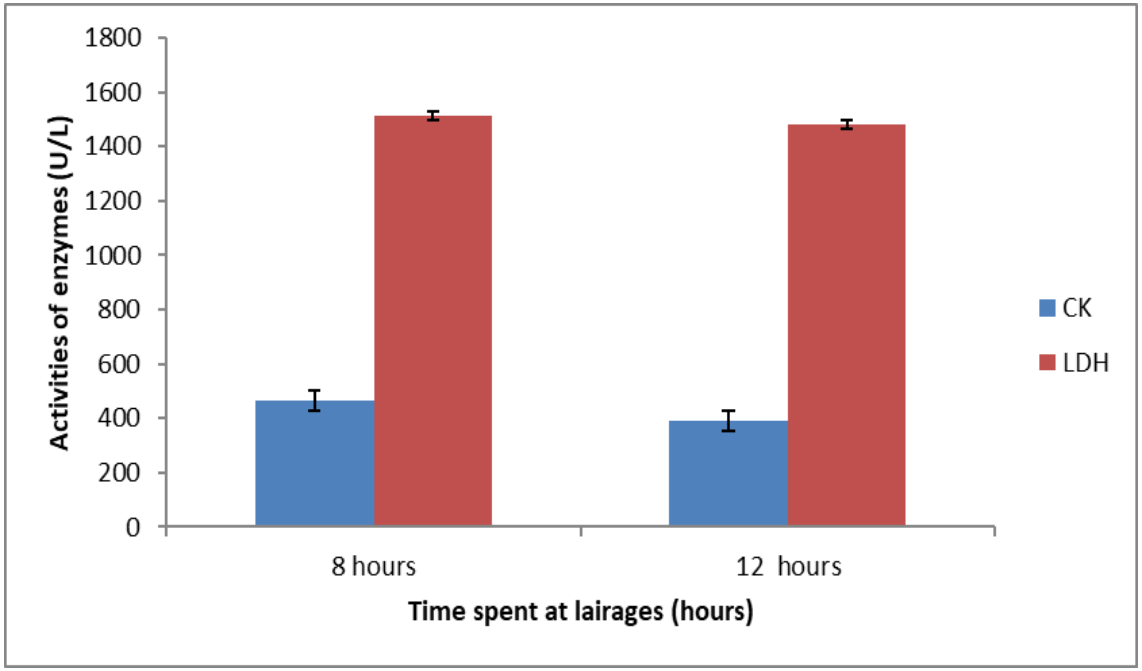
Statistical analysis

- The statistical model used was:
- $Yijl = \mu + \alpha i + \beta j + (\alpha\beta)ij + \varepsilon ijk$
- where: Yijk = response variable (CK, LDH, WCW, CCW, pHu, Tm24hours, L*,a*,b*,C*,H*,CL, TL,WBSF); μ = overall mean; αi = ith effect of distance travelled (195.5 km and 288.5 km); βj = jth effect of lairage duration (8 and 12 hours); $(\alpha\beta)ij$ = interaction between distance travelled and lairage duration; εijk = Random error



CK – Creatine kinase, LDH – Lactate dehydrogenase, U/l– Units per litre, km – kilometre

Figure 1: The relationship between distance travelled and the activities of creatine kinase and lactate dehydrogenase



CK – Creatine kinase, LDH – Lactate dehydrogenase, U/l– Units per litre

Figure 2: The relationship between lairage duration and the activities of creatine kinase and lactate dehydrogenase

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Table 1: Transportation distance and lairage duration on carcass and lamb technological attributes from the *Muscularis longmissius thoracis et lumborum*

Parameters	Transportation distance		Lairage duration		*P*-value		
	19.5 km	288.5 km	8 hours	12 hours	Distance	Lairage	D*L
WCW(kg)	20.10±0.320	20.08±0.325	20.09±0.334	20.09±0.311	0.9764	0.9851	0.6216
CCW(kg)	19.48±0.313	19.42±0.318	19.42±0.326	19.48±0.304	0.8838	0.8798	0.5731
CF (mm)	2.10± 0.069	2.13± 0.070	2.06± 0.072	2.17± 0.067	0.7892	0.2836	0.9945
pH_u	6.03± 0.144	6.19± 0.146	6.22±0.150	6.00± 0.140	0.4449	0.2999	0.2509
$T_{m24hours}$	16.05±0.193	15.84±0.196	16.08±0.201	15.81±0.187	0.4539	0.3306	0.0043**
L*	38.48±0.485	38.67±0.493	38.93±0.507	38.22±0.472	0.7799	0.3080	0.7691
a *	14.86±0.295	15.20±0.300	15.07±0.308	15.00±0.287	0.4215	0.8574	0.8634
b *	6.75± 0.394	7.20± 0.310	7.32± 0.411	6.64± 0.382	0.4287	0.2270	0.5203
C*	16.48±0.392	16.94±0.398	16.92±0.41	16.50±0.38	0.4138	0.4583	0.7601
H*	0.41± 0.018	0.44± 0.018	0.44± 0.018	0.41± 0.017	0.2717	0.2445	0.2329
TL (%)	11.12±0.805	15.17^{b}±0.819	12.84±0.841	13.45±0.783	0.0006***	0.5985	0.1478
CL (%)	27.33±1.241	28.42±1.262	25.12±1.210	30.62±1.207	0.5378	0.0025**	0.0333*
WBSF (N)	32.43±1.172	35.87±1.191	33.61±1.223	34.69±1.139	0.0422*	0.5204	0.9469

Significant differences at P< 0.05*, P< 0.01**, P< 0.001***,WCW= warm carcass weight, CCW = cold carcass weight, CF-carcass fatness, pH_u= ultimate pH, $T_{m24hours}$= meat temperature 24 hours post slaughter, L* = Lightness, a*= redness, b*= yellowness, C*= Chroma, H*= Hue angle and WBSF= Warner Braztler shear force

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Conclusion

- The results indicate that longer transportation and lairage durations made the lambs more susceptible to pre-slaughter stress and negatively affected the meat quality

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