Chilling and electrical stimulation of beef carcasses

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Effects of chilling and electrical stimulation on carcass and meat quality attributes of selected breeds of cattle with different carcass weights

Industry Sector: Cattle And Small Stock

Research Focus Area: Animal Products, Quality And Value-Adding

Research Institute: University Of Pretoria

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The Research Team

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Aims Of The Project

- To compile a comprehensive literature review on current chilling and electrical stimulation guidelines
- To compare chilling and electrical stimulation of selected cattle breeds of different carcass weights and to evaluate the effects of different chilling regimes and different stimulation procedures on carcass and meat quality attributes
- To make recommendations to the meat industry on acceptable ways of chilling and stimulating carcasses in order to obtain the best quality carcasses and meat

Executive Summary

This research focused on acceptable ways of chilling and electrically stimulating beef carcasses in order to obtain the best quality meat, given the current use of growth enhancing molecules (beta-adrenergic agonists) and the current increase in carcasses size to curve the negative impact of escalating maize prices on the economics of intensive feed of beef cattle.

The literature survey suggest that low voltage electrical stimulation (LVES) is safer and more practical in South African abattoirs compared to high voltage electrical stimulation (HVES). The current research indicates that low voltage electrical stimulation has beneficial effects on meat quality of beef carcasses. Furthermore, early post mortem LVES is more beneficial compared to LVES after evisceration in terms of most meat quality attributes. Shorter duration LVES (30 sec.) was more beneficial compared to long duration LVES (60 sec.). Current chilling regimes of larger carcasses demonstrate that the effects of beta-agonist treatment on beef tenderness becomes negligible with increasing carcass size, provided that such carcasses are electrically stimulated early post mortem. Optimum carcass stimulation and chilling regimes were proposed for commercial beef abattoirs in South Africa.

OUTPUTS

Scientific publications (ISI peer reviewed)

1. Agbeniga, B. & Webb, E.C. (2018). Influence of carcass weight on meat quality of commercial feedlot steers with similar feedlot, slaughter and post-mortem management, *Food Research International*, 105,793-800. (IF=3,086)
2. Agbeniga, B. & Webb, E.C. (2018). Effects of timing and duration of low voltage electrical stimulation on selected meat quality characteristics of light and heavy bovine carcasses, *Animal Production Science, (Accepted with minor changes)*.

Scientific conferences

1. B. Agbeniga, E.C. Webb, P.E. Strydom & L Frylinck, 2016. Effects of low voltage electrical stimulation and carcass size on meat tenderness and drip loss of beef carcasses treated with Zilmax®, 49th SASAS Congress, Cape Town, (Oral presentation).
2. B. Agbeniga & E.C. Webb, 2015. Effects of duration of electrical stimulation and carcass weight on carcass pH, temperature profile and shear force of Zilmax treated beef carcasses, 48th SASAS congress, Zululand, (Oral Presentation).

Industry lectures

1. Webb, E.C. (2016) Growth enhancers, residues and beef quality, Red Meat Abattoir Association Conference, Spier, Western Cape,
2. Webb, E.C. (2016) Abattoir management and carcass and beef quality, Devon abattoir workshop, Protea Hotel, 22 July 2016.
3. Webb, E.C. (2015). Factors that affect beef carcass and meat quality, North West RPO Koopmansfontein, October 2015.
8. Webb, E.C. (2015).Growth efficiency in feedlot cattle, Cattleman's conference, South African Feedlot Association, March, Kiewietskroon.

Popular Article

Interactions between early and delayed electrical stimulation and carcass size on pH, temperature decline and instrumental shear force of meat samples from Zilmax treated cattle

Introduction

The time of application and duration of electrical stimulation (ES) on light and heavy carcasses from Zilmax treated animals, poses new challenges in the meat processing industry in South Africa. Owing to the use of Zilmax, larger carcasses are now being processed at abattoirs that were built to accommodate smaller carcasses. This poses new challenges in terms of optimization of conversion of muscle to meat using ES and appropriate chilling regime. In this study, the effects of early or delayed low voltage electrical stimulation (LVES) (110V) applied to light and heavy carcasses of Zilmax treated cattle were evaluated for pH and temperature decline, and the resultant effects on instrumental shear force. One hundred and forty-nine Zilmax treated cattle (mainly steers) were assigned to 10 different treatment groups according to the combination of their carcass weight (≤ 130 or ≥ 145kg side), time of stimulation (early stimulation-3 min post mortem [p.m.] or late stimulation-45 min p.m.), and the duration of stimulation (30 or 60 sec). Analysis revealed significantly ($p < 0.05$) faster pH decline and the lowest pH in carcasses stimulated before evisceration, at all times of measurement compared to carcasses stimulated late or non-stimulated controls. The time of ES application exerted the greatest influence on the pH profile while duration of stimulation showed minor influence. Heavy carcasses in the early stimulated groups had the lowest rigor- and ultimate pH. Regarding temperature decline, heavy carcasses had the slowest decline ($p < 0.05$) and the highest carcass temperatures at all times from 45 min to 24 hr p.m. Time of ES application and duration of ES did not affect carcass temperature. In terms of shear force, carcasses stimulated at 3 min p.m. had the lowest ($p < 0.05$) shear force at 3 and 14 days p.m. compared to carcasses stimulated at 45 min p.m. and controls respectively. Heavy carcass groups, stimulated early, with the lowest rigor and pH_u, had the lowest shear force at 3 and 14 days p.m.

Effects of electrical stimulation and chilling on beef quality

Results of our recent study indicates that the time of application of electrical stimulation has an important influence on carcass pH and temperature profile, and in combination with carcass weight, has a large influence on the tenderness of beef. LVES provides a practical way to manipulate glycolysis in order to improve beef tenderness, but it appears that this treatment should be applied early post mortem in ordser to be efficient. Although there has been some suggestions to apply LVES later, the present results show that early post mortem application of LVES produced the lowest shear force, mainly due faster pH decline in combination with high initial carcass temperature.

Previous research suggested that at high muscle temperature combined with low pH, heat shortening may occur, leading to lower beef tenderness. Our results indicate that LVES treatment early post mortem passed through the heat shortening window (above 35°C) within 2 hr p.m. when the pH was less than 6. This finding clearly demonstrates that the proteolytic activity was not exhausted by the low pH and elevated initial temperature in the early stimulated carcasses.

Carcass weight also played a part in improving tenderness in the early stimulated carcasses. In addition, Zilmax is known to reduce tenderness in meat but the application of ES could improve tenderness by the early activation of the calpain system. It is important to note that ES-treatment improve but do not completely overcome the negative effects of Zilmax on tenderness. In this study, we found that the combination of early ES and carcass weight significantly lowered the shear force in the heavy carcass groups. Research by Webb and Morris on Zilmax treated cattle also show that heavier carcasses from zilmax treated cattle produced more tender meat.

On the other hand, carcasses stimulated late and the controls had slower pH decline at all times of measurement, which was also reflected in lower tenderness scores at both day 3 and 14 post mortem.

Results on the duration of electrical stimulation indicates that 30 seconds or less (15 seconds) provide most beneficial results, which agrees with a number of other international studies.

Conclusion

It is concluded that the application of low voltage electrical stimulation early p.m (3 min p.m) brought about a significantly ($p < 0.05$) lower shear force in carcasses from Zilmax treated cattle compared to the ones stimulated late (45 min p.m) and the un-stimulated controls. Heavy carcasses ($\geq$ 145kg) from the early stimulated groups had the lowest shear force values at 3 and 14 days p.m despite passing through the heat shortening window, which was due to lower initial pH and higher initial muscle temperature. More proteolytic activity in the heavy carcass groups was suspected to have contributed to the low shear force values and although, slightly higher (at 5.6 and 5.9 kg) when considering a threshold of 4.9 (Shorthose et al., 1986). It is acceptable, considering the fact that the animals were treated with Zilmax which is known to reduce tenderness.

Please contact the Primary Researcher if you need a copy of the comprehensive report of this project – Prof Edward Webb on edward.webb@up.ac.za