

# Electrical stimulation and carcass size: Interactions between pH, temperature decline and instrumental shear force

**T**he time of application and duration of electrical stimulation (ES) on light and heavy carcasses of Zilmax treated animals poses new challenges in the meat processing industry in South Africa. Owing to the use of Zilmax, larger carcasses are now processed at abattoirs that were built to accommodate smaller carcasses. This creates challenges in terms of optimising muscle to meat conversion using ES and the appropriate chilling regime.

In our 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 for the resultant effects on instrumental shear force.

Zilmax treated cattle (149 animals, mainly steers) were assigned to ten different treatment groups according to the combination of their carcass weight ( $\leq 130\text{kg}$  or  $\geq 145\text{kg}$ ), time of stimulation (early stimulation three minutes *post mortem* [pm] or late stimulation 45 minutes pm), and duration of stimulation (30 or 60 seconds).

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 pH.

Regarding temperature decline, heavy carcasses had the slowest decline ( $p < 0,05$ ) and the highest carcass temperatures at all times from 45 minutes to 24 hours pm. Time of ES application and duration of ES did not affect carcass temperature.

In terms of shear force, carcasses stimulated at three minutes pm had the lowest ( $p < 0,05$ ) shear force at three and 14 days pm, compared to carcasses stimulated at 45 minutes pm, and controls. Heavy carcass groups, stimulated early, with the lowest rigor and pH, had the lowest shear force at three and 14 days pm.

## Effects of ES and chilling

Results indicate that the time of application of ES has an important influence on carcass pH and temperature profile and, combined with carcass weight, has a large influence on the tenderness of beef.

LVES provides a practical way to manipulate glycolysis to improve beef tenderness, but it appears that this treatment should be applied early pm to be efficient. Although the later application of LVES has been suggested, the present results show that early pm application of LVES produced the lowest shear force, mainly due to faster pH decline combined with high initial carcass temperature. Previous research suggested that heat shortening may occur at high muscle temperature combined with low pH, leading to lower beef tenderness.

Our results indicate that LVES treatment early pm passed through the heat shortening window (above  $350^{\circ}\text{C}$ ) within two hours pm, when the pH was less than six. This finding clearly demonstrates that 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 improves but does 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 shows that heavier carcasses of Zilmax treated cattle produced more tender meat. On the other hand, carcasses stimulated late, as well as the controls, had slower pH decline at all times of measurement, which was reflected in lower tenderness scores at both three and 14 days pm.

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

## In conclusion

The early application of LVES (three minutes pm) brought about a significantly lower ( $p < 0,05$ ) shear force in the carcasses of Zilmax treated cattle, compared to carcasses stimulated late (45 minutes pm) and the non-stimulated controls.

Heavy carcasses ( $\geq 145\text{kg}$ ) from the early stimulated groups had the lowest shear force values at three and 14 days pm, 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, although slightly higher (at 5,6 and 5,9kg) when considering a threshold of 4,9 (Shorthose *et al.*, 1986). This is acceptable, considering the animals were treated with Zilmax, which is known to reduce tenderness. ❖

For enquiries, contact Prof Edward C Webb at [edward.webb@up.ac.za](mailto:edward.webb@up.ac.za).  
This research was funded by RMRD SA.

