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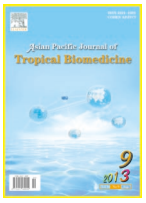

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Effects of high voltage electrical stimulation on the rate of pH decline, meat quality and color stability in chilled beef carcasses

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PEER REVIEW

Peer reviewer

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Comments

This is a good study in which the authors have done on meat pH decline which produced in the abattoir from the biggest meat production country Brazil. In the present study, better results (800 V, 25 seconds) were obtained in the muscles with lower electricity usage.
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ABSTRACT

Objective: To determine the effects of high voltage electrical stimulation (HVES, 800 Voltage) on rapid decreases in pH values and improvements in meat quality.
Methods: A total of 50 beef carcasses were applied, divided into two groups, one as a control and another for HVES. Meat quality was evaluated based on *M. longissimus dorsi* by examining pH and temperature levels at 1, 2, 5, 10 and 24 h, while color stability was examined seven days after slaughter.
Results: HVES decreased the pH values of the meat and accelerated rigor mortis ($P<0.05$). HVES caused differences in instrumental color values compared with the control groups across the ageing period at 4 °C.
Conclusion: the HVES had positive effects on meat quality and color stability, in contrast to undesirable consumer preferences.

KEYWORDS
Beef, Electrical stimulation, High voltage, pH

1. Introduction

Today, Brazil is one of the largest beef producers in the world. There are many livestock farms in Brazil, comprised of millions of cattle. The beef produced in Brazil is used both within the country and around the world[1].

In the meat production process, a great numbers of factors may affect meat quality. Characteristics such as color and taste directly affect consumers' preferences. These factors can be improved by various chemical and physical methods. One such application is high-voltage electrical stimulation (HVES), which is applied to beef carcasses immediately after slaughter. In commercial beef abattoirs, pre-rigor rapid chilling of beef carcasses has been widely used to improve the microbiological condition and decrease evaporative loss through rapid lowering the surface temperature to around 2 °C. According to Locker and Hagyard (1963), lowering the carcass temperature below 10 °C sooner than 10 h postmortem will cause cold shortening. It is critical to avoid cold shortening, so electrical stimulation has been proven as one of the effective methods to prevent the toughening

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effect of cold shortening[2-6].

Notwithstanding, electrical stimulation can cause a decline in postmortem pH (accelerating the rate of glycolysis). For electrical stimulation usage, voltage is the major parameter of electric current. For the operators' safety, low-voltage electrical stimulation (LVES) (voltage<100 V) is frequently used in many countries instead of high-voltage electrical stimulation (voltage>100 V). However, LVES has been reported to be less effective for meat quality when compared to HVES[6,7].

The objective of the present study is to determine the effects of HVES combined with pre-rigor rapid chilling on the measurements of carcass pH, temperature, weight decline postmortem and beef quality.

2. Materials and methods

2.1. Animals

Fifty Holstein bred bulls (approximately 18 month old, live, weight, 500±30 kg), fed on green pasture grass were transported to Promissao Commercial Modern Beef Abattoir, Brazil. After fasting for 12 h, with only water available to them, the animals were randomly distributed into two treatment groups (n=25). All bulls were killed on the same day and all of them were stunned using a captive bolt before exsanguination. In the first group, as a control, carcasses were conventionally chilled (air temperature 1 °C and humidity above 95%) without electrical stimulation. Carcasses in the second group were electrically stimulated for 25 seconds immediately after bleeding, using the high voltage timulator (voltage 800 V and current 2.5 A) and conventionally chilled. After chilling the carcass weight was recorded.

2.2. Carcass pH, temperature and meat quality measurements

The pH and temperature of the carcass were monitored using a portable pH meter and thermometer needle-tipped (GPRT1400AN Digital pH / mV / Thermometer, Greisinger®, Australia). These measurements were recorded at about 1 h (*i.e.* before loading into the chiller) and then 2, 5, 10 and 24 h postmortem. For each measurement, the pH probe and the thermometer were inserted into the carcasses at a similar depth and location (specify depth 4 mm, *M. longissimus* muscle). Meat quality measurements were assessed on the back (*M. longissimus*) and thigh (*M. semimembranosus*) muscles. At 24 h postmortem, the muscles were removed and vacuum packaged then held in the same cold room (10-15 °C) and were stored for 7 d prior to the evaluating the color. A nine-member trained sensory panel scored the color and wetness acceptability on the basis of the ten point hedonic rating scales[8].

2.3. Statistical analyses

The effects of HVES and pre-rigor rapid chilling on the rate of change of the carcass pH, temperature decline and evaporative loss were evaluated by One-way analysis of the variance technique where carcass pH, temperature decline and evaporative loss were used as dependent variables and variables of treatment group as an independent variable. Different treatment groups were compared using the Duncan's multiple-range test, at the significance level of 0.05. All statistical analyses were performed by SAS9.2 (SAS Institute Cary, North Carolina, 2010).

3. Results

Compared with the meat control group (Figures 1, 2), HVES effectively reduces the post-mortem pH and temperature values of beef carcass (P<0.05). Differences between the results of the groups at 0, 3, 5, 10 and 24 h were statistically significant (P<0.05).

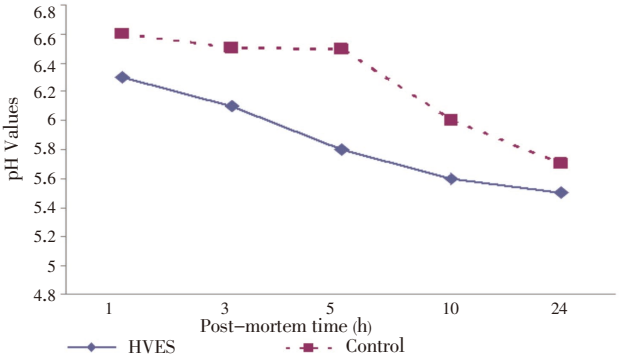

Figure 1. pH decline of beef carcasses within two groups.

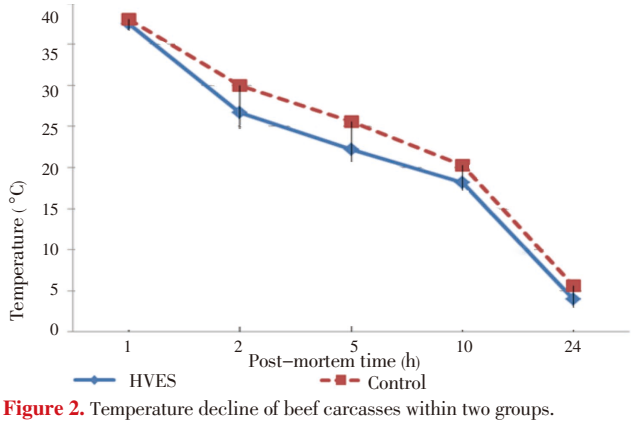

Figure 2. Temperature decline of beef carcasses within two groups.

4. Discussion

Similarly, many studies report that electrical stimulation accelerates glycolysis and causes a rapid pH decrease[9-11]. Morton *et al.* applied HVES (1130 V, 1.8-2 A) for 90 seconds to sheep carcasses[12]. In the present study too, better results (800 V, 25 seconds) were obtained in the muscles with lower electricity usage.

In another study conducted by Taylor and Martoccia (1995) on pork meat, HVES caused a 0.3 unit decrease in pH at 45 min of post-mortem[13].

Studies on bovine and buffalo muscle extensibility indicated that rigor mortis occurs at pH 5.9[14]. Applying these criteria to our study on beef muscle, we found that this rigor mortis occurs after 5 h. There is no report in literature on Brazil Holsteins meat HVES and the present results are comparable to the majority of those obtained for bovine, buffalo, deer and ovine carcasses[11,15-19].

In this study, HVES-applied carcasses were tenderer and characterized by greater stability in colour than the control group at the 7 d post-slaughter period. These findings were similar to those of other studies on cattle carcasses[6,18,20,21].

Results show that colour stability in the HVES group on the 7th day was a better red colour than in the control group. These findings show similarity with the report of Eikelenboom *et al.* (1999) and Cetin and Topcu (2009) founds improvement in meats[20,22]. In another study that conducted with McKenna *et al.* (2003), King *et al.* (2004) and Ledward *et al.* (1986) have found no differences between the ES and control group[23-25].

HVES appeared to increase the evaporative loss of conventionally chilled carcasses significantly were 0.38% more than control group ($P<0.05$). Gigiel and James (1984) reported the weight loss from chilled pork meat was 1% less than control group[26]. Janz *et al.* (2001) also reported that evaporative losses significantly greater than control group[7]. But McGeehin *et al.*(2002) reported that the evaporative losses for lamb carcasses did no differ from control group[27,28].

High voltage electrical stimulation is one of the post-slaughter methods used for increasing the meat quality. An obvious pH decrease and improvement in color and tenderness can occur in beef meat by applying HVES. It is concluded that the HVES is a useful tool in the solution of cold-shortening problem of meat and obtaining high quality meat.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

The methods for improving the meat quality and fast decreasing the meat pH is a goal that every author research for , so the research for decreasing the meat pH is necessary.

Research frontiers

Studies are being performed in order to determine the effective method for commercial abattoirs and improve the meat quality, Brazil.

Related reports

Electrical method description for Holsteins bull has never been reported before.

Innovations and breakthroughs

The results of the present study revealed that with 800 voltage could reach the best pH decline in right time and achieve the best quality.

Applications

Currently the meat storage and quality decreasing are problems if the pH decline is not fast enough before chilling. It is very interesting to know if there is an approach to keep the quality of the meat before chilling.

Peer review

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study, better results (800 V, 25 seconds) were obtained in the muscles with lower electricity usage.

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