Effects of glycerin supplementation on meat pH of young Holstein bulls mixed at the slaughterhouse

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Abstract

The aim of this study was to evaluate the effects of dietary glycerin supplementation on ultimate meat pH of bulls mixed during 3 h before slaughter. Forty-eight young Holstein bulls (464 ± 40 kg final BW) were randomly assigned to 1 of 4 concentrates containing 4 glycerin (86% glycerol) levels (0, 4, 8, and 12% of concentrate DM). Concentrate and straw were offered ad libitum. After 91 days, animals were randomly mixed at the slaughterhouse, in groups of 16 animals (n = 4 per treatment) with 0.80 animals per m^2, for 3 h before slaughter. Ultimate meat pH was measured at Longissimus Thoracis (LT) 24 h post-mortem. Average incidence of ultimate meat pH above 6.0 was 33, 58, 75 and 58 ± 3.1% for 0, 4, 8 and 12% glycerin level, respectively. In addition, glycerol supplementation did not affect ultimate meat pH (5.88, 6.17, 6.22, and 6.04 ± 0.140 for 0, 4, 8 and 12% glycerin level, respectively). Therefore, concentrate glycerin supplementation at levels up to 12% concentrate does not seem a plausible strategy to prevent a high ultimate meat pH of young Holstein bulls.

Introduction

Beef ultimate meat pH above 6.0 represents a meat quality problem, and is undesirable for human consumption (Viljoen et al., 2002), causing important industry economic losses. Main problems of beef ultimate meat pH above 6.0 are the dark red color (Mounier et al., 2006), tenderness variation (Silva et al., 1999), increased water holding capacity (Apple et al., 2005), poor palatability (Viljoen et al., 2002), and growth of microorganisms to unacceptable levels (Knöchel et al., 2007). Beef ultimate meat pH greater than 5.5 is the result of pre-slaughter glycogen depletion, and the consequent inability of muscle to accumulate adequate lactic acid concentration (Kannan et al., 2002). The glycogen depletion depends on physical exhaustion and psychological pre-slaughter stress of cattle (Mounier et al., 2006). Various stress factors have been reported as responsible for glycogen depletion, however, the most potent stressor producing high ultimate meat pH is that of mixing unfamiliar cattle together (Warris, 1990).

Recently, Parker et al. (2007) suggested that glycerin orally administrated to steers (2g/kg BW) 24 h before slaughter could help to reduce the incidence of meat pH above 6.0. Glycerin (rich in glycerol) is a by-product from the biodiesel industry (Dasari et al., 2005), which could be use as gluconeogenic substrate for ruminants (Chung et al., 2007). Glycerol can be converted to glucose in the liver of cattle and provide energy for cellular metabolism (Goff and Horst, 2003). However, there is a lack of information concerning the effect of the glycerin supplementation, as an energetic feed ingredient, for attenuating the effects of pre-slaughter management on beef ultimate meat pH. Thus, the aim of this study was to determine the effects of feeding different concentrate glycerin levels on ultimate meat pH of Holstein bulls submitted to a pre-slaughter stress, like mixing unfamiliar bulls, during 3 h before slaughter.

Materials and methods

Forty-eight Holstein bulls were used in a complete randomized design, and distributed in 48 individual pens (1.5 x 3 m). Bulls were randomly assigned to one of four concentrates containing: no glycerin (NG), a low dose (LG) of 4% glycerin, a medium dose (MG) of 8% glycerin, and a high dose (HG) of 12% glycerin on a DM basis. The glycerin was produced in a soy-diesel facility (Loiret and Haentjens, Barcelona, Spain) and contained 85.7% glycerol, 8.6% water, 5.5% salt, and 0.09% methanol. Bulls were fed concentrate and barley straw ad libitum, until 91 d of experiment.

Bulls were transported to the same commercial slaughterhouse after 91 d of study with a final BW of 460 ± 10.9 kg. Truck stocking density was 0.8 ± 0.23 animals per m^2, and transport distance was less than 1 km. Mountings were prevented in the truck by the low height of the compartments. Bulls arriving at the slaughterhouse were led through a corridor to 3 different pens, forming groups of 16 bulls (4 animals from each treatment) with 0.80 animals per m^2, for approximately 3 h before slaughter. Bulls were not fed at the slaughterhouse, but bulls did receive water ad libitum. Immediately following slaughter, HCW was recorded,

and carcass degree of finishing and conformation were graded according to the EU classification system into 1.2.3.4.5 (EU Regulation nº 1208/81) and into (S)EUROP categories (EU Regulation nº 1208/81, 1026/91), respectively. Dressing percentage was calculated from HCW. After 24 h of carcass chilling, a sample of Longissimus thoracis (LT) from the 6th to the 9th ribs was dissected. Ultimate meat pH was measured using a Crison portable meter equipped with a xerolyt electrode inserted in the LT muscle at the 6th rib at 24 h postmortem. Instrumental color measurements were recorded at 24 h postmortem for L* (lightness), a* (redness), and b* (yellowness) on the exposed cut surface of the LT muscle between the 6th and 7th ribs after 30 min of bloom time, using a Minolta Chromameter (CR-400, Minolta Inc., Osaka, Japan) in the CIELAB space (CIE, 1976).

Carcass and meat quality characteristics were analyzed using a mixed-effects model (SAS Inst. Inc., Cary, NC). The model included final BW as a covariate, and glycerin level as fixed effects. A Chi-square-test was conducted to evaluate the effects of glycerin level on carcass classification data (categorical variables).

Results and discussion

Glycerin supplementation did not affect HCW (244.2 ± 2.72 kg), dressing percentage (52.6 ± 0.51%), finishing degree (58% classified as "3"), and conformation (63% classified as "O"). In agreement, Mach et al. (2008) reported similar carcass quality data when feeding Holstein bulls high-concentrate diets to a final BW similar to that of the current study. In addition, glycerin supplementation did not affect colorimetric parameters of LT (32.31 ± 1.22, 13.35 ± 0.69, and 1.10 ± 0.58, for *L**, *a**, and *b**, respectively) and ultimate meat pH (5.88, 6.17, 6.22, and 6.04 ± 0.140 for 0, 4, 8 and 12% glycerin level, respectively), although the average incidence of ultimate meat pH above 6.0 was 33, 58, 75 and 58 ± 3.1% for 0, 4, 8 and 12% glycerin level, respectively. In contrast to our results, Mach et al. (2008) analyzing 5,494 cattle carcasses at a commercial slaughterhouse in Spain, housed in different pens, in groups of 10.3 ± 3.36 animals with 0.3 ± 0.09 animals per m^2, during an average waiting time of 12.3 ± 0.06 h with a maximum of 37.2 h, reported that the incidence of ultimate meat pH greater than 6 was 4.02%. These differences among studies could probably be attributed to the different pre-slaughter management. Whereas, in the present study, animals were individually housed during the experiment, limiting interactions between each others, and then mixed in 3 different pens at slaughterhouse for 3 hours, in the study of Mach et al. (2008), bulls in the slaughterhouse were not mixed with bulls from other pens or farms. Supporting present results, Mounier et al (2006) reported that mixing bulls increases the social behaviour (specially agonistic and sexual interactions), inducing depletion of muscle glycogen content and limiting the extent of muscle acidification. Furthermore, present results suggest that concentrate glycerin supplementation at levels up to 12% concentrate does not seem a plausible strategy to prevent a high ultimate meat pH of young Holstein bulls. Gardner and Pethick (2005) reported that glycerol and propylene glycol mixed in drinking water at the rate of 3.5% and 1.5%, respectively, during 24 h of waiting time at slaughterhouse, were effective to reduce the ultimate pH of cattle about 0.1 pH unit. In addition, Parker et al. (2007) reported that steers orally dosed at 24 and 48 h before slaughter with glycerol (2 g/kg BW) presented greater glucose concentrations that nonsupplemented steers, and suggested that elevated blood glucose concentration in the glycerol treated animals may provide a preferential fuel for liver gluconeogenesis. The contradictory results between the present study and these cited studies when glycerine is supplemented to finishing bulls on meat pH migh be attributed to the glycerine supplementation strategy (mixed in the concentrate or orally) and to the doses used.

Conclusions

The average incidence of ultimate meat pH above 6.0 in young Holstein bulls supplemented with glycerin diets and mixed at the slaughterhouse was 33, 58, 75 and 58 ± 3.1% for 0, 4, 8 and 12% glycerin level, respectively. Glycerin supplementation at levels up to 12% concentrate does not seem a plausible strategy to prevent a high ultimate meat pH of young Holstein bulls.

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