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CLENBUTEROL IN VEAL CALVES: THE EFFECT OF DOSE AND WITHDRAWAL PERIOD ON CARCASS AND MEAT QUALITY

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INTRODUCTION

Clenbuterol is an orally active ß-agonist. Its positive effect on the growth of slaughter animals was, for the first time, described in 1984 (Baker *et al.*, 1984; Dalrymple *et al.*, 1984; Ricks *et al.*, 1984).

During the last decade, consumer demands for leaner meat have increased. This resulted in an emphasis on carcass composition, less fat and more muscle. Clenbuterol, altering carcass composition by reduction of net fat accretion and enhancing lean disposition, may be helpful in meeting the changed demands.

When used for therapeutic purposes, clenbuterol is applied in doses of the order of 0.8µg/kg BW. According to Miller *et al.* (1988), to be a repartitioning agent, clenbuterol needs to be given in dosages five to 10 times higher than those required for therapeutic treatments.

Several reports have indicated that the administration of clenbuterol, as it reduces protein degradation (Williams *et al.*, 1988) negatively affects meat tenderness (e.g., Berge *et al.*, 1990). However, it is not clear if the negative effects on meat quality only occur at the high repartitioning dosages or also at the low therapeutic dosages. Furthermore, it is not clear if the negative effect on meat quality occurs at the same levels as the positive effect on carcass composition.

High concentration of clenbuterol in food may be harmful for the human being. Therefore, toxicological aspects have to be considered. Meyer and Rinke (1991) studied the pharmacokinetics of clenbuterol in veal calves. Their data indicates that the half life of clenbuterol in urine amounts to 10 hours for the first phase of elimination and to approximately 2.7 days for the second phase. With higher dosages, longer withdrawal periods may be necessary. Results by Geesink *et al.* (1993) suggest that the negative effects on meat quality may disappear with longer withdrawal periods (> eight days).

The purpose of the present study was to compare the effect of two levels of daily clenbuterol administration, 0.8µg/kg BW versus 4.0µg/kg BW and withdrawal period, three versus 10 days, on carcass and meat quality.

MATERIALS AND METHODS

Treatments

Fifty Friesian-Holstein veal calves (male), aged 17 to 19 weeks and with an average weight of 186kg, were randomly assigned to one of five groups (n=10 for each group). Animals in groups 1 and 2 received clenbuterol 4.0µg/kg BW a day for 33 days. Groups 3 and 4 received therapeutic doses (0.8µg/kg BW) of clenbuterol for 45 days. The withdrawal period between clenbuterol treatment and slaughter was 10 days for groups 1 and 3, and three days for groups 2 and 4. Group 5 served as control.

All animals were slaughtered on the same day under the similar conditions (no electrical stimulation). After 24

hours of chilling, the *m.longissimus* from one side of the carcass was excised, deboned, weighed and vacuum packaged. After seven days of vacuum packaged storage at 22 °C, meat quality characteristics were assessed.

Measurements

Drip losses were determined by re-weighing the unpacked meat. A slice of carcass 2cm thick was cut and exposed to air for one hour. Using a tristimulus reflectometer (Minolta Chroma meter II reflectance) L*, a* and b* colour values were determined. Cuts of three to four centimetres thick were heated in polyethylene bags in a water bath until a core temperature of 70 °C was reached. Subsequently, these cuts were chilled in running tap water for 40 minutes (Boccard *et al.*, 1981). Samples with a 1cm² diameter were cut in a longitudinal direction. Shear forces of these cores were measured using a draw bench equipped with a Warner-Bratzler shearing device. Sarcomere length measurements were performed according to the procedure described by Koolmees *et al.* (1986). The degree of sarcoplasmic protein denaturation was assessed using the procedure described by Hart (1962). Haematin content was assessed according to Hornsey (1956). A simple sensory evaluation on tenderness traits by a 10-member consumer panel relied on preference (paired comparison) tests of muscle strips heated in butter (no salt or spice added).

Data were analyzed using ANOVA.

RESULTS AND DISCUSSION

Table 1 includes the major primary production parameters. As compared with control animals, clenbuterol-treated calves had gained considerably more weight, particularly in the case of short withdrawal periods. At longer withdrawal periods, the effects were particularly evident at higher dosages. The differences in `paid carcass weight' [defined as `hot carcass weight'-2%] were even more pronounced.

Table 2 includes the carcass grading traits. The EUROP scores for conformation were markedly higher the higher the dosage. Effects on conformation of withdrawal periods were less clear. Fat cover scores of clenbuterol-treated animals were significantly lowered (denoting a leaner carcass) only in the case of the 4µg/kg BW daily dose.

The results on meat quality characteristics are included in Table 3. pH and temperature were not significantly affected by the treatments. Garssen *et al.* (1992) reported that administration of clenbuterol resulted in a higher ultimate pH, which they suggested was the consequence of lower glycogen levels. The fact that they administered higher levels of clenbuterol may explain this difference in results.

Drip losses were significantly affected by treatment. Irrespective of the dose and withdrawal period, drip losses were higher for clenbuterol-treated animals than for control. The higher transmission values of the clenbuterol-treated animals suggest that an increased degree of protein denaturation was responsible for this increase in drip loss. It is not clear what may have caused this increased protein denaturation. Garssen *et al.* (1992) and Geesink *et al.* (1993) also reported a lower water-holding capacity (higher drip losses) in meat from clenbuterol-treated calves.

Cooking losses were affected only in the high dosage groups. Increased cooking losses in clenbuterol-treated samples have been reported by Geesink *et al.* (1993). However, the dosage in their study was lower than the lowest dosage in the present study. It is not clear what may have caused these increased cooking losses; an increased water/protein ration may be involved.

The effect of clenbuterol on colour values was very inconsistent. There seems to be hardly any differences in colour. These results contradict reports by Garssen *et al.* (1992) and Geesink *et al.* (1993). In both these studies, clenbuterol induced higher L*-values as well as lower a*-values. The higher L*-values were ascribed to the lower water-holding capacity (Geesink *et al.*, 1993), the lower a*-values by the lower myoglobin (haematin) content (Garssen *et al.*, 1992; Geesink *et al.*, 1993). In the present study, treatment had an inconsistent effect on the haematin values. Only in the high dosage group with a three day withdrawal period the haematin concentration tended to be lower.

Shear forces were lowest in the control group. The shear force of groups 3 and 4 were similar to those of the control group. Treatment with 4µg clenbuterol resulted in a 25% increase in shear force. Withdrawal time did not seem to reverse this negative effect. Differences in sarcomere length cannot explain the observed differences in shear force. Similar,or larger, increases in shear forces have been reported by others (Garssen *et al.*, 1993; Geesink *et al.*, 1993).

Panel evaluation of tenderness (Table 4) largely confirm our findings on shear force. Especially at the high dosage the toughening effects of clenbuterol treatment were easily discernable by the majority of panellists.

CONCLUSION

Although clenbuterol has distinct advantages with regard to improving feed conversion and carcass grade (more favourable conformation and fat cover scores), treatment with this ß-agonist causes significant toughening particularly at the higher `repartitioning' dosages. Besides considerations of public health and consumer acceptability, the meat industry seems well advised to refrain from the use of this agent.

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Table 1. Effect of clenbuterol on primary production parameters (expressed as ■treated, - control).

■treated - control	clenbuterol 0.8µg/kg BW 3 days	10 days	4µg/kg BW 3 days	10 days
Feed conversion	-0.16	-0.13	-0.20	-0.15
Live weight	10.1	4.2	11.3	8.9
Dressing %	1.7	2.0	2.8	2.8
Paid carcass weight	16.0	11.8	21.5	19.6

Table 2. The effect of clenbuterol treatment of veal calves (two dosages with two withdrawal periods) on carcass classification variables (EUROP).

Carcass trait (■treated - control)	clenbuterol 0.8µg/kg BW 3 days	10 days	4µg/kg BW 3 days	10 days
■ conformation score (EUROP)	0.8*	0.7*	1.0*	1.2*
■ Fat cover score■	0.0^{NS}	0.0^{NS}	-0.4*	-0.2*
■ Carcass colour+	0.1^{NS}	0.1^{NS}	-0.1^{NS}	-0.1^{NS}

* P.

+ 0 = very red; 9 = very white.

Table 3. The effect of clenbuterol treatment of veal calves with two dosages and two withdrawal periods (n=10 per treatment group) on major physical-chemical meat quality traits.

	clenbuterol 0.8µg/kg BW 3 days	10 days	4µg/kg BW 3 days	10 days	Control
pH, 45min	6.6	6.5	6.6	6.6	6.5
pH, 75min	6.2	6.2	6.6	6.6	6.2
pH, 24h	5.4	5.4	6.6	6.6	5.4
Drip	1.51^{ab}	1.55^{ab}	1.57^{b}	1.67	1.13^{a}
Cooking	20.1^{a}	21.7^{ac}	24.3^{b}	22.9^{b}	21.1^{ac}
Transmission	66.3^{b}	70.7^{b}	65.3^{b}	67.5^{b}	52.2^{a}
Shear force	3.22^{ac}	3.71^{bc}	4.07^{b}	4.17^{b}	1.73^{a}
Sarc. length	1.77^{a}	1.71^{ab}	1.64^{b}	1.74^{a}	1.73^{a}
L*	55.0^{ab}	53.9^{b}	58.3^{a}	54.7^{ab}	57.4^{ab}
a*	18.9^{b}	18.6^{b}	17.5^{a}	18.1^{ab}	17.6^{ab}
b*	12.3^{c}	11.4^{bd}	11.6^{bcd}	10.6^{a}	11.3^{ad}
Hematine	43.5^{ab}	49.3^{b}	37.5^{a}	42.4^{ab}	43.5^{ab}

Figures with superscripts not containing a common letter differ significantly ($P<0.05$).

Table 4. Panel preference test (10-member panel).

Paired comparisons	Panel preference
0.8µg/3d vs C	20% preference for control 80% no difference
0.8µg/10d vs C	20% preference for control 20% preference for treated 60% no difference
4µg/3d vs C	100% preference for control
4µg/10d vs C	60% preference for control 40% no difference
C_1 vs C_2	20% preference for control 1 20% preference for control 2 60% no difference