EFFECTS OF CLENBUTEROL AND SALBUTAMOL ON BODY AND CARCASS COMPOSITION OF VEAL CALVES

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SUMMARY

The objectives of this study were to examine effects of dietary clenbuterol and salbutamol on body and carcass composition of veal calves. 60 Male calves were fattened on a complete milk-replacer ration for 24 weeks. Treatment with clenbuterol (1.6 mg per head/day; group B, n=15) and salbutamol [60 (C) and 100 mg (D) per head/day] was during the last 28 days, including a withdrawal period of three days. A control group (A) was left untreated. Final LW for groups B, C and D tended to be higher, while carcass weights and dressing percentages were significantly higher. Right carcass sides of groups A(10), B(11) and D(10) were anatomically dissected. Weights of all fatty tissues were decreased in groups B and D: kidney plus channel, mesenteric and omental fat ($P<0.05$); cod, intermuscular and subcutaneous fat (NS). ß-Agonists decreased weights of several organs and non-carcass tissues: hide (B,C), liver (C,D), heart (B), kidneys (B,D), thymus (B), spleen (B) and pancreas (B,C,D). Carcass lean % was higher in B and D ($P<0.001$) as were lean/fat and lean/bone ratios. Carcass bone (B,D) and fat (D) % were decreased. Relative weight of carcass hindquarter increased ($P<0.02$) in groups B and D. Anatomical jointing indicated that in the hindquarter, weight of the proximal pelvic limb increased ($P<0.01$) relative to total carcass weight; in the forequarter, relative weights of neck and thorax region (D; $P<0.02$) and of distal thoracic limb ($P<0.001$) decreased. The same tendency of shifting of weight held for the muscles in the joints mentioned, relative to carcass total muscle weight. Relative weight of some discrete muscles of the proximal pelvic limb increased as a result of BA. In veal calves clenbuterol and the higher dose of salbutamol had roughly identical effects inducing muscle hypertrophy and reduction of fatty tissues and differential effects on weight growth of some organs.

Introduction

Beta-adrenergic agonists (BA) or repartitioning agents produce an increase in skeletal muscle mass and a reduction in body fat content in all the major meat-producing species (Moloney et al., 1991). Williams et al. (1987) suggested that effects on muscle accretion should be most pronounced during the stage of highest rate of protein turnover *i.e.* in the young growing animal. Studies on the effect of duration of administration of BA indicate that little is to be gained in long-term compared to short-term treatments towards a fixed slaughter age (Moloney et al., 1991). The objectives of this study were to examine effects of dietary BA on body and carcass composition of milk-fed veal calves.

Materials and methods

60 Black and White veal calves (bulls) with average initial live weight of 45.7 kg were fattened on a 100% milk-replacer ration during 24 weeks. ß-Agonists were given to 3 groups of 15 calves each from week 21 onwards (treatment period, including a withdrawal period of 3 days before slaughter), while 15 calves were left untreated as a control. BA were added twice daily to the reconstituted milk. Group B received 1.6 mg clenbuterol per head/day, groups C and D 60 and 100 mg salbutamol per head/day respectively. These dosages are equivalent to approximately 0.5 mg clenbuterol, 30 and 50 mg salbutamol per kg milk replacer (dry matter) respectively. Group A was the zero control. On each of 4 successive slaughterdays 15 calves (4 or 3 of each treatment group) were weighed at 6.30 am and feed was withheld.

The animals were transported over 0.5 km to the institute's slaughter-facility and after captive bolt stunning exsanguinated. Electrical stimulation of carcasses was not applied. Carcasses were weighed 45 min after stunning (hot carcass weight). Weights of several organs and tissues were determined: skin, empty sto-

machs and intestines, heart, liver, kidneys, spleen, thymus, pancreas, adrenals, pituitary, testicles, kidney fat, channel fat, mesenteric fat and omental fat. After overnight chilling the cold carcass weight was determined. Of groups A, B and D, 10, 11 and 10 right carcass sides respectively were frozen for later dissection with complete tissue separation according to the method of Williams and Bergström (1980) for beef carcasses. Tissues were distinguished into the categories lean, fat, bone and "other tissues" (tendons, lymphatic nodes, nerves, blood vessels and *ligamentum nichae*).
Further details of the experimental design and some results for carcass quality are given by Garssen et al. (1992).

Statistics: Analysis of variance was carried out for live performance and carcass quality measurements. No significant effects were found of slaughterday on growth and final LW. Covariance analysis was used to adjust final live weight (LW) and carcass weights for LW at the start of the treatment period. Remaining data were analysed with the Student's t-test.

Results and discussion

At the start of the experiment calves were randomized over four groups on the basis of initial live weight. During the preliminary growth period of 20 weeks, two calves in goup B had to be replaced which was the cause of a significant difference in live weight before treatment between groups B and D.

Over the 28 days treatment period (including three days withdrawal) BA effected a higher rate of gain for group D ($P< 0.05$; Table 1) though not resulting in a higher final live weight. After slaughter significant higher weights for hot and cold carcasses were found. When, because of the lower initial weight of group B, results for final live weight and carcass weights were adjusted with live weight at the start of treatment as covariate, carcass weights for all BA-treated groups were again found higher compared to controls ($P< 0.05$). Feed intake was the same for all groups during the preliminary as well as the treatment period and feed efficiency improved though not significantly as a result of BA (data not shown).

Of non-carcass tissues and organs, compared with controls, lower weights were found for hide (B,C), liver (C,D), heart (B), kidneys (B,D), thymus (B), spleen (B), pancreas (B,C,D), pituitary (B) and the adipose tissues: kidney (B,D), channel (B), mesenteric (B,D) and omental fat (D) (Table 1). On the other hand no weight differences were found for the intestines, stomachs, testicles, and adrenal glands. In meat-producing animals BA invariably decrease mass of internal fat depots whereas also weights of organs are often found lowered. In calves fed clenbuterol for 105 days, Williams et al. (1987) found lower weights for hide, viscera and liver and Chikhou et al. (1993) mentioned negative effects of cimaterol on mass of hide and heart of steers of 275 kg final live weight.

While in the present experiment on the one hand BA treatment tended to enhance body weight, on the other hand weighing of both carcasses and non-carcass parts revealed a concomitant shift towards a higher contribution of the carcass and a lower contribution of the non-carcass parts to body weight growth. This was reflected in dressing percentages, which for all treated groups were higher ($P< 0.01$; Table 1) than those of controls. Reports on effects of BA on rate of gain and live weight in young cattle are not unanimous. While some (Williams et al., 1987 and Chikhou et al., 1993) found no effects, on the other hand Berge et al. (1993) observed for veal calves fed clenbuterol a higher live weight gain which however significantly reversed during a 14-day withdrawal period. Vestergaard and Sejrsen (1989) found significant increases of daily gain and of final live weight in young bulls fed cimaterol.

In order to examine further the influence of BA on carcass compositional growth, half carcasses of groups A(10), B(11), and D(10) were dissected with complete tissue separation. Comparison of average weights of total lean, bone and fat indicated an increase of muscle mass of 11% and 19% for groups B and D respectively as a result of BA whereas bone weight was found lower in group B (Table 2). As compared with controls, non-significant decreases of 3% (B) and 5% (D) were shown for carcass fat weight, as the sum of intermuscular and subcutaneous fat, and of 7% (B) and 11% (D) for cod fat. A clenbuterol-induced retardation of bone growth seems unlikely since live weight and proportionately bone weight for group B were already lower at the start of treatment. As a result of the repartitioning effect of BA on protein and fat metabolism towards an increased muscle protein accretion and decreased fat deposition, carcass muscle/fat and muscle/bone ratios were found to be significantly higher for groups B and D.

Jointing of the carcass side into seven anatomical regions, followed by tissue separation allowed to determine possible differential effects of BA over the carcass more specifically (Table 2). Relative weights of the proximal pelvic limb were found to be increased for groups B ($P< 0.01$) and D ($P< 0.001$), whereas weights of neck and thorax region (D; $P< 0.02$) of distal thoracic limb (B,D) and distal pelvic limbs (B) decrea-

sed compared to controls. Obviously, BA effected a shift of carcass weight distribution towards a relatively heavier hindquarter and lighter forequarter. When muscle weights of individual regions were taken as a percentage of total carcass muscle mass as shown in Table 3, relative muscle weight appeared to be increased by BA for the proximal pelvic limb (B,D) and decreased for the neck and thorax region (B,D) and distal thoracic limb (B,D). This indicates a more pronounced hypertrophic muscle growth by BA for the hindquarter. Similar results were obtained by Chikhou et al. (1993) for steers of 275 kg slaughterweight, treated with cimaterol for 29 weeks including a 7 day withdrawal period.

Also all individual muscles, contributing 2.5% at least to total carcass muscle weight were examined (Table 3). Significant hypertrophic effects of BA were found for relative weights of the *mm. semimembranosus* and *gluteus medius* (B,D) and the smaller *mm. adductor* (B) and *tensor fasciae latae* (D) which together form part of the proximal pelvic limb. As distinct from the *m. longissimus lumborum* also the relative weight of the *m.longissimus thoracis* (B) was higher. All muscles mentioned before are regarded as being mainly 'white-typed' (Monin, 1983; Rao and Gault, 1989). The hypertrophy observed is in line with the finding that the anabolic effect of BA is specific for the Type II (fast twitch, mixed glycolytic/oxidative) fibres, which respond with an increase of the cross-sectional area (Yang and McElligott, 1989). On the other hand relative weight of the 'red-typed' *m. serratus ventralis* decreased (D). A decreased fat accretion by the action of BA, was most manifest in the non-carcass depots (Table 1). Related to final live weights, the contribution of these depots together with cod fat was 5.75% in controls, which was significantly higher ($P<0.01$) than in the BA-treated groups B (4.78%) and D (4.58%). Fat within the carcass was less affected by BA. The weight ratio of carcass fat depots (subcutaneous/intermuscular) did not change as a result of BA-treatment. When dissectible fat within anatomical joints was quantified and related to total carcass fat, it became clear that BA did not produce a differential effect on carcass fat partition.

It can be concluded that in this experiment clenbuterol and the higher dose level of salbutamol had roughly identical effects on muscle and adipose tissues. This implies a much greater efficiency of clenbuterol on a molar base. However, effects on organs and non-carcass tissues were in a few cases different. For repartitioning effects of salbutamol there was evidence for a dose response relation.

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