Effects of ractopamine hydrochloride on growth performance and carcass characteristics in wool and hair lambs

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Abstract

This study aimed at evaluating the effects of ractopamine hydrochloride (RAC) on growth performance and carcass characteristics of wool and hair lambs. For this purpose, 48 lambs averaging 31.3 kg body weight, of which twenty were wool (Ramboullet x Suffolk) and twenty eight were hair (Tabasco) lambs, and four levels of RAC (0, 10, 20, and 30 mg/kg diet, dry matter basis) were used. Wool lambs fed 20 and 30 mg RAC had higher (P<0.05) total gain and lower feed conversion than 0 and 10 mg RAC. Wool lambs fed 20 mg RAC had the highest carcass weight, dressing, legs weight and longissimus area as compared to 0, 10 and 30 mg RAC. In hair lambs there were not effect of RAC on growth performance and carcass characteristics. It was concluded that addition of RAC to finishing diets offered the best dose level of RAC in diet for growth performance and carcass traits on wool and hair lambs.

Materials and methods

This experiment was conducted under the supervision of the Academic Committee of Colegio de Postgraduados, Campus Montecillo, according to experimental animal guidelines and procedures, enacted by the State of Mexico in Mexico. Two experiments were conducted with different sheep breeds (wool and hair) each with four levels of RAC (0, 10, 20, and 30 mg/kg diet, dry matter basis). Forty eight lambs (31.3±5.8 kg BW), of which twenty were wool (Ramboullet x Suffolk), and twenty eight were hair (Tabasco) lambs. Ractopamine hydrochloride (RAC; Optaflexx, Elanco Animal Health, Greenfield, IN, USA) was added in the feed offered and refused were daily recorded. Body weight was recorded at slaughter. Chilled carcass weight (4ºC) was recorded 24 h after slaughter. The carcass length, leg length, legstuff used to adjust the diet.

Introduction

In a world that struggles with rising meat consumption, feed shortages, and environmental waste, improving the efficiency of animal production becomes critical. Anabolic and repartitioning agents remain the most effective and reliable means to alter the deposition of fat and lean in livestock (Silience, 2004). However, the illegal use of clenbuterol a β-agonist for animal feeding has caused considerable alarm, with cases of food poisoning in México (Strada et al., 2008). While it is possible to eliminate the health risk of drug residues through carcasses screening, or approving access to short-acting compounds like ractopamine, it is much harder to remove the fear of drug residues among consumers. In December 2000, ractopamine became the first β-agonist to be registered by the US Federal Drug Administration, for commercial use as a pig-feed additive (Mills, 2002). Ractopamine hydrochloride (RAC) has been extensively used in cattle (Walker et al., 2010) and swine (Leick et al., 2010) with beneficial effects on carcass and meat traits. México (Diario Oficial de la Federación, 2002) and several other countries have authorized RAC in livestock feeding. The effects of RAC on sheep have been evaluated recently in hair lambs (Robles et al., 2009; Lopez et al., 2010) with beneficial effects on carcass characteristics. Daily recommendations of RAC for lambs are based on body weight (BW) (Robles et al., 2009; Lopez et al., 2010), which are not practiced under feedlot conditions due to variation in weight and feed intake. Also, these recommendations are based on trials using only hair lambs. An elevated sensitivity of wool lambs to RAC could be indicative of greater beta-adrenergic receptor affinity and higher number of receptor than hair lambs (Gisson et al., 1996) then we hypothesized that RAC effect might be different in wool and hair lambs. Therefore, the objective of this study was to determine the best dose level of RAC in diet for growth performance and carcass traits on wool and hair lambs.

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Results

Experimental diets averaged (per kg as DM basis) 139 g crude protein, 260 g neutral detergent fibre (NDG), and 65 g ash. Chemical composition of diets was similar. Wool lambs showed cubic effects (P<0.05) of RAC level on total gain and feed conversion, being 20 and 30 mg RAC which offered the highest total gains and the lowest feed conversion values (Table 1) as compared to 0 and 10 mg RAC. In wool lambs, hot and chilled carcass weights and dressing were affected quadratically (P<0.05) by RAC level, being lambs fed 20 mg RAC which showed the highest values. In wool lambs, dorsal fat and hindquarters were not affected by RAC (Table 2), but lambs fed 20 mg RAC had heavier legs, skin, offal, gastrointestinal tract and gastrointestinal content, as well as higher

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Table 1. Growth performance and carcass dressing of wool lambs fed ractopamine chloride.

| Ractopamine, mg/kg DM | 0    | 10   | 20   | 30   | SEM   |
|-----------------------|------|------|------|------|-------|
| Growth performance    |      |      |      |      |       |
| Initial body weight, kg | 34.9 | 40.7 | 40.0 | 34.9 | 4.8   |
| Final body weight°, kg | 45.0 | 50.8 | 51.4 | 46.4 | 4.4   |
| Total gain°, kg       | 10.1 | 10.1 | 11.4 | 11.5 | 1.1   |
| Average daily gain, kg| 0.337| 0.337| 0.380| 0.383| 0.09  |
| Dry matter intake, kg | 1.58 | 1.59 | 1.61 | 1.68 | 0.15  |
| Feed conversion#§     | 4.7  | 4.7  | 4.2  | 4.4  | 0.35  |
| Carcass performance   |      |      |      |      |       |
| Hot carcass weight°, kg| 20.1 | 23.2 | 25.4 | 22.6 | 3.2   |
| Chilled carcass weight°, kg | 19.4 | 22.9 | 24.9 | 21.5 | 3.2   |
| Hot carcass dressing°, %| 44.7 | 45.7 | 49.4 | 48.7 | 3.8   |
| Chilled carcass dressing°, %| 43.1 | 43.3 | 46.7 | 46.3 | 3.5   |

| Ractopamine, mg/kg DM | 0    | 10   | 20   | 30   | SEM   |
|-----------------------|------|------|------|------|-------|
| Carcass traits        |      |      |      |      |       |
| Dorsal fat at 12°th rib, mm | 4.0  | 4.2  | 4.0  | 4.2  | 0.31  |
| Hindquarters, cm°     | 60.0 | 60.2 | 60.2 | 60.1 | 3.1   |
| Hindquarters, kg°     | 31.1 | 30.4 | 30.4 | 30.3 | 2.0   |
| Legs weight°, kg       | 10.0 | 10.8 | 12.0 | 10.2 | 0.82  |

| Ractopamine, mg/kg DM | 0    | 10   | 20   | 30   | SEM   |
|-----------------------|------|------|------|------|-------|
| Organ                 |      |      |      |      |       |
| Blood, kg             | 2.0  | 1.8  | 1.9  | 1.9  | 0.31  |
| Head, kg              | 2.0  | 1.9  | 2.1  | 2.0  | 0.30  |
| Skin°, kg             | 4.5  | 4.5  | 5.2  | 4.9  | 0.39  |
| Offal°, kg            | 6.0  | 6.1  | 6.4  | 5.9  | 0.41  |
| Gastrointestinal tract°, kg | 4.0  | 4.1  | 4.4  | 4.0  | 0.33  |
| Gastrointestinal content, kg | 3.5  | 3.3  | 3.5  | 3.3  | 0.29  |

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*Quadratic effect (P<0.01) of RAC level, °the Hunter L* values are a measure of lightness (a higher value indicates a lighter colour); the Hunter a* values are a measure of redness (a higher value indicates a redder colour); the Hunter b* values are a measure of yellowness (a higher value indicates a more yellow colour). #Means in the same row with different superscripts differ (P≤0.05).
values of Longissimus dorsi area than lambs fed 0, 10 or 30 mg RAC (quadratic effect of RAC level at P<0.05). In wool lambs, there was no RAC effect on shear force, pH, water activity, water-holding capacity, meat colour, and blood and head weight.

In hair lambs, growth and carcass performance were not affected by RAC levels (Table 3). In hair lambs, there were no differences in carcass, LD traits and organ characteristics for the different RAC doses (Table 4).

**Discussion**

According to the DMI and final BW showed in Table 1, wool lambs fed diets with 10, 20 and 30 mg/kg DM, received 0.31, 0.62 and 0.108 mg RAC/kg BW, and hair lambs received 0.39, 0.78, and 0.123 mg RAC/kg BW, respectively. The daily RAC doses used in this experiment are in agreement with doses (0.35, 0.70, and 105 mg/kg BW) evaluated by Lopez et al. (2010). These authors found that final weight, total weight gain, ADG, carcass weight, dressing percentage, and Longissimus muscle area of hair lambs, increased linearly as levels of RAC increased. These results are partially in agreement with the results found in wool lambs in the present study.

The RAC levels evaluated in our experiment showed a quadratic effect in most of the traits evaluated only for wool lambs. Optimal response in terms of growth performance and carcass traits was observed at the 20 mg RAC/kg diet. The basis for this quadratic effect to the RAC level is not certain, but similarly Walker and Drouillard (2010) found that low-medium, but not high RAC doses, increased growth of gram-negative bacteria in the rumen which affected positively rumen fermentation. More research is needed to support the effects of RAC on rumen microorganisms and fermentation.

The different response of wool and hair lambs to RAC has not been evaluated in lambs. Inconsistent with the present research, Gruber et al. (2007) did not observe an interaction of various biological cattle types and RAC supplementation. Reason for inconsistencies between studies is unclear, but could involve direct (e.g., tissue specific) and indirect (e.g., endocrine) changes associated with fat and muscle metabolism (Gilson et al., 1996). Although, both alpha and beta-adrenergic receptors are present in ovine adipose tissue (Watt et al., 1991), variations in the sensitivity and responsiveness of individual adipose depots to catecholamines stimulation have been demonstrated in lambs. Ractopamine is similar in structure to natural catecholamines (Mills, 2002). Variations in the sensitivity of RAC on specific lamb breed could be due to differences of adiposities characteristics and basal lipolysis (Zamiri and Iaadifar, 1995). Thus, the elevated sensitivity of wool lambs to RAC could be indicative of greater beta-adrenergic receptor affinity and higher number of receptor than hair lambs (Gilson et al., 1996).

In agreement with our results, the benefits of feeding RAC to lamb on live and carcass traits have been found in finishing lambs.

![Table 3. Growth performance and carcass dressing of hair lambs fed ractopamine chlorhydrate.](Ital J Anim Sci vol.12:e32, 2013)

| Ractopamine, mg/kg DM | 0     | 10    | 20    | 30    | SEM  |
|----------------------|-------|-------|-------|-------|------|
| Growth performance   |       |       |       |       |      |
| Initial body weight, kg | 26.9  | 25.1  | 24.4  | 23.6  | 6.1  |
| Final body weight, kg | 36.6  | 35.1  | 34.5  | 34.1  | 6.3  |
| Total gain, kg       | 9.7   | 10.0  | 10.1  | 10.5  | 1.4  |
| Average daily gain, kg | 0.323 | 0.333 | 0.337 | 0.350 | 0.10 |
| Dry matter intake, kg | 1.41  | 1.24  | 1.35  | 1.40  | 0.17 |
| Feed conversion°     | 4.4   | 4.1   | 4.0   | 4.0   | 0.37 |
| Carcass performance  |       |       |       |       |      |
| Hot carcass weight, kg | 17.9  | 17.6  | 17.5  | 17.1  | 3.5  |
| Chilled carcass weight, kg | 17.3  | 16.8  | 16.9  | 16.6  | 3.6  |
| Hot carcass dressing, % | 49.0  | 50.0  | 49.6  | 50.3  | 3.9  |
| Chilled carcass dressing, % | 47.2  | 47.9  | 47.9  | 48.7  | 3.6  |

°Feed conversion = dry matter intake / average daily gain.

![Table 4. Carcass and Longissimus dorsi traits, and organs weight in hair lambs fed ractopamine chlorhydrate.](Ital J Anim Sci vol.12:e32, 2013)

| Ractopamine, mg/kg DM | 0     | 10    | 20    | 30    | SEM  |
|----------------------|-------|-------|-------|-------|------|
| Carcass traits       |       |       |       |       |      |
| Dorsal fat at 12th rib, mm | 3.0   | 3.1   | 3.1   | 3.2   | 0.32 |
| Hindquarters perimeters, cm | 57.2  | 57.2  | 57.1  | 57.1  | 3.3  |
| Hindquarters width, cm | 28.1  | 28.1  | 28.1  | 28.0  | 2.1  |
| Legs weight, kg       | 8.5   | 8.3   | 8.1   | 8.0   | 0.84 |
| Longissimus dorsi     |       |       |       |       |      |
| Area, mm²             | 10.4  | 10.0  | 10.6  | 9.9   | 1.1  |
| Shear force, kg/cm²   | 2.0   | 1.7   | 1.8   | 1.9   | 0.35 |
| pH                   | 5.74  | 5.69  | 5.72  | 5.72  | 0.10 |
| Water activity        | 0.97  | 0.97  | 0.97  | 0.97  | 0.07 |
| Water-holding capacity, mL | 35.9  | 36.5  | 36.4  | 36.6  | 3.2  |
| Colour*               |       |       |       |       |      |
| L*                   | 34.3  | 37.7  | 36.6  | 36.7  | 3.1  |
| a*                   | 18.6  | 19.3  | 18.6  | 19.3  | 0.81 |
| b*                   | 6.9   | 7.1   | 7.1   | 6.8   | 0.83 |
| Organs               |       |       |       |       |      |
| Blood, kg             | 1.4   | 1.3   | 1.3   | 1.3   | 0.32 |
| Head, kg              | 1.9   | 1.7   | 1.6   | 1.6   | 0.31 |
| Skin, kg              | 2.8   | 2.8   | 2.7   | 2.8   | 0.40 |
| Offal, kg             | 6.0   | 6.1   | 6.1   | 5.9   | 0.42 |
| Gastrointestinal tract, kg | 4.4   | 4.5   | 4.5   | 4.2   | 0.35 |
| Gastrointestinal content, kg | 2.7   | 2.6   | 2.6   | 2.6   | 0.31 |

*The Hunter L* values are a measure of lightness (a higher value indicates a lighter colour); the Hunter a* values are a measure of redness (a higher value indicates a redder colour); the Hunter b* values are a measure of yellowness (a higher value indicates a more yellow colour).
(Robles et al., 2009; Lopez et al., 2010) as a result of repartitioning accretion of protein relative to fat (Bryant et al., 2010). The mechanism by which RAC increases longissimus area in our experiment could be interconnected with its ability to alter the metabolic profile of the individual fibres (Gonzalez et al., 2009). In agreement with these researchers, in the current study, RAC supplementation did not affect the colour characteristics in the longissimus.

**Conclusions**

Given these results, it is concluded that RAC at 20 mg/kg diet may have an important effect on growth performance and carcass traits in wool lambs. Effective use of RAC for managing growth of finishing lambs requires a more thorough understanding of how various kinds of lambs respond to its inclusion in finishing diets. Larger-scale commercial studies would assist in making broader inferences concerning responses of various breed lambs to RAC supplementation.

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