EFFECTS OF HORMONAL GROWTH PROMOTANTS AND β-AGONISTS ON BEEF TENDERNESS: COMPARISONS OF META-ANALYSES

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I. INTRODUCTION

Hormonal growth promotants (HGP) used in beef cattle include oestrogenic agents, zeranol, progesterones, testosterones and trenbolone. The β-agonists (BA) include zilpaterol and ractopamine. These production modifiers (HGP and BA) commonly used in the USA and other beef industries world-wide improve the efficiency of production, increase beef production, and have environmental benefits. We compare the effects of BA and HGP on Warner Bratzler shear force (WBSF) using indirect comparisons of results from three meta-analysis. We hypothesised that BA would increase WBSF compared to HGP possibly reflecting differences in physiological mechanisms of action in increasing muscle mass between HGP and BA.

II. MATERIALS AND METHODS

The data used in this study were obtained from three meta-analyses [1,2]. The methods used for literature search were described in detail in Lean et al. [1,2]. Research engines, Google Scholar (http://scholar.google.com/), and Pub Med (http://www.ncbi.nlm.nih.gov/pubmed) were searched on each occasion, and for BA, Scirus, ScienceDirect and CAB, and for HGP, ISI Web of Science (http://wokinfo.com/). Systematic search methods and reasons for inclusion or exclusion of studies were used. Study bases and criteria for inclusion and exclusion of studies were similar; studies were in English, used interventions in randomized, replicated experiments in which a reference group was present and WBSF was measured, there were sufficient data to determine the effect size (ES), they included a measure of effect amenable to ES analysis (i.e. standardized mean difference [SMD]), and included a measure of variance (SE or SD) for each effect estimate. The *Musculus longissimus thoracis et lumborum* (LM) was assessed and data from other muscle groups was excluded for the HGP data and, the predominant muscle assessed in the BA studies was LM. For each data base, other treatments, for example HGP in the BA database or BA in the HGP database are balanced across comparisons.

Data were structured to allow a classical meta-analytical evaluation of differences in responses. Many experiments used multiple treatment comparisons. Consequently, there is dependence within experiment and the effects of experiment and treatment need to be evaluated by meta-regression using multi-level models [3, 4]. The comparison between a control and an HGP treatment group is defined as a 'treatment comparison'. Within an experiment, there could be one treatment comparison or several (i.e. a multi-arm experiment). For the models presented in this paper, robust regression models were used that account for the nesting of treatment comparisons within experiment [4] and programmed as *robumeta* in Stata [5]. Methods used to estimate these effects have been described in detail [5]. Important aspects of the robust model are that: the correlation structure of the comparisons does not need to be known to compute the pooled ES or variances, only that the vectors of estimates from different experiments are independent and that regularity conditions are satisfied; the experiment or treatment comparison level regressors do not need to be fixed; the theorem is asymptotic based on the number of experiments, rather than the treatment comparisons; and the theorem is relatively robust to regularity assumptions. Effect sizes were converted to weighted mean differences in WBSF (kg) using the relationship between ES and standard deviation to provide responses in familiar units.

III. RESULTS AND DISCUSSION

There was a substantial number of treatment comparisons; however, relatively few experiments were present at the time that the initial BA literature searches were conducted. In 2013-4, only 13 experiments were identified (47 comparisons) for zilpaterol and 9 for ractopamine (17 comparisons). In 2017, there was 28 studies (177 comparisons) identified for hormonal growth promotants (Table 1).

Table 1 Warner Bratzler Shear Force (WBSF) estimates from meta-analyses of 3 different interventions. Effects of zilpaterol, ractopamine and hormonal growth promotants, number of comparisons, studies, effect size, standard error of the effect size, 95% confidence interval, *P*-value and estimated weighted mean difference in WBSF in kg

Variable	N Comparison	N Study	Effect Size	Standard Error	95% Confidence Interval	*P*-value	Estimated weighted mean difference WBSF (kg)
WBSF, kg (robust) Zilpaterol	47	13	1.287	0.273	0.643 - 1.931	0.002	0.80
WBSF, kg (robust) Ractopamine	17	9	0.500	0.098	0.255 - 0.745	0.003	0.30
WBSF, kg (robust) HGP	177	28	0.306	0.053	0.181 - 0.431	0.001	0.33

Estimates of WBSF for zilpaterol and ractopamine are updated from Lean et al. [1] using robust regression methods. Table 1 shows that the 95% confidence interval estimates of ES derived from the meta-analyses overlap for zilpaterol and ractopamine and for ractopamine and HGP, but not for HGP and zilpaterol. The estimates for weighted mean difference for the HGP and ractopamine are similar (0.33 and 0.30 kg, respectively), but the estimated WBSF for zilpaterol is larger (0.80 kg). Comparisons of ES and weighted mean differences are indirect, i.e. the estimates are not based on direct comparisons in a study, rather comparisons based on different studies. Song et al. [6] evaluated 44 comparisons from 28 systematic reviews in which direct and indirect estimates of effect could be compared and found while agreement levels were modest (kappa = 0.51), there were only 3 comparisons with substantial differences in outcome. Comparability of ES derived from different studies, will depend on the similarities in the populations from which these are derived. In this case, the populations were very similar, with the majority of studies being obtained from studies conducted in the USA on feedlot cattle. These considerations in regard to indirect comparisons lead to a conclusion that, within the range of treatment responses reported, zilpaterol had a greater effect on WBSF than ractopamine or HGP. There are differences in the action of the two BA on muscle [7, 8] and to HGP, and striking differences in the hot carcass weights between zilpaterol and ractopamine [1]. It remains to be determined whether the differences in WBSF observed in this study reflect differences in mode of action of the different BA and HGP or in the populations studied.

IV. IV. CONCLUSIONS

There are marked differences in WBSF for the two BA, zilpaterol and ractopamine; also for zilpaterol and HGP. These findings encourage the need for studies to directly compare effects and mechanisms of action of different growth enhancers in order to determine the optimal means by which production efficiency can be enhanced and beef quality maintained or improved.

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