IMPROVING THE RESPONSE TO PAYLEAN WITH THE NOVEL USE OF PST

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Executive Summary

Ractopamine hydrochloride (RAC, Paylean™, Elanco Animal Health) is a beta adrenergic agonist (ß-agonist) that is approved for use as an in feed ingredient for pigs. The growth and efficiency response of finisher pigs to dietary RAC is most pronounced during the first 2 weeks of feeding and declines thereafter.

The aim of this study was to determine if a one-off dose of pST to finisher pigs offered RAC diets could enhance ß-receptor sensitivity and therefore sustain the response to RAC through to commercial slaughter weights. A total of 97 female pigs (PrimeGro™ Genetics) were identified at 17 weeks of age and transferred to individual finisher accommodation. Pigs were offered a commercial grower diet for an initial seven day period while they acclimatised to the individual pens. At 18 weeks of age, pigs were individually weighed and randomly allocated to one of five experimental treatments: A: Control finisher diet, no RAC for 28 days; B: RAC finisher diet for 28 days; C: RAC finisher diet for 28 days plus one dose of 10 mg pST at day 14; D: RAC finisher diet for 28 days plus one dose of 10 mg pST at day 14 and again at day 21, E: Control finisher diet for 28 days plus daily pST injection (5 mg/d) from day 14 to day 28. The RAC finisher diet was formulated to contain 7.5 ppm RAC (Paylean™, Elanco Animal Health). Individual pig weights and feed intake were recorded weekly to the end of the 28 day test period. Pigs were slaughtered in a commercial abattoir and carcass information obtained.

Pigs offered the RAC finisher diet consumed more feed (2.39 and 2.53 kg/d for the control and RAC treatments respectively, P=0.009) and tended to grow faster (1.01 and 1.07 kg/d respectively, P=0.11) than pigs offered the control finisher diet during the initial 14 days of the test period. There was no impact of dietary RAC on feed efficiency during this time. During the subsequent period from 14 to 28 days, pigs offered the RAC diet gained weight faster than the control animals (1.04 and 1.18 kg/d for the control and RAC treatments respectively), with the response largely attributed to an increase in feed intake (2.84 and 3.07 kg/d respectively).

The addition of the pST treatment at day 14, or alternatively at day 14 and day 21, did not improve growth rate or feed efficiency compared to those pigs offered the RAC diet without pST. There was no impact of RAC/pST strategy on carcass weight or dressing percentage. There was however a marginal improvement (0.4mm) in P2 back fat depth when pigs fed the RAC diet were administered pST at day 14 and at day 21. In conclusion, the results from this investigation do not support the novel use of pST to maintain the growth performance response to RAC during the finisher period.

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1. Introduction

Ractopamine hydrochloride (RAC, Paylean™ Elanco Animal Health, Greenfield, IN) is a beta adrenergic agonist (ß-agonist) that is approved for use as an in feed ingredient for pigs. RAC has been widely demonstrated to improve feed efficiency and growth rates both in Australia ((Dunshea *et al.* 1993a; Dunshea *et al.* 1993b; Smits and Cadogan 2003) and overseas (Schinckel *et al.* 2001) by repartitioning nutrients towards increased lean tissue deposition. Physiological ß-agonists such as norepinephrine and epinephrine along with synthetic ß-agonists such as RAC produce a physiological response by binding to ß-adrenergic receptors located on the surface of mammalian cells, thereby activating the G_s protein. The α-subunit of this G_s protein is then able to initiate the production of cyclic adenosine monophosphate (cAMP) through enzymatic activation (Mersmann 1998). cAMP is a major intracellular signalling molecule and its production subsequently influences the activation/ inactivation of numerous intracellular enzymes and the transcription of genes within the cell (Mersmann 1998). There are three subtypes of ß-receptors in the pig (ß1, ß2, and ß3), with the distribution of the receptor subtypes varying between tissues (ie muscle and adipose tissue). The resulting changes in growth performance, feed efficiency and carcass composition observed with ß-agonist's are due to the multiple effects that the activation of the G_s protein has on the regulation of muscle and adipose tissue synthesis and degradation.

The response of finisher pigs to dietary RAC is not constant over the duration of a finisher feeding regime but is most pronounced during the first 2 weeks of feeding and declines thereafter due to the down regulation of ß-receptors (Dunshea *et al.* 1993b; Mills 2002; Sainz *et al.* 1993; Spurlock *et al.* 1994). Several methods have been investigated in an effort to maintain the performance benefits from RAC over a longer feeding period. These have included using step up programs (can become costly with higher inclusion concentrations of RAC) and intermittent feeding (currently being evaluated in CRC project 2H-102). Another potential approach is to utilise recombinant porcine somatotropin (pST, Reporcin™, Zamira Life Sciences) to re-sensitise the ß-receptors. Porcine somatotropin is naturally produced in the pig and is one of the major factors controlling the growth of an animal. On its own, recombinant pST delivered daily to finisher pigs for 28 days prior to slaughter increases average daily gain, improves feed efficiency and reduces adipose tissue deposition (Dunshea 2002). In combination with RAC, daily or twice weekly pST treatment during the final two weeks prior to slaughter has been shown to improve feed efficiency above that of RAC alone (Pork CRC project 2A-105). In cattle, the lypolytic response to epinephrine is enhanced with bovine ST administration as measured by plasma nonesterified fatty acid (NEFA) concentrations following an epinephrine challenge (Sechen *et al.* 1990). Given this, it is hypothesised that a one-off dose of pST to finisher pigs that had been offered RAC diets for the previous two weeks may be enough to enhance ß-receptor sensitivity and therefore sustain the response to RAC through to commercial slaughter weights.

An initial experiment (Rivalea protocol number 10N050C) was conducted during July and August 2010. Analyses of the data showed that there was a lack of a response to the standard finisher Paylean strategy (5 ppm for 28 days). As such, the experiment has been repeated with some minor adjustments to the protocol. The starting age in this secondary study was increased by one week to 17 weeks of age at selection. In addition, the RAC concentration in the test diets was increased to 7.5 ppm and a positive control was

included in the treatment regime (control finisher diet for the 28 day test period plus daily pST injection (5 mg/d) from day 14 to 28).

2. Methodology

Animals and treatments

A total of 97 female pigs (Large White x Landrace, PrimeGro™ Genetics) were identified at 17 weeks of age and transferred to individual finisher accommodation. Pigs were selected in one replicate on the 9th November 2010. Pigs were offered a commercial grower diet (13.9 MJ digestible energy per kg and 0.70 g available lysine per MJ DE) for an initial seven day period while they acclimatised to the individual pens. At 18 weeks of age pigs were individually weighed and randomly allocated to one of five experimental treatments: A: Control finisher diet, no RAC for 28 days; B: RAC finisher diet for 28 days; C: RAC finisher diet for 28 days plus one dose of 10 mg pST at day 14; D: RAC finisher diet for 28 days plus one dose of 10 mg pST at day 14 and again at day 21; E: Control finisher diet, no RAC for 28 days plus daily pST injection (5 mg/d) from day 14 to day 28. The dietary compositions of the two finisher diets are displayed in Table 1. The RAC finisher diet was formulated to contain 7.5 ppm RAC (Paylean™, Elanco Animal Health) with actual Ractopamine concentration analysed by an independent laboratory and displayed in Table 1. The finisher diets were formulated to contain 13.8 MJ digestible energy and 0.62 g available lysine per MJ DE. All diets were pelleted and fed *ad libitum* through to slaughter at 22 weeks of age. All animals had *ad libitum* access to water via nipple drinkers for the entire experimental period. All procedures outlined in this investigation were approved by the Rivalea Animal Care and Ethics Committee (License SPPL111).

Management and measures

Individual pig weights were recorded at entry to the facility (17 weeks of age, day -7) and again at days 0, 7, 14, 21 and 28. Individual feed intakes were recorded weekly as estimated by feed disappearance and feed conversion efficiency subsequently calculated. Pigs were slaughtered at a commercial abattoir at the conclusion of the 28 day test period and hot standard carcass weight (HSCW) and fat depth at the P2 site (65 mm from the midline, measured using the PorkScan ultrasound system) were measured, with dressing percentage calculated from live weight and carcass weight.

Statistical analyses

Differences in growth performance and carcass characteristics due to the RAC/pST treatment strategy were determined using residual maximum likelihood (REML) mixed model analyses. Growth rate, feed intake and feed efficiency data for the initial 14 day period were pooled for the animals offered the control diet and also pooled for the pigs offered the RAC diets given that the pST treatments had not yet commenced. The experimental unit for all analyses was the individual animal. All analyses were performed using Genstat for Windows 8th Edition (Payne *et al.* 2005).

Table 1 - Ingredient composition and analysed nutrient profile of each of the experimental finisher diets, % of diet (as fed basis)

	Control	RAC
Wheat	63.0	63.0
Millmix	21.3	21.3
Soyabean meal	6.0	6.0
Meat meal	3.9	3.9
Water	1.0	1.0
Natuphos 5000	0.01	0.01
Porzyme 9310	0.02	0.02
Tallow	2.4	2.4
Salt	0.2	0.2
Limestone	1.3	1.3
Lysine HCL	0.41	0.41
Methionine	0.05	0.05
Threonine	0.17	0.17
Copper premix	0.10	0.10
Rivalea finisher premix	0.07	0.07
Rumensin	0.08	0.08
Paylean premix		0.0375
Estimated nutrient composition, %*		
DE, MJ/kg	13.8	13.8
Crude protein	17.6	17.6
Crude fat	4.3	4.3
Crude fibre	3.7	3.7
Total Lysine	1.0	1.0
Available lysine: DE ratio g/MJ DE	0.62	0.62
Measured Ractopamine concentration (ppm)		
Ractopamine^	<0.1	7.1

*Estimated from Rivalea Australia Pty Ltd composition data
^Analysed Ractopamine concentration from AsureQuality, Auckland New Zealand

3. Outcomes

The impact of dietary RAC supplementation on growth performance during the initial 14 day feeding period is displayed in Table 2. Pigs offered the RAC diet during the initial 7 day feeding period gained weight 9.4 % faster than those offered the control diet (0.96 and 1.05 kg/d respectively for the control and RAC treatment groups, sed 0.057, P=0.097). This response was not maintained during the subsequent week (ROG day 7 to 14: 1.06 and 1.08 kg/d respectively, sed 0.071, P=0.72), resulting in a more marginal difference in growth performance over the entire 14 day period (Table 2). Feed intake was greater in the RAC treatment group during the initial 14 day period, while feed efficiency was not influenced by diet.

Table 2 - Influence of dietary RAC supplementation on growth performance during the initial 14 day feeding period (pooled data)

	Control	RAC	SED	P-value
ROG (kg/d)	1.01	1.07	0.037	0.11
ADFI (kg/d)	2.39	2.53	0.051	0.009
FCR (kg/kg)	2.42	2.44	0.093	0.84

The impact of dietary RAC supplementation during the finisher period in combination with a one or two dose pST treatment is displayed in Table 3. Growth rate continued to be numerically greater in the pigs offered the RAC diet during the 14 to 28 day period compared to the control animals (1.04 and 1.18 kg/d respectively for the control and RAC treatments groups), with this response largely attributed to an increase in feed intake during this time (2.84 and 3.07 kg/d respectively). Feed efficiency was similar between the pigs offered the control and RAC diets. The addition of the pST treatment at day 14 or alternatively at day 14 and day 21 did not improve growth rate or feed efficiency during the 14 to 28 day period when compared to the pigs offered the RAC diet without additional pST. Daily pST injections from day 14 to day 28 in the absence of dietary RAC resulted in a marked reduction in feed intake and an improvement in feed efficiency during the injection period. Growth rate was also increased by almost 8 %, although this difference was not significant.

Considering the performance from day 0 to 21 or from day 0 to 28, the daily injection of pST from day 14 onwards provided clear advantages in reducing feed intake, improving feed efficiency and minimising adipose tissue deposition during this time. Over the full 28 day experimental period, pigs offered the RAC diet without pST administration gained weight almost 10 % faster than the control animals, with a proportion of this response attributed to a 7% increase in feed intake. Feed efficiency was similar between the two treatment groups. The addition of the pST injections at either day 14 or at day 14 and day 21 did not improve growth rate or feed efficiency above that of the pigs offered the RAC diet without pST.

Carcass weights were similar across the five treatments groups, as was dressing percentage. There was however a trend for reduced P2 back fat depth when pigs offered the control diet were injected daily with pST from day 14 to day 28. The pigs offered the RAC diet and administered pST on day 14 and day 21 also displayed a marginal improvement in carcass P2 (0.4 mm).

There were no adverse effects of either RAC or pST supplementation on animal welfare during the course of this investigation. There were no deaths or removals during the study.

Table 3 - Influence of dietary RAC with or without pST treatment on growth performance and carcass characteristics

	Control	RAC for 28 days	RAC for 28 days plus pST day 14	RAC 28 days plus pST day 14 & day 21	Control diet plus pST daily (5mg/d) day 14-28	SED	*P*-Value
Weight day 0	69.2	69.2	69.3	69.3	69.3	1.54-1.61	1.00
Weight day 14	83.2	84.1	83.5	83.9	83.6	1.82-1.90	0.99
Weight day 28	97.8	100.5	99.0	98.6	99.3	2.15-2.24	0.78
P2 Day 0	7.0	7.0	7.1	7.0	7.0	0.20-0.21	0.99
Leg fat day 0	7.7	7.7	7.7	7.8	7.7	0.31-0.32	0.99
Day 14-28							
ROG (kg/d)	1.04	1.18	1.11	1.05	1.12	0.067-0.071	0.28
ADFI (kg/d)	2.84	3.07	3.00	2.86	2.47	0.111-0.115	<0.001
FCR (kg/kg)	2.75	2.74	2.73	2.78	2.23	0.139-0.145	0.001
Day 0-21							
ROG (kg/d)	1.02	1.13	1.08	1.08	1.09	0.047-0.050	0.26
ADFI (kg/d)	2.53	2.73	2.64	2.60	2.40	0.086-0.093	0.010
FCR (kg/kg)	2.50	2.45	2.48	2.43	2.23	0.096-0.103	0.068
Day 0-28							
ROG (kg/d)	1.02	1.12	1.06	1.08	1.07	0.041-0.044	0.17
ADFI (kg/d)	2.62	2.82	2.75	2.69	2.43	0.085-0.091	<0.001
FCR (kg/kg)	2.58	2.54	2.60	2.49	2.27	0.079-0.085	0.001
ΔP2 day 0-28 (mm)	1.9	2.0	1.8	1.8	1.6	0.26-0.27	0.64
Δ Leg fat depth day 0-28 (mm)	2.8	2.8	2.9	2.6	1.8	0.41-0.43	0.091
Carcass characteristics							
Carcass weight (kg)	73.0	73.5	73.8	72.2	73.4	1.86-2.00	0.93
Carcass P2 (mm)	8.8	8.5	8.6	8.1	7.3	0.55-0.59	0.087
Dressing percentage (%)	74.6	73.5	74.3	73.4	73.7	0.70-0.76	0.38

4. Application of Research

The results from this investigation do not support the novel use of pST to maintain the performance response to dietary RAC during the finisher period. There was no evidence that the one shot or two shot pST regime was able to improve growth rate or feed efficiency above that of the animals offered the standard RAC diet. There was however a marginal improvement (0.4 mm) in carcass P2 back fat depth with the use of dietary RAC in combination with a pST injection at day 14 and day 21. This response may warrant further investigation with finisher pigs of differing genotypes to determine if there is indeed a true effect on carcass P2 from the novel application of pST.

The magnitude of improvement in growth rate with dietary RAC was similar to recent results at the same facility with group housed gilts. It was however unexpected that the improved growth response in this present study was, at least in part, due to an increase in feed intake without any improvement in feed efficiency. This response is unusual and is difficult to explain. The marked improvement in feed efficiency (19 %), reduction in feed intake (13 %) and moderate increase in growth rate (7.7 %) with the daily administration of 5 mg pST during the late finisher period indicates that the diets were nutritionally adequate to enable a response to be observed. The performance improvements observed with the daily administration of pST again highlight the benefits of this product during the finisher period.

5. Conclusion

- From the results of this investigation, the novel use of pST (one or two shot regime) to maintain the growth response to dietary RAC during the finisher period is not supported.
- There may be some opportunity to use a one or two shot pST strategy in combination with dietary RAC to reduce carcass P2, although further investigations would be required to confirm this effect.
- The daily administration of pST during the finisher period in accordance with the label directions remains a resource for producers wishing to improve feed efficiency and reduce adipose tissue deposition.

6. Limitations/Risks

The magnitude of the response to pST and RAC may differ with genotype and as such the response to a one or two shot pST regime may also vary.

7. Recommendations

As a result of the outcomes in this study the following recommendations have been made:

- The use of pST (one or two shot regime) to assist in maintaining the growth response to RAC during the finisher period is not supported from the results in this investigation.
- The daily administration of pST during the finisher period in accordance with the label directions remains a resource for producers wishing to improve feed efficiency and reduce adipose tissue deposition.

8. Acknowledgements

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