PEER REVIEWED

Effect of initial respiratory viral-bacterial combination vaccine on performance, health, and carcass traits of auction-market derived feedlot heifers

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Abstract

A total of 2,528 lightweight heifers were used to compare 2 viral-bacterial respiratory vaccine products containing modified-live infectious bovine rhinotracheitis virus, parainfluenza-3 virus, bovine respiratory syncytial virus, bovine viral diarrhea virus types 1 and 2, and a *Mannheimia haemolytica* bacterial component, on performance, health, and carcass characteristics of cattle in a commercial feedlot setting. The vaccine products compared were Pyramid® 5 + Presponse® SQ (PYR PSQ) and Bovi-Shield GOLD® One Shot (BOV ONE). No differences ($P \geq 0.68$) in gain performance or feed conversion were observed between treatments. Hot-carcass weight tended to be less ($P = 0.06$) in cattle administered PYR PSQ compared to cattle in the BOV ONE treatment group. Percentages of "no roll" and Yield Grade 4 carcasses were higher ($P \leq 0.04$) for BOV ONE cattle, while the percentage of Yield Grade 1 carcasses was higher ($P = 0.05$) in the PYR PSQ treatment. Neither BRD first treatment morbidity nor retreatment risks were significantly different among treatments ($P \geq 0.33$), with 13.25% of all cattle receiving treatment for BRD. The incidence of chronics, case fatalities, and mortalities associated with BRD also did not differ ($P \geq 0.46$) between treatments. Furthermore, the incidence of chronics and mortalities due to all causes did not differ ($P \geq 0.62$) between treatments. There was little evidence to suggest that administration of these different combination vaccines to lightweight auction-market heifers upon arrival at the feedlot results in important health differences.

Key words: bovine, respiratory, BRD morbidity, *Mannheimia haemolytica*, vaccine

Résumé

Une étude comportant 2 528 taures de poids léger a comparé deux vaccins respiratoires viraux-bactériens avec des virus vivants modifiés, contenant le virus de la rhinotrachéite infectieuse bovine, le virus parainfluenza 3 bovin, le virus respiratoire syncytial bovin, le virus de la diarrhée virale bovine de type 1 et 2 et une composante bactérienne de *Mannheimia haemolytica*, au niveau de la performance, de la santé et des caractéristiques de la carcasse chez des bovins dans un parc d'engraissement commercial. Les marques de vaccin à l'étude étaient le Pyramid® 5 + Presponse® SQ (PYR PSQ) et le Bovi-Shield GOLD® One Shot (BOV ONE). Il n'y avait pas de différence entre les deux produits au niveau de la performance du gain ou de la conversion alimentaire ($P \geq 0.68$). Le poids de la carcasse chaude était légèrement moindre ($P = 0.06$) chez les bovins recevant le produit PYR PSQ plutôt que le produit BOV ONE. Le pourcentage des carcasses *'no roll'* et de catégorie de rendement 4 était significativement plus élevé ($P \leq 0.04$) dans le traitement BOV ONE. Le pourcentage de carcasses de catégorie de rendement 1 était significativement plus élevé ($P = 0.05$) dans le traitement PYR PSQ. Il n'y avait pas de différence entre les traitements pour les risques d'un premier traitement de ou de retraitement ($P \geq 0.33$) chez les bovins traités pour le complexe respiratoire bovin (CRB). Au total 13.25% des bovins ont reçu un traitement pour le CRB. L'incidence de cas chroniques, de létalité et de mortalité associés au CRB n'était pas différente entre les deux traitements ($P \geq 0.46$). De plus, l'incidence de cas chroniques et de mortalité pour toutes les causes n'était pas différente entre les traitements ($P \geq 0.62$). Il y avait peu d'évidence que l'administration de ces différents vaccins de combinaison à l'arrivée au parc d'engraissement affecte la performance et la santé chez des taures de poids léger préparées pour le marché des encans.

Introduction

Mannheimia haemolytica is the major bacterial pathogen involved in the pathogenesis of bovine respiratory disease (BRD) in cattle.[3] Further, fibrinous pneumonia attributable to *M. haemolytica* is the most important cause of BRD mortality.[1] In healthy cattle, *M. haemolytica* bacteria are present in the tonsillar crypt and exist as normal microbial flora; however, during stress and/or viral-induced immune dysfunction, these bacteria rapidly proliferate, colonize the nasopharynx, and enter the lungs via aerosolized droplets.[7] Bacteria secrete leukotoxin (LKT) during this growth phase, stimulating serum antibody responses during both natural exposure and LKT-containing vaccine exposure.[6] Typically, the proliferation of *M. haemolytica* and subsequent release of LKT follows viral challenge, which makes the use of vaccination against the common respiratory viruses important and lends justification for the use of such agents in combination with bacterin/toxoid product formulations.

Respiratory viral vaccines possess unique characteristics, such as antigen content, specific strains of killed and/or live-attenuated virus, and presence or absence of an adjuvant. Similarly, bacterial and toxoid components within vaccines can vary; therefore, the objective of this study was to compare the effects of 2 initial respiratory viral-bacterial combination vaccines on performance, health, and carcass traits of auction-market derived heifers fed in a commercial feedlot setting.

Materials and Methods

Cattle

A total of 2,528 heifer calves were allocated to 15 blocks of 2 treatments each, for a total of 30 pens, to evaluate the effects of initial respiratory viral-bacterial combination vaccine on performance, health, and carcass traits. Crossbred heifers of English, Brahman, and exotic origin were procured from auction markets in Kansas, Kentucky, Missouri, Oklahoma, and Tennessee and delivered to a commercial feedlot from November 07, 2013 to December 05, 2013. Calves were unloaded and penned by truckload/source upon arrival and those that were sick, injured, or steers were placed in separate pens. Prior to weighing cattle at initiation of the study, re-implant, and shipping, the load scale was certified, as is standard for scales utilized for commerce. Cattle were randomized as they entered the chute, alternating every other calf to 1 of 2 vaccination treatments until pen replicates were complete to ensure that cattle were equally represented in each group. A coin toss determined which treatment the first animal of each replicate received. Pens housed approximately 84 calves per pen, and average initial weight was 669 lb (304 kg) (range 621 to 717 lb; 282 to 326 kg).

Processing

Upon arrival, cattle were placed in pens and provided *ad libitum* access to prairie grass hay and water prior to processing within 36 hours. Cattle were administered the following items:

- Serially-numbered lot ear tag with processing date
- Trial vaccine according to randomization
  - Modified-live infectious bovine rhinotracheitis virus (IBRV), parainfluenza-3 virus (PI_3V), bovine viral diarrhea virus types 1 and 2 (BVDV), and bovine respiratory syncytial virus (BRSV) combination vaccine + *Mannheimia haemolytica* toxoid (2 mL)[a] administered SC in the neck
  - Modified-live IBRV, PI_3V, BVDV types 1 and 2, and BRSV combination vaccine + whole cultures of *Mannheimia haemolytic* (2 mL)[b] administered SC in the neck
  - Tilmicosin[c] (2 mL/100 lb (45.5 kg) of body weight) administered SC in the right neck to all replicates due to high-risk status
  - Moxidectin[d] (1 mL/110 lb (50 kg) of body weight) administered SC in the right neck
  - Growth promoting implant[e]
  - Oxfendazole[f] (0.9 mL/100 lb (45 kg) of body weight) administered orally
  - Pregnancy check via ultrasound

Forty-nine short-bred heifers (less than 90 days in gestation) were confirmed and aborted at the time of processing. Heifers more than 90 days in gestation were not enrolled in the trial. A terminal implant[g] was administered at approximately 78 days-on-feed (DOF) (range 65 to 91 DOF). No heifers were revaccinated with viral respiratory vaccine.

Treatment Assignment

Vaccine treatment was determined as cattle went through the chute, with alternating treatment assigned to each animal as it was processed and a coin toss to designate which treatment the first animal of each replicate would receive. Truckloads of cattle were kept together to ensure that cattle in each replicate were of similar background, age, and weight. A total of 15 pen replicates were placed on study, averaging 84 calves per pen (range 79 to 102). All cattle were housed in open air pens with dirt floors and 140 feet (42.7 meters) of linear concrete bunk space and fence-line overflow water tanks.

Pen riders and treatment personnel were blinded to experimental treatment, and cattle exhibiting clinical signs of disease were pulled from their home pen for evaluation. Standard feedlot protocol specified that cattle must have a rectal temperature of ≥ 104° F (40° C), and clinical signs of BRD, including depression, lowered head carriage, nasal and/or ocular discharge, coughing, stiff gait, or depressed ruminal fossa, to qualify for treatment. Treated cattle were generally returned to their home pen; however, those that were treated more than twice were recovered in hospital pens or railed (culled), if necessary. Feed consumed by animals retained in the hospital was prorated back to the appropriate home pen prior to data analysis. Any animals treated for BRD at least 3

times were considered chronics and removed from the final growth performance analysis. Dead cattle were necropsied by either a veterinarian or feedlot personnel.

Feed

Cattle were fed 3 times daily. Diets were consistent across treatments and replicates, and consisted of steam-flaked corn, high-moisture corn, wet distillers grain, corn silage, alfalfa hay, and liquid supplement. Monensin[h] and tylosin[i] were fed for the entire feeding period. At approximately 35 DOF, melengestrol acetate[j] was incorporated into the third step-up ration. Ractopamine[k] was included in the ration when heifers were within 30 days of harvest.

Marketing

Heifers were visually assessed to determine adequate finish for market, and had an average of 163 (DOF range of 144 to 181 when harvested). A total of 89 heifers either died or were railed through alternate marketing channels prior to the end of the study. All heifers from a given replicate were harvested on the same day, with 11 harvest dates. Carcass data were provided by lot rather than individual ID, as cattle were sold on the grid. Heifers were shipped to a packing plant in Kansas, and routine carcass data were collected for all cattle.

Statistical Analyses

Data with binomial (e.g. health outcomes) and normal distributions (e.g. ADG) were analyzed using generalized and general linear mixed models, respectively, in SAS[l] Glimmix. Data were analyzed as a randomized complete block design with pen as experimental unit. Model adjusted mean estimates (LSmean), corresponding standard errors or confidence intervals, are reported for each treatment group. Treatment and replicate (block) were included in the model as categorical variables; treatment was considered a fixed effect, and replicate was considered a random effect.

Results and Discussion

Performance, carcass, health, and financial data are presented in Tables 1, 2, 3, and 4, respectively. Cattle were fed for an average of 163 days. No differences in ADG ($P = 0.87$) or feed efficiency ($P = 0.68$) were observed. Additionally, no performance differences were observed at time of reimplant (data not shown). Cattle administered PYR PSQ had a greater percentage of Yield Grade 1 carcasses ($P = 0.05$); whereas, cattle administered BOV ONE had a greater percentage of "no-roll" ($P = 0.04$) and Yield Grade 4 ($P = 0.01$) carcasses. Hot-carcass weight ($P = 0.06$) tended to be greater in the BOV ONE treatment group. The mean number of head harvested per pen did not differ statistically; however, across the entire study, 7 more animals survived to harvest in the PYR PSQ group compared to those in the BOV ONE group.

No differences were observed between treatment groups (P values > 0.33) with regard to first BRD treatment risk (morbidity) or retreatment risks. Across all cattle, a total of 335 were treated at least once for BRD (13.25%), and 50 animals (1.98%) died from BRD. Case fatality risk was not different ($P = 0.53$) among treatments, 11.95% and 15.34% for PYR PSQ and BOV ONE groups, respectively. Similarly, BRD mortality was not different ($P = 0.46$), 1.66% and 2.29% for PYR PSQ and BOV ONE, respectively. Of the 2,528 heifers on study, a total of 89 (3.52%) died or were railed (all causes). An animal was railed when it could no longer compete with its peers, as evidenced by poor weight gain, or was unlikely to recover from illness. No differences between treatments were observed in total chronics ($P = 0.62$) or total mortality ($P = 0.63$). While several health outcomes (Table 3) appeared to be numerically better in PYR PSQ animals, no statistical significance was observed between treatments.

Multiple studies have demonstrated an immune response to parenteral administration of LKT-containing bacterin products.[2,4,5] Bacterial and toxoid components in vaccines vary. The LKT antigenic component of PYR PSQ is

Table 1. Feed and gain performance of feedlot heifers vaccinated at arrival with different viral/bacterial combination respiratory vaccines (model-adjusted means).

Item	PYR PSQ*	BOV ONE†	SE	*P*-value
No. pens	15	15		
No. heifers received‡	84.27	84.27	1.64	1.00
No. heifers shipped‡	81.53	81.07	1.74	0.50
Initial weight§, lb	669.28	668.56	8.19	0.76
Days-on-feed	163	163		1.00
Average daily gain‖, lb	3.15	3.16	0.05	0.87
Feed:gain¶	6.05	6.09	0.06	0.68

*Pyramid® 5 + Presponse® SQ, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
†Bovi-Shield GOLD® One Shot, Zoetis, Florham Park, NJ
‡Pen average
§Weight at feedlot
‖Deads-in
¶Based on unshrunk initial weights and 4% shrunk final weights

derived from a cell-free extract, whereas the LKT antigenic component of BOV ONE is comprised of a bacterin/toxoid combination.[3] Despite the variation in vaccine components, no significant differences among health variables were observed (Table 3). While the ability to assess disease prevention by the vaccines is not possible, as a negative control was not included in this study, it appears that PYR PSQ and BOV ONE combination vaccines were comparable for on-arrival vaccination of feedlot heifers.

It is unclear why there were a greater number of "no-rolls" and Yield Grade 4 carcasses and fewer Yield Grade 1 carcasses in the BOV ONE group as compared to the PYR PSQ group. While there were no significant differences in clinical morbidity and mortality outcomes (Table 3), the observed differences in the distribution of carcass yield may be reflective of more subtle differences in subclinical disease or survival of a subset of the population until harvest. The observed carcass differences are reflected in the significant difference ($P = 0.03$) among treatment groups in the mean dollars per head for total carcass adjustments (total carcass premiums and discounts from closeouts for all harvested cattle) as shown in Table 4.

Table 2. Carcass traits of feedlot heifers vaccinated at arrival with different viral/bacterial combination vaccines (model-adjusted means and 95% confidence intervals).

Item	PYR PSQ*	BOV ONE†	*P*-value
Total head finished	1223	1216	-
Hot carcass weight, lb	762.75	767.90	0.06
	(752.68 – 772.81)	(757.83 – 777.97)	
≥ Choice, %	69.99	68.75	0.51
	(65.37 – 74.22)	(64.06 – 73.08)	
Select, %	29.12	29.26	0.94
	(24.84 – 33.79)	(24.97 – 33.95)	
No roll, %	0.73	1.64	0.04
	(0.34 – 1.59)	(0.87 – 3.08)	
Yield Grade 1, %	9.90	7.60	0.05
	(7.59 – 12.81)	(5.71 – 10.04)	
Yield Grade 2, %	40.36	40.09	0.89
	(36.75 – 44.08)	(36.48 – 43.81)	
Yield Grade 3, %	40.60	39.88	0.72
	(36.95 – 44.37)	(36.24 – 43.64)	
Yield Grade 4, %	8.16	11.46	0.01
	(6.29 – 10.53)	(9.04 – 14.42)	
Yield Grade 5, %	0.31	0.31	0.99
	(0.10 – 0.93)	(0.10 – 0.94)	

*Pyramid® 5 + Presponse® SQ, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
†Bovi-Shield GOLD® One Shot, Zoetis, Florham Park, NJ

Table 3. Health performance of feedlot heifers vaccinated at arrival with different viral/bacterial combination vaccines (model-adjusted means and 95% confidence intervals).

Item	PYR PSQ*	BOV ONE†	*P*-value
BRD 1st treatment morbidity, %	12.01	13.32	0.33
	(9.03 – 15.81)	(10.08 – 17.40)	
BRD retreatment risk‡, %	28.29	26.13	0.66
	(21.50 – 36.25)	(19.85 – 33.57)	
BRD case fatality, %	11.95	15.34	0.53
	(0.60 – 75.20)	(1.26 – 72.10)	
BRD mortality, %	1.66	2.29	0.46
	(0.10 – 21.67)	(2.15 – 20.35)	
Mortality-all causes, %	2.61	2.92	0.63
	(1.80 – 3.77)	(2.06 – 4.14)	
Chronic-BRD, %	0.32	0.32	0.99
	(0.11 – 0.89)	(0.11 – 0.89)	
Chronic-all causes, %	0.63	0.87	0.62
	(0.01 – 36.59)	(0.02 – 29.16)	

*Pyramid® 5 + Presponse® SQ, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
†Bovi-Shield GOLD® One Shot, Zoetis, Florham Park, NJ
‡Retreatment risk for each pen was calculated as the percentage of cattle first treated for BRD that were subsequently treated again for BRD.

Table 4. Financial data of feedlot heifers vaccinated at arrival with different viral/bacterial combination vaccines (model-adjusted means).

Item	PYR PSQ*	BOV ONE†	SE	*P*-value
Overall medicine costs‡, $/hd	26.94	27.27	0.85	0.53
BRD treatment costs, $/hd	4.87	5.26	0.70	0.48
Cost of gain§, $/cwt, deads in	99.34	101.39	1.37	0.20
Total carcass adjustments to net harvested‖, $/hd	20.01	14.33	2.28	0.03
Total cattle revenue¶, $	1,498.90	1,506.61	41.16	0.23
Total feedlot costs per hd, $	478.46	486.28	7.44	0.16

*Pyramid® 5 + Presponse® SQ, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
†Bovi-Shield GOLD® One Shot, Zoetis, Florham Park, NJ
‡Includes metaphylaxis
§From feedlot closeouts; all actual costs and/or revenues were included, except vaccine costs which were set to 0$ for both groups
‖All actual carcass premiums and discounts from closeouts were included for all harvested cattle; excludes chronic sales
¶Mean total feedlot costs include feed, yardage, processing, medicine, and others

No differences in overall medicine costs or cost of BRD treatment were observed between treatments ($P \geq 0.48$) (Table 4). Mean cost of gain ($/cwt) with dead cattle included (pay weight to pay weight) was not significantly different ($P = 0.20$) between treatment groups. Total cattle revenue and total feedlot costs, including yardage, feed, processing, and medicine, did not differ ($P \geq 0.16$) between treatments.

Conclusion

The PYR PSQ and BOV ONE respiratory viral/bacterial combination vaccines compared in this trial contain different viral/bacterial components and adjuvants, yet are designed to stimulate immunity to the same pathogens (IBRV, PI-3V, BRSV, BVDV types 1 and 2, and *Mannheimia haemolytica* LKT). There was little evidence to suggest that there were any important health differences between these 2 combination vaccines when administered to lightweight auction-market heifers upon arrival at the feedlot.

Endnotes

[a]Pyramid® 5 + Presponse® SQ, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[b]Bovi-Shield GOLD® One Shot, Zoetis, Florham Park, NJ
[c]Micotil, Elanco Animal Health, Greenfield, IN
[d]Cydectin, Boehringer Ingelheim Vetmedica, Inc., St. Joseph MO
[e]Revalor-IH, Merck Animal Health, Summit, NJ
[f]Synanthic, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[g]Revalor-H, Merck Animal Health, Summit, NJ
[h]Rumensin, Elanco Animal Health, Greenfield, IN
[i]Tylan, Elanco Animal Health, Greenfield, IN
[j]HeifermaX, Elanco Animal Health, Greenfield, IN
[k]Optaflexx, Elanco Animal Health, Greenfield, IN
[l]SAS Institute Inc., Cary, NC, Software Version 9.3

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