

Effect of porcine circovirus type 2 vaccine on postweaning performance and carcass composition

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Summary

Objective: To evaluate the effect of porcine circovirus type 2 (PCV2) vaccination on average daily gain (ADG), mortality, carcass fat depth, loin depth, and percent lean.

Materials and methods: Pigs were weighed and ear-tagged 2 days prior to weaning to examine the influences of PCV2 vaccination on ADG, mortality, and carcass composition. Within litters, pigs were matched in pairs by gender and weight. Matched pairs of pigs were randomly allocated to Vaccinated and Control groups. Vaccinated pigs received a PCV2 killed baculovirus vector

vaccine at weaning (approximately 3 weeks of age) and 3 weeks later. Pigs were weighed again at the end of the nursery phase and prior to marketing. Carcass data from the two groups of pigs were collected and compared.

Results: Overall ADG was higher for Vaccinated pigs (630.5 g per day) than for Control pigs (580.6 g per day; $P < .001$). More Vaccinated pigs (93%) went to primary markets than did control pigs (79%; $P < .01$). Vaccinated and Control pigs did not differ in carcass fat depth, loin depth, or percent lean ($P > .05$).

Implications: Under the conditions of this study, PCV2 vaccination has a large impact on growth rate and on the proportion of pigs going to primary markets, but not on carcass fat depth, loin depth, or percent lean, measurements that are used to determine market value.

Keywords: swine, porcine circovirus, carcass composition, vaccine, herd health and production medicine

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Resumen - Efecto de la vacuna contra circovirus porcino tipo 2 en el desempeño post destete y composición del canal

Objetivo: Evaluar el efecto de la vacunación contra circovirus porcino tipo 2 (PCV2 por sus siglas en inglés) en la ganancia diaria promedio (ADG por sus siglas en inglés), mortalidad, profundidad de la grasa del canal, profundidad del lomo, y porcentaje de magro.

Materiales y métodos: Los cerdos se pesaron e identificaron en la oreja 2 días antes del destete para evaluar la influencia de la vacunación contra PCV2 en la ADG, mortalidad, y composición del canal. Dentro

de las camadas, los cerdos se organizaron en pares por género y peso. Las parejas de cerdos se distribuyeron al azar en el grupo Vacunado y Control. Los cerdos del grupo Vacunado recibieron una vacuna muerta de PCV2 con un baculovirus como vector, al destete (aproximadamente a las 3 semanas de edad) y 3 semanas después. Los cerdos se pesaron nuevamente al término de la fase de destete y antes de la venta. Se recolectaron y compararon los datos de la canal de los dos grupos de cerdos.

Resultados: La ADG total fue mayor en los cerdos del grupo Vacunado (630.5 g por día) que en el Control (580.6 g por día; $P < .001$). Más cerdos del grupo Vacunado

(93%) que del Control (79%; $P < .01$) fueron clasificados como cerdos de primera. Los cerdos del grupo Vacunado y Control no difirieron en la profundidad de la grasa de la canal, profundidad del lomo ó porcentaje de magro ($P > .05$).

Implicaciones: Bajo las condiciones de este estudio, la vacunación contra PCV2 tiene un gran impacto en el índice de crecimiento y en la proporción de cerdos de primera, pero no en la profundidad de la grasa de la canal, la profundidad del lomo ó el porcentaje de magro, medidas que se utilizan para determinar el valor de mercado.

Résumé - Effet d'un vaccin contre le circovirus porcine de type 2 sur les performances de production en période post-sevrage et la composition de la carcasse

Objectif: Évaluer l'effet de la vaccination contre le circovirus porcine de type 2 (PCV2) sur le gain quotidien moyen (ADG), la mortalité, l'épaisseur du gras de la carcasse, la profondeur de la longe, et le pourcentage de maigre.

Matériels et méthodes: Les porcs ont été pesés et un marqueur d'oreille apposé 2 jours avant le sevrage afin d'examiner les effets d'une vaccination contre PCV2 sur l'ADG, la mortalité et la composition de la carcasse. À l'intérieur des portées, les porcs ont été jumelés par genre et poids. Les

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paires de porcs étaient allouées de manière aléatoire aux groupes Vaccinés et Témoin. Les porcs vaccinés ont reçu du PCV2 tué dans un vecteur de baculovirus au moment du sevrage (environ 3 semaines d'âge) et 3 semaines plus tard. Les porcs ont été pesés de nouveau à la fin de la période en pouponnière et avant la mise en marché. Les données sur les carcasses des deux groupes ont été obtenues et comparées.

Résultats: Globalement, l'ADG était plus élevé pour les porcs Vaccinés (630.5 g/j) que pour les porcs Témoin (580.6 g/j; $P < .001$). Plus de porcs Vaccinés (93%) sont allés aux marchés primaires que les porcs Témoin (79%; $P < .01$). Aucune différence ne fut notée entre les deux groupes en ce qui concerne l'épaisseur de gras de la carcasse, la profondeur de la longe, ou le pourcentage de maigre ($P > .05$).

Implications: Dans les conditions expérimentales de la présente étude, la vaccination contre PCV2 avait un impact marqué sur le taux de croissance et le pourcentage de porcs acheminés aux marchés primaires, mais pas sur l'épaisseur de gras de la carcasse, la profondeur de la longe, ou le pourcentage de maigre, données qui sont utilisées pour déterminer la valeur marchande.

The effect of circovirus vaccination on mortality rate and performance has been reported in studies that compared vaccinated pigs with nonvaccinated pigs under field conditions. Some of the effects of porcine circovirus type 2 (PCV2) vaccination in pigs include greater ADG during the finishing period, lower finishing cull rates, and a lower probability of being lightweight at the time of marketing, than in nonvaccinated pigs.¹⁻³ Also, it has been reported that a greater percentage of vaccinated pigs than nonvaccinated pigs were marketed into the primary market chain.⁴ It is important to measure pig growth efficiency, but measures of efficiency should include the amount of lean edible pork produced and how desirable it is for processing and consumption.⁵ Carcass weight, fat depth, loin depth, and percent lean are the common carcass measurements implemented to establish the market value of pigs. These measurements also provide information to producers to improve carcass composition.⁶ If vaccination impacts carcass composition, this information is necessary to completely determine the cost-benefit ratio of employing vaccine. There are reports that in pigs vaccinated for PCV2 and *Mycobacterium*

plasma hyopneumoniae, carcass weight is greater than in nonvaccinated pigs^{2,7,8} and that loin muscle depth is greater in PCV2-vaccinated pigs.⁷ But it was also reported that *M hyopneumoniae* vaccination had no effect on loin eye area, backfat thickness, or index,⁸ and PCV2 vaccination had no effect on lean meat ratio.² Disease suppresses appetite and therefore growth rate, which negatively impacts profitability. However, purposeful reduction in feed intake (limit feeding) has been used to reduce backfat of finishing pigs and improve carcass merit. Some diseases are catabolic and reduce muscle mass. Because of all the potential impacts of disease on carcass composition, studies of vaccine effectiveness should include carcass measurements. The purpose of this study was to evaluate the effect of PCV2 vaccination on ADG, mortality, and carcass measurements.

Materials and methods

Study pigs were commercially owned animals managed under the standard operating procedures of the farm. Housing was standard within the industry for each phase of growth and the animals were humanely cared for. The National Pork Board's PQA Plus guidelines⁹ for animal care and handling were observed.

Herd

The study was conducted at an isolated 1200-sow farrow-to-wean farm in northeast Michigan without a history or clinical signs of porcine circovirus associated diseases (PCVAD) and positive for *M hyopneumoniae* and porcine reproductive and respiratory syndrome (PRRS). The herd was originally composed of Landrace and Landrace × Large White sows. During the year before this study was initiated, replacement gilts and semen for artificial insemination were obtained from Newsham Choice Genetics, West Des Moines, Iowa. Mortality rates in the nursery (4.0%) and finisher (3.5%) were lower than those reported in herds which had experienced severe PCVAD (cumulative mortality rate 12.4% at finishing).¹ The farm had not previously used a PCV2 vaccine.

Pigs

Three hundred forty-eight unweaned crossbred pigs (19 days of age approximately), encompassing all 39 litters in one week's farrowing group, were included in the study. Parity distribution in that week's farrowing group was typical of the industry, with approxi-

mately 20% gilt litters and no sows over parity 8. Because maternal immunity was considered to have a major influence on disease status, treatment groups were determined as follows. At 2 days prior to weaning (approximately 3 weeks of age), all piglets within each litter were weighed on an electronic scale with an accuracy of 1%. Their weights were recorded on their backs, and the piglets were returned to the farrowing crate. Pigs were then assigned to pairs within a litter by weight and gender. Within a pair, vaccination with PCV2 vaccine (Vaccinated; 174 pigs) or no treatment (Control; 174 pigs) was determined by coin toss. Pigs were individually identified with ear tags at the time of treatment designation. After weaning, the pigs were housed for approximately 6 weeks in nursery rooms, stocked at 15 to 20 pigs per pen with the two treatment groups mixed in the pens. Pigs were vaccinated against *M hyopneumoniae* during the fourth week in the nursery in accordance with the farm's vaccination protocol. For the finishing phase, pigs were reallocated to 18 pens (2.4 m × 7.05 m), with the ratio of Control to Vaccinated pigs ranging from 3:7 to 7:3. The finishing barn (15 m × 240 m) was a curtain-sided building with a totally slatted floor. At 27 weeks of age, the first group of pigs was sent to slaughter, with the remaining pigs marketed in two batches at subsequent 2-week intervals. Pigs were loaded and penned in the truck by treatment designation and remained with their treatment groups through harvest. Carcass measurements from 159 Vaccinated and 138 Control pigs were provided by the packing plant.

PCV2 vaccine

The PCV2 vaccine administered in the study was a commercially available killed baculovirus-expressed capsid-protein-derived vaccine (Circumvent PCV; Intervet/Schering-Plough Animal Health, Millsboro, Delaware). The vaccine was administered according to label instructions.

Study design

The study was a controlled clinical trial. The pigs assigned to the Vaccinated group were given a single dose of the PCV2 vaccine (2 mL) intramuscularly in the neck 2 days before weaning (approximately 3 weeks of age). Three weeks later, pigs received the booster dose of vaccine in accordance with the manufacturer's recommendations. All pigs were weighed before they were moved from the nursery to the finishing buildings (8 weeks of age); 13 pens containing 186

of the study animals (87 Controls and 99 Vaccinated) were weighed at 22 weeks of age; and 11 pens containing 159 pigs (60 Controls and 99 Vaccinated) were weighed at 24 weeks of age. Normal management practices on the farm resulted in some pens containing non-trial pigs, so many pigs had to be moved from their pens to the scale to accomplish weighing. Two days were chosen to weigh pigs in order to have sufficient help to process them. Parameters calculated were average daily gain (ADG) for the nursery (weight gain ÷ the number of days from first PCV2 vaccination to the end of the nursery phase) ADG for the finishing phase (weight gain ÷ the number of days from the end of the nursery phase to 154 days of age and 168 days of age), and overall ADG (weight gain ÷ the number of days from first PCV2 vaccination to 168 days of age). Pigs that were euthanized or died (without severe postmortem autolysis) were necropsied. The percentage of pigs that reached the primary market was calculated. Primary market for this study was defined as pigs sold to the primary purchaser at full market weight. When pigs were marketed, carcass weight, loin depth, fat depth, and lean percentage were obtained from the slaughter plant and compared for Vaccinates and Controls. Pigs were sent to slaughter in three loads at 2-week intervals, with each load composed of the pigs that had reached market weight at that time. In the slaughter plant, it was possible to track the treatment classification but not individual pig identification; treatment identification was possible through the ear tags and the location of the animals in different compartments in the truck. The first two loads were composed primarily of Vaccinated rather than Control pigs.

Statistical analysis

For carcass measurements, data were analyzed with a linear mixed model using the Mixed Procedure software in SAS version 9.1 (SAS Institute Inc, Cary, North Carolina). Slaughter day was considered a random effect. The treatment group within a load was the experimental unit. Treatment (Vaccinated versus Control) was included as a fixed effect. Carcass weight was adjusted to a common market age by including age at market as a covariate in the model. Data for ADG and live weight were analyzed with an ANOVA using General Linear Model software in SAS. The individual pig was the experimental unit. The model included the effects of treatment and gender. Results are reported as least squares means. Chi-square and Fisher's exact test were used to

investigate possible differences in mortality between treatments. Values of $P < .05$ were considered significant.

Results

Live weight

At weaning and at the conclusion of the nursery phase, Vaccinated and Control pigs did not differ in weight (Table 1). However, at 22 and 24 weeks of age, Vaccinated pigs were significantly heavier than Control pigs (Table 1).

Growth performance

There was no significant interaction between PCV2 vaccination and gender, demonstrating that the effect of vaccination was the same in males and females. From weaning until the end of nursery phase, ADG did not differ significantly between groups (Table 2). The ADG did differ between Control and Vaccinated groups from the end of nursery to 22 weeks of age and from the end of nursery to 24 weeks of age; overall ADG also differed between treatment groups (Table 2). Among the 174 pigs in each treatment group that initiated the study, 93% of Vaccinated pigs and 79% of Control pigs went to primary markets ($P < .01$). A total of 162 Vaccinated pigs and 138 Control pigs were sent to the slaughter plant (primary market). It was possible to obtain the data from 159 Vaccinated pigs and 138 Control pigs from the slaughter plant.

Carcass composition

In 159 Vaccinated pigs and 138 Controls at slaughter, carcass weight (87.98 kg and 86.89 kg, respectively), carcass backfat

depth (15.7 mm and 15.8 mm, respectively), loin depth (65.88 mm and 65.02 mm, respectively), and percent lean (57.09% and 56.91%, respectively) did not differ significantly between the two treatments (F test; $P > .05$).

Mortality rate

There was a numerical difference in the overall mortality rate between Controls (12 of 174; 6.9%) and Vaccinated pigs (5 of 174; 2.9%), but the difference was not significant ($P > .05$; relative risk [RR], 0.37; 95% confidence interval [CI], 0.13-1.08). Similarly, the numerical difference in mortality rate during the nursery phase was not statistically different between treatment groups: 2.4% for Vaccinated and 4.7% for Control ($P > .05$; RR 0.48; 95% CI, 0.14-1.65). In the finisher phase, mortality rate did not differ between Vaccinated and Control animals ($P > .05$; RR 0.22; 95% CI, 0.02-2.02). Of the 17 pigs that died during the study, 12 (eight Control and four Vaccinated) died during the nursery phase with no lesions characteristic of PCV2 infection, and five died in the finisher phase (four Controls and one Vaccinated) with mild macroscopic lesions of PCV2 infection. Histopathology was not performed at finishing.

Discussion

Results of this study indicate that in this herd, vaccination against PCV2 resulted in significantly greater ADG during the finishing phase and in fewer lightweight pigs at marketing.

Table 1: Average weights (SD) of pigs in a commercial swine production facility, either vaccinated for PCV2 (Vaccinated) or not vaccinated (Control)*

Phase	Body weight (kg)				P†
	n	Vaccinated	n	Control	
Weaning‡	173	5.01 (0.09)	173	4.95 (0.09)	> .05
Nursery§	166	15.82 (0.27)	163	15.79 (0.27)	> .05
Finisher (22 weeks of age)	99	82.08 (1.12)	87	77.56 (1.22)	< .01
Finisher (24 weeks of age)	99	98.04 (1.42)	60	90.52 (2.05)	< .001

* Vaccinated pigs were vaccinated at 3 and 6 weeks of age with a killed PCV2 vaccine. Controls were neither vaccinated nor sham-vaccinated.

† ANOVA used to derive the P values.

‡ Pigs were weighed 2 days before they were weaned (weaning at approximately 21 days of age).

§ Pigs were weighed at 8 weeks of age before moving to the finisher.

PCV2 = porcine circovirus type 2

Table 2: Least squares means of average daily gain (g) in pigs in a commercial swine production facility, either vaccinated for PCV2 (Vaccinated) at 3 and 6 weeks of age or not vaccinated (Control)*

Phase	n	Vaccinated	SE	n	Control	SE	P†
Weaning to end of nursery	165	308.4	0.006	161	308.4	0.006	> .05
End of nursery to 22 weeks of age	99	671.3	0.01	86	621.4	0.01	< .001
End of nursery to 24 weeks of age	98	725.7	0.02	57	657.7	0.01	< .001
Weaning to 24 weeks of age	98	630.5	0.01	59	580.6	0.01	< .001

* 174 pigs were assigned to each treatment group (Vaccinated and Control). Vaccinated animals received a killed PCV2 vaccine 2 days before weaning (approximately 3 weeks of age) and 3 weeks later. Pigs were weighed at approximately 3 weeks of age (346 pigs) and at the end of the nursery phase (8 weeks of age). Pigs were again weighed at either 22 or 24 weeks of age (variation due to the weighing process). Number of observations varied at each weigh date due to loss of pigs or the weighing process.

† F test used to derive the P values.

The overall mortality rate, the mortality rate during the finishing phase, and the mortality rate during the nursery phase did not differ significantly between Vaccinated and Control groups. In this herd, PCV2 infection was subclinical, which can reduce growth rate but may have no detrimental effect on mortality, in accordance with previous studies.^{7,10,11} In subclinical cases, development of cellular immunity may limit the severity of disease expression.^{12,13} The subclinical presentation of PCV2 in this herd was confirmed by the absence of lesions during the nursery phase and observation of mild macroscopic lesions during the finishing phase. These results do not agree with those of a previous study¹⁴ that reported significant differences in mortality rate between vaccinated and nonvaccinated animals with subclinical PCVAD in a herd that was free of PRRS and *M hyopneumoniae*. However, these results are in agreement with two other studies^{7,11} that reported no difference in mortality rate between vaccinated and nonvaccinated pigs in herds with subclinical PCV2 infection: one of these herds was PRRS-negative and *M hyopneumoniae*-positive. During the nursery phase in the current study, PCV2 vaccination had no significant effect on ADG. From the end of nursery phase to 22 weeks of age, ADG was greater by 7.4% in Vaccinated pigs than in Control pigs. From the end of the nursery phase to 24 weeks of age, ADG was greater by 9.4% in Vaccinated pigs than in Control pigs. Finally, ADG from weaning to 24 weeks was greater by 7.9% (49.9 g) in Vaccinated pigs than in Controls. These results agree with those of other studies that evaluated the effects of PCV2 vaccination on growth performance.¹⁻³ In the current study, ADG was

higher in Vaccinated pigs than in Controls, yet mortality rates in the two treatment groups were similar, suggesting that the herd experienced subclinical PCV2 infection, with mortality rate unaffected but with a negative effect on growth performance.

The immune response to disease-organism antigens is a major cause of reduced growth rate, as indicated by studies in several species.^{15,16} In pigs, it has been reported to reduce live weight, growth, feed intake, and muscle growth during antigen challenge.¹⁵ Even though ADG in the current study differed significantly between Vaccinated and Control pigs, the common carcass measurements used to determine carcass value did not differ significantly between treatment groups. Carcass weight did not differ significantly between Control and Vaccinated pigs when adjusted to common market age. The major influences upon carcass yield are live weight, fatness, and genotype.¹⁶ Previous studies reported that pigs vaccinated against PCV2 had heavier carcass weights.^{2,7} Vaccinated pigs grew faster and a greater percentage were marketed into primary markets; thus, under the conditions of this study (ie, vaccinating pigs in a herd subclinically infected with PCV2), vaccinated pigs can be marketed younger at a constant market weight, or will be heavier at a constant market age, than nonvaccinated pigs. This is in agreement with a previous study⁴ that reported a higher percentage of vaccinated versus control pigs that were marketed into prime markets. In a study⁸ that compared pigs vaccinated with a killed *Mycoplasma hyopneumoniae* vaccine with controls, carcass weight of vaccinated pigs was greater and percentage of lightweight pigs was lower than the same parameters in nonvaccinated

pigs, but there were no effects on other carcass characteristics. In a study that evaluated the effects of antigenic challenge (an *Escherichia coli* lipopolysaccharide and either modified-live or killed vaccines) on growth and composition of segregated early-weaned pigs, there was no significant difference in backfat depth measurements between control and antigen-treated pigs.¹⁵ In cattle, even though no clear mechanisms have been established linking disease and carcass traits, there is growing evidence that disease has the potential to affect not only carcass weight, but also the quantity, location, and ratio of muscle, fat, and water; more research is required to understand how cattle disease affects carcass traits.¹⁷ Exposure of animals to pathogenic or nonpathogenic antigens results in release of cytokines. In a previous study¹⁸ it was demonstrated that administration of interleukin-1 and tumor necrosis factor induces anorexia, depresses protein synthesis, and stimulates protein degradation in skeletal muscle. Also, acute activation of the immune system via administration of nonpathogenic antigens results in lower voluntary feed intake, body growth rate, and efficiency of feed utilization in chicks and pigs.¹⁸ Minimizing the exposure of pigs to environmental antigens (pathogenic and nonpathogenic) consequently minimizes chronic activation of their immune systems, allowing them to express their whole potential for body growth, efficiency of food utilization, and carcass leanness.¹⁸

In this study, backfat depth did not differ significantly between treatment groups. This herd's subclinical PCV2 status could explain why there was no difference in backfat thickness between Vaccinated and Control pigs. Pigs clinically infected with PCV2

may have greater variation in weight gain, which would influence backfat depth.¹⁶ Since there was no significant difference between treatment groups for backfat and loin depth, consequently, lean percentage also did not differ between Control and Vaccinated animals. This result does not agree with that in a previous study⁷ that reported greater loin muscle depth in vaccinated pigs, but does agree with results of a study² that evaluated carcasses from pigs vaccinated against PCV2 and nonvaccinated controls. A Canadian field trial¹⁴ reported that pigs that received one dose of PCV2 vaccine had fewer kilograms lean meat per carcass than pigs that received two doses of vaccine. In another study,¹⁵ carcasses from control pigs had greater loin depth than carcasses from antigen-treated pigs. This trial controlled for carcass weight when backfat and loin eye were compared. In another trial⁷ examining these traits, all pigs were marketed at a designated time, and body weight was considerably less in unvaccinated pigs.

Implications

- Under the conditions of this study, in a herd subclinically infected with PCV2, growth rate is better in pigs vaccinated for PCV2 than in nonvaccinated pigs.
- Pigs vaccinated for PCV2 may reach market weight faster than nonvaccinated pigs.
- PCV2 vaccination can be used to increase the proportion of pigs sold to the primary market.
- Under the conditions of this study, improvement in carcass fat depth, loin depth, and percent lean should not be anticipated after initiating a PCV2 vaccination program.

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