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Effects of Gruel Feeding and Oral Dextrose on the Survivability of Pigs After Weaning

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Effects of Gruel Feeding and Oral Dextrose on the Survivability of Pigs After Weaning

Abstract

Two experiments were conducted using 3,087 (Exp. 1) and 988 (Exp. 2) pigs to determine the effect of gruel feeding (Exp. 1) and administering oral dextrose (Exp. 2) on pig survivability after weaning. Upon arrival to the nursery, the smallest 10% of pigs were selected and randomly placed in designated pens with 61 to 108 pigs per pen. Pens of small pigs were assigned to 1 of 2 treatments in a completely randomized design. Treatments consisted of gruel feeding two or four times per day starting 14-d post-placement. At each gruel feeding, approximately 2.5 lb of solid feed was added to a round Rotecna bowl (Rotecna S.A., Agramunt, Spain) located at the front of the pen. Water was added to feed at a decreasing rate over time such that d 0 to 5, 6 to 10, and 11 to 14 the ratio of water to feed was 3:1, 1:1, and 1:3, respectively. In Exp. 2, every other pig removed from general population or pens of small pigs for welfare considerations (lameness, sick, or fallback) received a single 10 mL oral dose of a 50% dextrose solution (Vet One, MWI Animal Health, Boise, ID), as a source of glucose, before being placed in a removal pen. All removed pigs were tagged and weighed, blood glucose measured prior to and 30 min after entering removal pens, and their body temperature recorded. Overall, gruel feeding the small pigs two or four times per day for 14-d post-placement did not influence (P > 0.10) mortality from weaning to the end of gruel feeding (3.78 vs. 4.25%, respectively). Likewise, dextrose administration did not influence (P > 0.10) pig mortality after removal to approximately d 38 after weaning (21.4 vs. 23.4% respectively), even though blood glucose levels increased (P < 0.001) for pigs administered dextrose compared to pigs not administered dextrose (increased by 11.4 vs. 19.1 mg/dL). An interaction was observed for blood glucose and body temperature (P < 0.001). Pigs with a blood glucose less than 70 mg/dL had increased mortality as body temperature at removal increased. In contrast, pigs with a blood glucose between 70 and 120 mg/dL or greater than 120 mg/dL had decreased mortality as body temperature increased. Pigs weighing less than 10 lb at removal had an increased mortality (P < 0.001) compared to pigs weighing greater than 10 lb at removal. In summary, gruel feeding four times per day vs. two times per day or providing removed pigs glucose supplementation did not improve survivability of pigs after weaning. Additionally, removed pigs with low body weight, body temperature below or above the normal range, or high blood glucose had decreased survivability.

Keywords

dextrose, glucose supplement, gruel feeding, mortality, nursery pig, weaning

Cover Page Footnote

This project was supported by the National Pork Board and the Foundation for Food and Agriculture Research grant #18-147. Appreciation is expressed to Pillen Family Farms (Columbus, NE) for their technical support in this trial.

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K-STATE Research and Extension

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Effects of Gruel Feeding and Oral Dextrose on the Survivability of Pigs After Weaning[1,2]

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Summary

Two experiments were conducted using 3,087 (Exp. 1) and 988 (Exp. 2) pigs to determine the effect of gruel feeding (Exp. 1) and administering oral dextrose (Exp. 2) on pig survivability after weaning. Upon arrival to the nursery, the smallest 10% of pigs were selected and randomly placed in designated pens with 61 to 108 pigs per pen. Pens of small pigs were assigned to 1 of 2 treatments in a completely randomized design. Treatments consisted of gruel feeding two or four times per day starting 14-d post-placement. At each gruel feeding, approximately 2.5 lb of solid feed was added to a round Rotecna bowl (Rotecna S.A., Agramunt, Spain) located at the front of the pen. Water was added to feed at a decreasing rate over time such that d 0 to 5, 6 to 10, and 11 to 14 the ratio of water to feed was 3:1, 1:1, and 1:3, respectively. In Exp. 2, every other pig removed from general population or pens of small pigs for welfare considerations (lameness, sick, or fallback) received a single 10 mL oral dose of a 50% dextrose solution (Vet One, MWI Animal Health, Boise, ID), as a source of glucose, before being placed in a removal pen. All removed pigs were tagged and weighed, blood glucose measured prior to and 30 min after entering removal pens, and their body temperature recorded. Overall, gruel feeding the small pigs two or four times per day for 14-d post-placement did not influence ($P > 0.10$) mortality from weaning to the end of gruel feeding (3.78 vs. 4.25%, respectively). Likewise, dextrose administration did not influence ($P > 0.10$) pig mortality after removal to approximately d 38 after weaning (21.4 vs. 23.4% respectively), even though blood glucose levels increased ($P < 0.001$) for pigs administered dextrose compared to pigs not administered dextrose (increased by 11.4 vs. 19.1 mg/dL). An interaction was observed for blood glucose and body temperature ($P < 0.001$). Pigs with a blood glucose less than 70 mg/dL had increased mortality as body temperature at removal increased. In contrast, pigs with a blood glucose between 70 and 120 mg/dL or greater than 120 mg/dL had decreased mortality as body temperature increased. Pigs weighing less than 10 lb at removal had an increased mortality ($P < 0.001$) compared to pigs

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[2] Appreciation is expressed to Pillen Family Farms (Columbus, NE) for their technical support in this trial.

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weighing greater than 10 lb at removal. In summary, gruel feeding four times per day vs. two times per day or providing removed pigs glucose supplementation did not improve survivability of pigs after weaning. Additionally, removed pigs with low body weight, body temperature below or above the normal range, or high blood glucose had decreased survivability.

Introduction

Gruel feeding is a strategy commonly used throughout the swine industry to transition weaned pigs from sow's milk to solid feed. While practices for gruel feeding vary, gruel is often provided to populations of small pigs to encourage earlier feed intake and minimize fallout rates. However, limited research publications are available to validate gruel feeding protocols and the impact on pig survivability. Likewise, for pigs that struggle to maintain nutrient intake after weaning, there are few intervention strategies available. Depleted energy reserves in this population may further prevent pigs from consuming feed and water, thus, we hypothesized that an oral glucose supplement may be beneficial for improving pig livability. Therefore, the objective of these studies was to determine the effect of gruel feeding and oral dextrose on the mortality of pigs post-weaning.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in these experiments. Two experiments were conducted at a commercial nursery site in Nebraska. Each pen was equipped with two 8-hole stainless steel feeders and a nipple bar waterer to allow *ad libitum* access to feed and water.

A total of 3,087 (Exp. 1) and 988 (Exp. 2) pigs (241 × 600, DNA) were used in two trials to measure nursery pig survivability. Pigs were weaned at approximately 21 d of age and transported to a 14,400 head nursery and placed in rooms based on sow source.

In Exp. 1, the smallest 10% of pigs were selected at entry to the nursery and randomly placed in designated pens. A total of 34 pens across 8 rooms were used for the small pigs with 61 to 108 pigs per pen. Pens of small pigs were assigned to 1 of 2 treatments in a completely randomized design. Treatments consisted of gruel feeding two or four times per day for 14 d. The treatment period began after the last pigs were placed in each room, with fill times ranging from 2 to 10 d. At each gruel feeding, approximately 2.5 lb of solid feed was added to a round Rotecna bowl (Rotecna S.A., Agramunt, Spain) located at the front of the pen. Water was added to feed at a decreasing rate over time such that d 0 to 5, 6 to 10, and 11 to 14 the ratio of water to feed was 3:1, 1:1, and 1:3, respectively. Pens of pigs were equipped with a heat lamp and monitored daily to track mortalities.

In Exp. 2, over a 4-week period post-placement, every other pig removed from the general population or pens of small pigs for welfare considerations (lameness, sick, or fallback) received a single 10 mL oral dose of a 50% hypertonic dextrose solution (Vet One, MWI Animal Health, Boise, ID) and were placed in removal pens equipped with heat lamps. The 10 mL of solution provided 5 g of dextrose, which delivers 17 kcal. All removed pigs were tagged and weighed, blood glucose measured prior to and 30 min after entering removal pens, and body temperature recorded. Blood glucose was measured by pricking an ear auricular vein with a needle and using a handheld Glucom-

eter (AimStrip Plus, Germaine Laboratories Inc., San Antonio, TX). Mortality was then tracked through the end of the nursery, for approximately 38 d post-placement.

Common corn-soybean meal-based nursery diets were fed in 3 phases and were based on a feed budget. Phase 1 feed budget was provided at 5.5 lb per head, phase 2 feed budget was provided at 12 lb per head, and phase 3 feed budget was provided at 35 lb per head. In removal and small pig pens, an early-wean diet was fed at approximately 3.3 lb per head prior to beginning phase 1 feed. All diets were fed in meal form.

Data analysis

Gruel feeding data were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS (v. 9.4, SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Treatment was considered a fixed effect and room as a random effect. A binomial model was used to determine mortality percentage and results were considered significant at $P \leq 0.05$.

Dextrose data were also analyzed as a completely randomized design with room as a random effect and pig as the experimental unit. The predictor variables of body weight, body temperature, and blood glucose were categorized into biologically significant categories and least squares means were determined using a binary model with mortality as the outcome. A quadratic equation for the continuous predictor variables of body temperature and blood glucose were tested to determine the predicted probability of mortality based on body temperature and blood glucose.

Results and Discussion

In Exp. 1, gruel feeding the small pigs two versus four times per day for 14-d post-placement did not influence the removal ($P = 0.239$) or mortality ($P = 0.437$) rate from weaning to the end of the gruel feeding period (Table 1). In Exp. 2, dextrose administration did not influence (Table 2; $P = 0.443$) survivability of pigs removed from pens to approximately 38 d post-weaning. However, blood glucose concentrations were increased ($P < 0.001$) in pigs administered dextrose, which confirms that dextrose supplementation at 10 mL per pig increased circulating blood glucose.

For categorical predictor variables, pigs with a body weight under 10 lb at the time of removal had increased mortality ($P < 0.001$; Figure 1) compared to pigs with a body weight between 10 and 12 lb or greater than 12 lb at removal. An interaction was observed for blood glucose and body temperature ($P < 0.001$; Figure 2). For pigs with a blood glucose less than 70 mg/dL, mortality increased ($P < 0.05$) when body temperature was greater than 103.5°F compared to pigs with a body temperature within the normal range of 101.5 to 103.5°F. The mortality of pigs with a body temperature less than 101.5°F was intermediate. Additionally, providing an oral dose of dextrose to pigs with a blood glucose less than 70 mg/dL did not improve survivability ($P > 0.10$; Figure 3). In contrast, pigs with normal blood glucose in the range of 70 to 120 mg/dL had increased ($P < 0.05$) mortality when body temperature was less than 101.5°F compared to pigs with a body temperature within the normal range of 101.5-103.5°F. The mortality of pigs with a body temperature greater than 103.5°F was intermediate. Pigs with a blood glucose greater than 120 mg/dL and a body temperature less than 101.5°F had increased ($P < 0.05$) mortality compared to pigs with a body temperature of 101.5°F or greater. Furthermore, the combination of high blood glucose

and low body temperature resulted in substantially greater mortality compared to any other combinations of blood glucose and body temperature. However, this represented a small proportion of pigs (approximately 2.6%).

Another way to view the data in Figure 2 is that pigs with a body temperature less than 101.5°F and a blood glucose greater than 120 mg/dL had increased mortality ($P < 0.05$) compared to pigs with lower blood glucose levels. No evidence for differences were observed in mortality for pigs with a body temperature of 101.5 to 103.5°F based on blood glucose level ($P > 0.05$). Pigs with a body temperature greater than 103.5°F and a blood glucose less than 70 mg/dL had increased ($P = 0.033$) mortality compared to pigs with a high body temperature and a blood glucose between 70 and 120 mg/dL. Additionally, for pigs with a body temperature greater than 103.5°F, there was no evidence ($P > 0.10$) that blood glucose greater than 120 mg/dL resulted in mortality levels different from pigs with a lower blood glucose.

For continuous predictor variables, a quadratic relationship was observed for body temperature and probability of mortality ($P < 0.001$; Figure 4). Pigs with a body temperature below or above the normal range had increased mortality. Likewise, a quadratic relationship was observed for blood glucose and probability of mortality ($P < 0.001$; Figure 5). Pigs with low or high blood glucose had increased mortality. Once pigs reached a blood glucose greater than 250 mg/dL their probability of mortality was nearly 100%.

In summary, gruel feeding four times per day vs. two times per day or providing the removed pigs dextrose supplementation to increase circulating glucose did not improve survivability of pigs after weaning. Additionally, removed pigs with low body weight, body temperature above or below the normal range, or high blood glucose had reduced survivability. These results indicate there are metabolic differences in pigs at the time of removal which may impact their survivability. More research is needed using alternative protocols to understand the value of gruel feeding on pig survival post-weaning, and how to better manage pigs after removal to maintain body temperature and feed intake.

Table 1. Effect of gruel feeding on the removal and mortality rate of pens of small nursery pigs, Exp. 1[1,2]

	Gruel application, times/d			
	2	4	SEM	*P* =
Count d 0	1,530	1,557	---	---
Count d 14	1,253	1,262	---	---
Mortality/removal analysis, %				
Removal	14.1	15.6	2.50	0.239
Mortality[3]	3.78	4.25	1.560	0.437

[1] A total of 3,087 mixed sex pigs were used with 61 to 108 pigs per pen and 17 replicates per treatment.
[2] Gruel feed was offered either two times per day or four times per day for 14 d. The treatment period began after the last pigs were placed in each room, with fill times ranging from 2 to 10 d. At each feeding, approximately 2.5 lb of solid feed was added to a round Rotecna bowl located at the front of the pen. Water spigots mounted on pen gates was used to mix water and solid feed. Gruel consistency changed over time according to standard farm procedures. A heat lamp was also provided in each pen.
[3] Mortality = (mortality after removal + mortality in pen) ÷ initial pen inventory.

Table 2. Effect of oral dextrose on the mortality rate of nursery pigs removed from general population or small pig pens, Exp. 2[1]

	Oral dextrose			
	No	Yes	SEM	*P* =
Count	476	512	---	---
Blood glucose, mg/dL				
Entry	82.1	74.1	2.03	0.002
30-minute[2]	89.8	96.8	1.40	< 0.001
Change[2,3]	11.8	18.7	1.40	< 0.001
Mortality, %	21.4	23.4	4.02	0.443

[1] Every other pig that entered the removal pen received a 10 mL oral dose of a 50% hypertonic dextrose solution. The 10 mL of solution provided 5 g of dextrose, which delivers 17 kcal.
[2] Entry blood glucose used as a covariate.
[3] Represents the average change in blood glucose over a 30-minute period after pigs entered the removal pen.

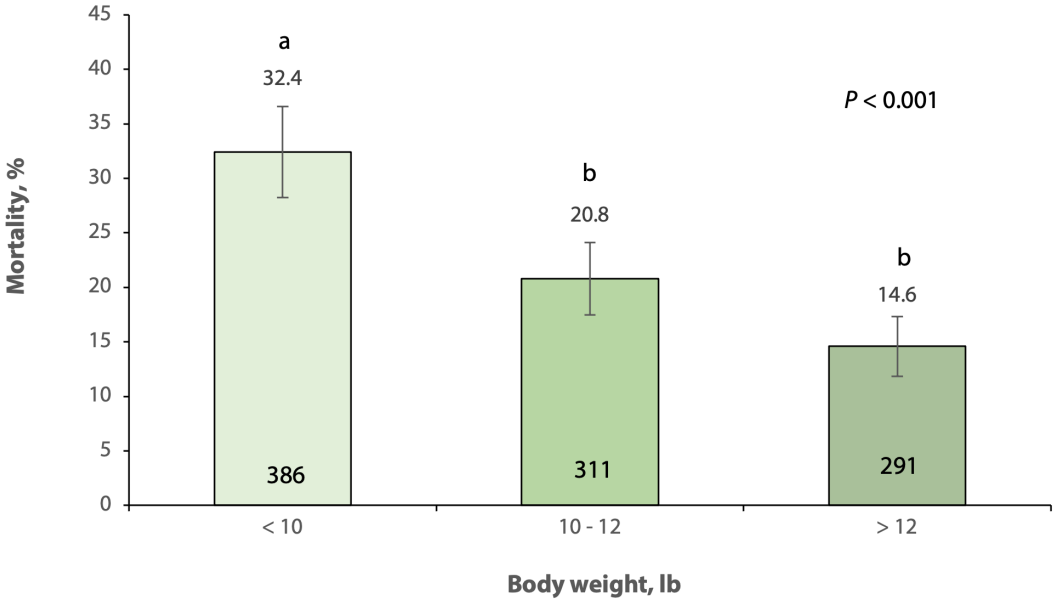

Figure 1. Main effect of body weight at removal on the mortality of nursery pigs after removal. Number listed within each bar represents pig count.

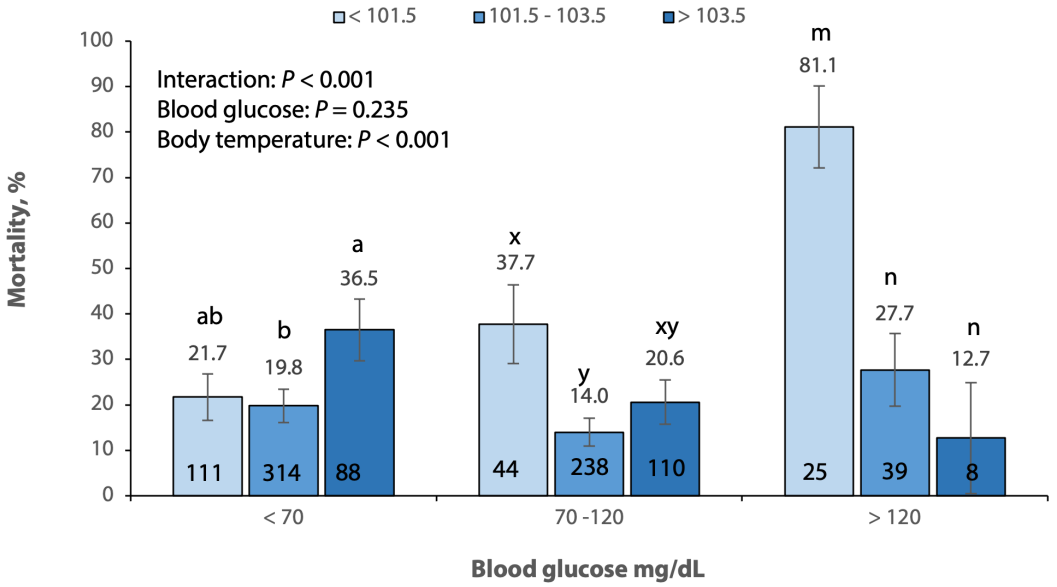

Figure 2. Interactive effect of blood glucose and body temperature at removal on the mortality of nursery pigs after removal. Bars within blood glucose category that lack a common superscript differ by $P < 0.05$. Number listed within each bar represents pig count.

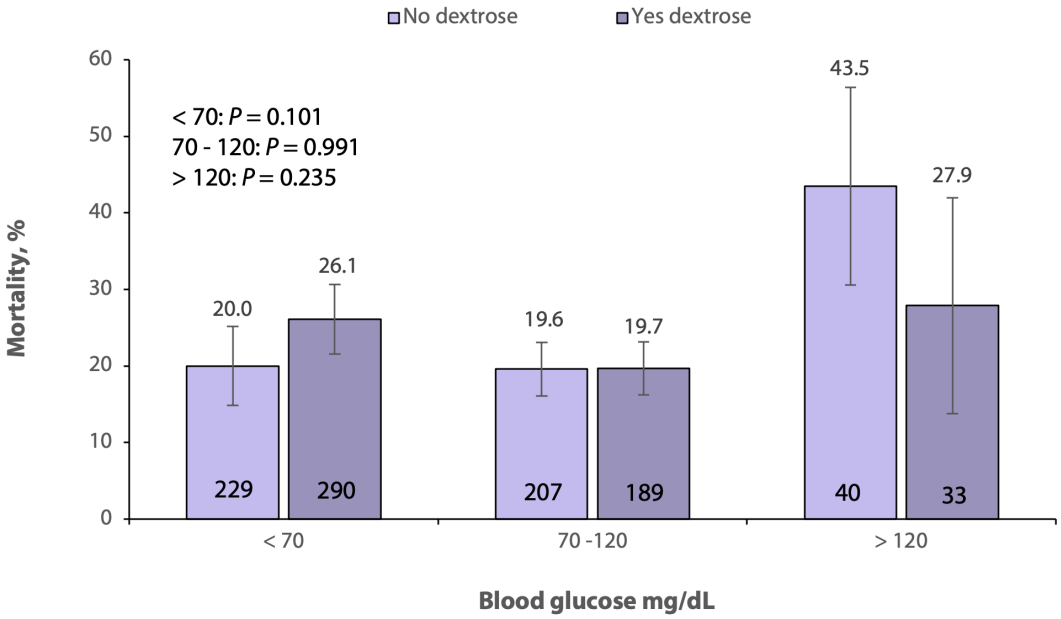

Figure 3. Effect of oral dextrose at removal within blood glucose category on the mortality of nursery pigs after removal. Number listed within each bar represents pig count.

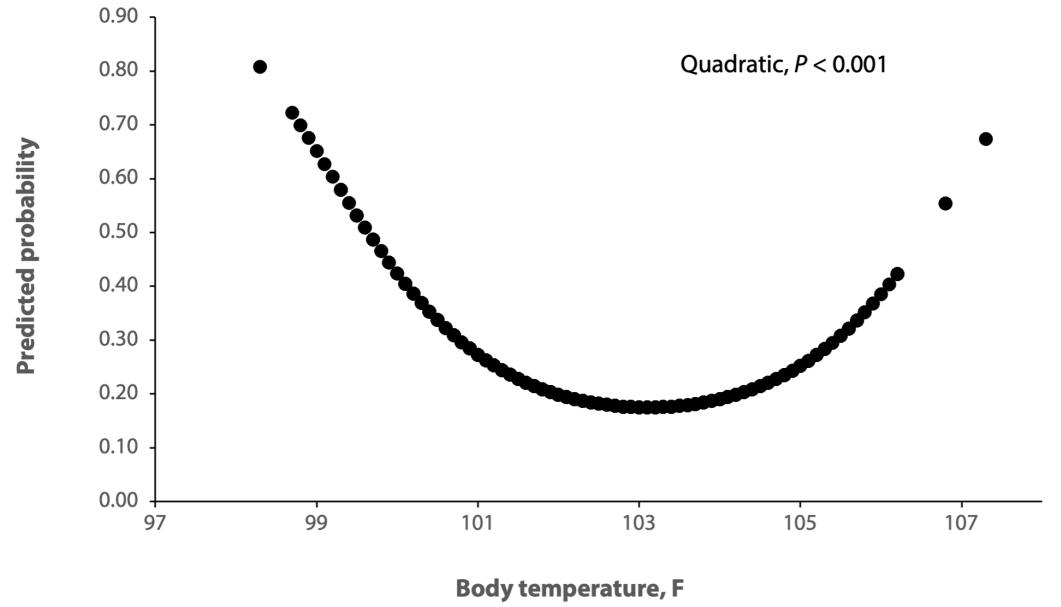

Figure 4. Effect of body temperature at removal on the predicted probability of mortality of nursery pigs after removal.

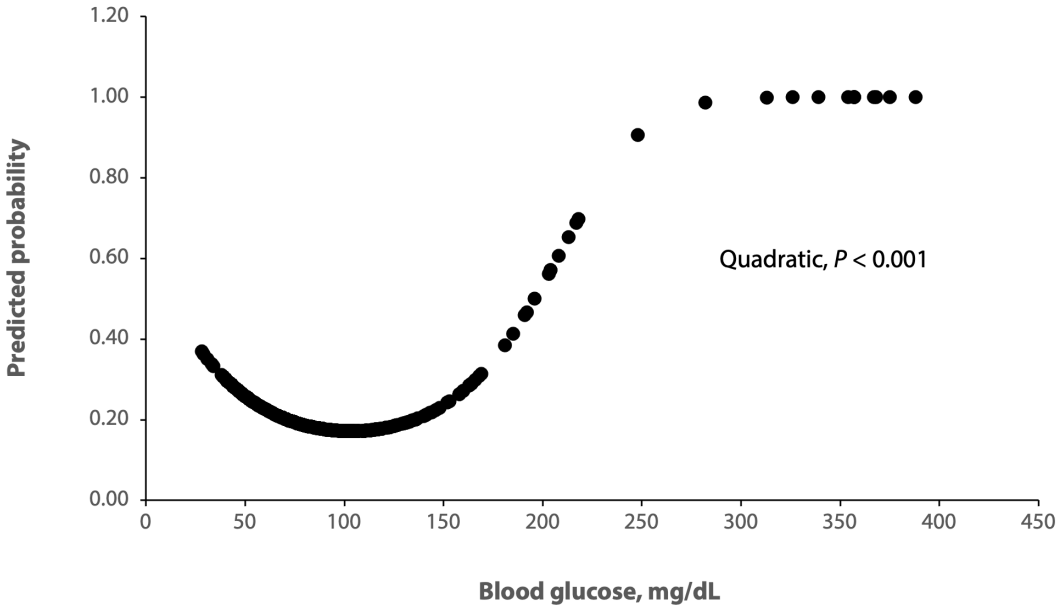

Figure 5. Effect of blood glucose at removal on the predicted probability of mortality of nursery pigs after removal.