PRAIRIE SWINE CENTRE

2024

PRAIRIE SWINE CENTRE

ANNUAL **RESEARCH** REPORT

PRAIRIE SWINE CENTRE

MISSION STATEMENT

"We provide solutions through knowledge, helping to build a profitable and sustainable pork industry"

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2024 Report Highlights

Chairman's Report

Tackling issues impacting profitability and sustainability

Don Down, Chairman of the Board

The Pork Industry continues to adjust to external pressures. As Canadian Pork producers adapt to the changes, the Prairie Swine Centre has focused on providing solutions that help tackle the issues impacting profitability and sustainability of the Pork Value Chain.

Feed costs continue to be an area of focus for pork producers. Evaluating new feed ingredients and utilizing our existing grain supply require due diligence along with research and the introduction of new technology. The increasing cost of energy has pushed up the cost of production over the last few years. The Prairie Swine Centre Engineering and Nutrition research teams have focused on providing solutions to these rising costs.

Animal wellbeing continues to be an area of importance to the consumers of the pork we produce in Canada, consumed in Canada and around the world. The Prairie Swine Centre Ethology team remains focused on research into sow housing, animal handling, enrichment and transport.

Under Murray's leadership the Prairie Swine Centre has continued to provide research results to the industry. The Centre's focus is to adapt to our changing environment and to address the key issues we face as industry.

Communication and dissemination of key research findings as well as programs supporting biosecurity and disease management has been the focus of the Prairie Swine Centre Knowledge Transfer and Translation team. They have been focused on getting the messages out to the Prok industry across Canada and to different types and size of producers. The increasing need of information on demand has required the team to work through different communication channels across Canada and the global pork network.

The Centre Board wants to recognize the production staff at the Centre as they continue to conduct and support world class research while achieving sow, nursery and finisher production numbers that benchmark amongst the best in Canada.

As we move into 2025 the Board and Senior Staff will work on integrating the valuable research by cooperating with other research centres in Canada and around the world.

The PSC deeply appreciates and values the financial support from the Province of Saskatchewan as well as the Pork Boards from Manitoba, Saskatchewan, Alberta, Ontario, and Quebec. The PSC also wants to highlight the valuable relationship with the University of Saskatchewan and continue to help the University achieve its own research and teaching objectives.

On behalf of the board, I want to thank the Prairie Swine Centre team for their hard work and commitment which has led to a successful research year. This annual research report is evidence of the passion and dedication of the entire team. I want to thank retiring Board members for their expertise and contributions, and welcome new Board members for 2025.

The PSC board looks forward to working with Murray Pettit and his highly skilled team during the coming year.

CEO Report

Supporting the pork industry through our research programs

Murray Pettitt, Ph.D. - CEO

It has been another challenging year in the Canadian Swine Industry. While feed prices softened compared to those of recent years, pig prices have seen only a modest rally and profitability continues to remain challenging. Prairie Swine Centre remains committed to supporting the industry during these difficult times through our research programs. Reducing the cost of production and creating tools to improve profitability is an important component of the research performed at the Centre.

Prairie Swine Centre remains focused on assisting producers and the information contained in this report and on our website at www.prairieswine.com can aid with profitability, nutrition strategies, animal health and animal welfare issues. Our online searchable database, PorkInsight provides practical, production-focused information focused on enhancing the sustainability of the pork industry. We have recently introduced two new short booklets on managing costs; one focused on high feed costs and the second on energy costs. The information contained in these booklets can assist producers in reducing production costs and are available on the PSC website. The scientists and staff of PSC are always willing to provide support to producers and the pork value chain and we urge you to contact us. Contact information for each of us is listed on our website.

This report contains articles describing the most recent work from Prairie Swine Centre. This includes the development of strategies to mitigate the negative effects of indigestible protein in high protein nursery diets, the use of a fibre blend in nursery diets to improve gut health, determining the optimum environmental temperature requirements of sows and grower-finisher pigs to reduce energy costs and greenhouse gases while maintaining their long-term overall productivity and performance, and the positive effects of enrichment on increasing ADG, lowering handling scores, reducing lesions, improving tail bite scores, improving carcass weights and increased carcass lean %. These and other results detailed in this report can assist producers in addressing some of the common challenges faced on an ongoing basis.

New to the report this year is a page highlighting the graduate student awards received by students performing their research at PSC. They represent the future of our swine industry and I urge you to get to know them when you have the opportunity. We are very proud of their accomplishments.

I wish to acknowledge ongoing, long-standing core financial support from the Saskatchewan Government's Agriculture Development Fund and the producers from Saskatchewan, Alberta, Manitoba and Ontario through their provincial Pork Boards. Your continued confidence and financial support for the work we do at PSC is critical for us to serve the Canadian pork industry in an ongoing manner – we are most grateful for your support. Our continuing strong relationship with the University of Saskatchewan enables both the University and PSC to achieve our respective research and teaching objectives and train the next generation of swine professionals. These graduates will become managers and leaders in the swine industry in the years to come.

I would also like to thank the members of PSC's volunteer Board of Directors. They bring valuable experiences to PSC from the perspectives of producers, government, university and related industries and their insights help PSC achieving our goal of providing value to our customers. Finally, I wish to thank the staff and students at PSC who make all this happen. Their dedication to excellence is the source of PSC's ability to continue to support the swine industry.

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Operations Manager's Report

Achieving High Productivity in a Research Environment

Tatjana Ometlic, RVT. - Manager, Operations

This past fiscal year the focus of the production team was on maintaining production efficiency and consistent throughput of pigs, wean to finish. Our production numbers are continuously improving and the rolling averages for the first 5 months of this year are all exceeding the target (Table 1). We continue to have an exceptionally high number of pigs born alive and when not in conflict with the research projects in the farrowing rooms, production staff use every opportunity to create an extra nurse sow in the room. This has certainly helped us wean more pigs this fiscal year. Staff presence has been critical for tasks as this is labour intensive. Typically, we would create a few nurse sows per week, one for the newborn litter and one or two for the smaller weaners. We have exceeded our target for the number of pigs weaned per sow per year.

With more pigs born alive, we have seen more variations in birth weights with more low birth weights, which drove the Pre-Wean Mortality (PWM) rate higher. PWM is an area that is hard to manage. When possible, we continue to use practical tools, such as split nursing 18+ piglets born alive, and feeding electrolyte and creep feed for disadvantaged pigs in the first and last week of lactation.

Running research trials in all areas of the barn creates challenges of maintaining operational efficiencies and animal flow while accommodating the projects. As a research facility that promotes a robust research program and delivery of many services to our external researchers at U of S, WCVM, and VIDO, as well as providing the rest of the pork industry with novel science-based information, it is our first priority to accommodate the needs of research teams. Ability to adjust and adapt has always been the PSC strong suit. In 2023, we had 14 research projects started in grow finish, breeding, gestation, farrowing, and nursery rooms. Over 2400 animals have been used for research at PSC as well as for external research. We continue the balancing act between managing high productivity and meeting research needs.

Table 1. Production targets for fiscal year 2024

Category	Target/week	Rolling Average*
# Bred	14.0	15.1
# Sows farrowed	12.7	13.0
# Pigs born alive	178	197.8
Average born alive	14.0	15.2
# Piglets weaned	161	175.0
Pre-wean mortality	9.6%	13.3%
Post-wean mortality	3.0%	1.5%
Finish mortality	2.0%	1.9%
# Sold/week	156.0	168.2

**January - May, 2024*

Production's biggest challenge this spring was to maintain the animal flow throughout the grow finish barn and manage the density of pigs in the pens as we were struggling with space availability. Due to a couple of research trials (2 commercial rooms and 3 semi-intensive rooms), we had to manage higher densities in most of the finisher rooms. As a result, our grow finish mortality is slightly higher, but still below the set target. We have seen a few more tail bites over the past several months due to the higher pen densities. To manage the animal flow in grow finish rooms and meet the space requirements from the Canadian Code of Practice we have shipped additional loads of market hogs over the past several months. We continue to ship feeders and off spec hogs to our abattoirs on a weekly basis which greatly helps alleviate some of the density issues. We continue to sell hogs/feeders on a more regular basis this year to our local abattoirs, Penner Farms, and Riverview Colony. The production staff continuously works on addressing pen densities in a timely manner as well as providing different enrichment objects through all stages of production. We are also looking into the feeding management of our finisher pigs to improve the number of overall lean pigs being shipped. As of June 7th, we have sold 8,687 animals and by the end of this fiscal year, we should be close to 9000 animals sold. This is way above the target of animals to be sold for this year.

Table 2. Production parameters

	2020	2021	2022	2023	Jan-May 2024
Number of sows farrowed:	661	636	628	701	285
Conception rate %:	91.4	86.0	88.1	99.1	93.5
Farrowing rate %:	91.5	87.5	85.9	92.7	89.2
Average born alive/litter:	14.4	14.3	14.9	14.9	15.4
Farrowing index:	2.46	2.48	2.46	2.47	2.45
Number weaned/sow:	12.6	12.5	12.7	13.1	13.1
Pre-wean mortality %:	12.1	12.6	14.2	13.8	13.2
Pigs weaned/sow/year:	29.2	29.5	28.2	30.4	30.1

The production team focuses on improving the number of pigs weaned per sow per year and on increasing productivity of our sows by adjusting gestation feed intake and regular body scoring using calipers as a tool. In benchmarking with other farms with PIC genetics across Canada and USA, we continue to be in the upper 10th percentile of Pig Champ data for 2023 and the first quarter of 2024.

Looking at the Performance Trend Analysis for the 2023 year (Table 2), we can see a significant improvement in farrowing rate. The key driver affecting production performance is throughput and only by having a well-trained staff and operating under standard production practices, are we able to sustain that. Having a positive culture and employee engagement in the barn plays the key difference.

In the past year, we have been focusing on animal flow and throughput of pigs weaned to marketed. We have been steadily weaning over 13 pigs per sow per litter and maintaining the post wean and grow finish mortality on the low end. For the past 12 months, total born has been at 17.4. That has put us as one of the leading farms in North America for this trait. Live born is currently at 15.4, which is also very good, but there is definitely some lost opportunity there as our stillborn are still higher than what we would like to see. A health investigation around the higher stillborn rate did not provide any conclusions as to why we have a higher-than-average stillborn rate on the farm. As a team we looked at all the areas of farrowing room management, where we could make more improvements to reduce the numbers of stillborns as well as sows productivity and body condition during the lactation phase. In the first quarter of 2024, we did reduce stillborn rate by 1%, while total number born and total born alive has improved about 0.5 pig each. Staff presence has been critical for these improvements.

Over the 2022/23 year, we have been collecting data on number of animals bred with the semen that was either six to eight days post-collection. These breeding events would occur at the times where either we were short fresh semen doses or there were disruptions in delivery due to the weather or holidays. The data looks promising and we have not really seen a significant drop in our farrowing rate or conception and numbers born alive are still over the target. As of June 3, 2024, we have started with once-a-week semen delivery, and we will continue this until the first farrowings happen in late September. We will be keeping a close eye on the conception rate and reviewing data again by the end of the year to see if there are any significant changes in conception or farrowing rate and if new adjustments need to be made.

Our gilts are growing at a fast rate and 30-40% of them reach the optimal weight for breeding by their second heat, but rather than the ideal age of 200-225 days they get bred at 180-190 days of age. To maximize the number of gilts bred within the right quadrant of weight, HNS and age we decided to address the nutritional specs of our gilts feeding program and slow down the growth rate. Replacement gilts will be transitioning earlier to grower and finisher diets, while in nursery and grow finish area, and nutritional specs for the gilt developer diet have changed to slow down the growth rate. We started the new feeding program on June 3, so by the end of this summer we should have some information on how things are progressing and changes we are seeing.

Knowledge Transfer Report

Creating a robust catalogue of resources for producers

Ken Engele, BSA. (Manager), and Miranda Smit, Ph.D. (Assistant Manager) - Knowledge Transfer

Ken Engele

Miranda Smit

"Delivering timely, relevant, and practical information is the goal of the Knowledge Transfer Program at the Centre. "

The past six months have been a bit of a wild ride, with the past 18 months testing the patience of many producers throughout the industry. Negative margins, the likes of not seen in the past 25 years, create a challenging environment. However, one thing that remains constant is the resiliency of pork producers throughout Canada, as we seemingly come through these events more determined more than ever.

Delivering timely, relevant, and practical information is the goal of the Knowledge Transfer program at the Centre. While over the past 30 years we have changed how we do it, fundamentally we still focus on providing information adopted on farms across Canada. The adoption of these best management practices helps create a sustainable industry, one that needs to focus on the environment, welfare and economics. Sustainability on-farm is like a three-legged stool – missing any one leg (environment, welfare, economics) will cause the stool to collapse. If one leg is shorter than the others it will cause it to wobble, creating uncertain times ahead, but eventually it will tip over. Creating a long-term vision for your operation and the pork industry ensures we are in the best position when times are profitable.

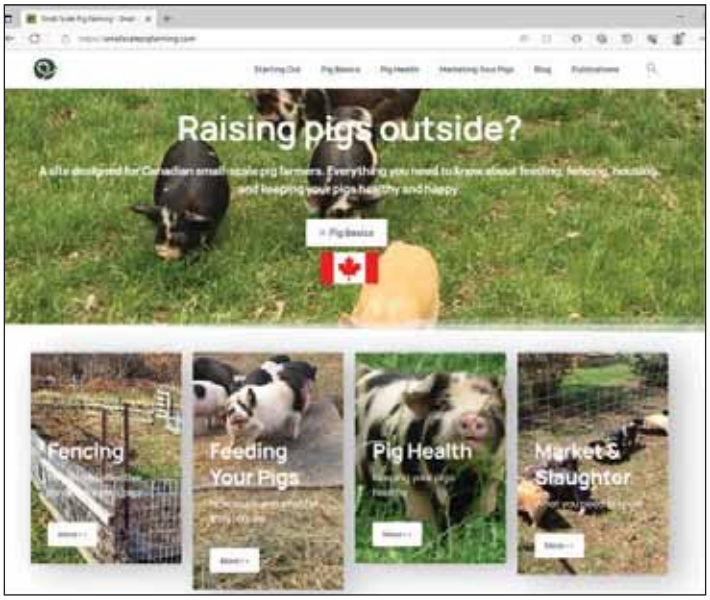
Knowledge Transfer is a two-way street. Not only do we work on delivering results to the industry, we also gather input from the industry. The knowledge we gather from the industry provides input on our research programs and the types of information we need to provide that have the greatest impact to producers, at a specific point in time. We continue to engage with producers and the industry at various meetings, conferences, trade shows and other in-person events (PSC Spring Producer Meetings, Alberta Pork Congress, Red Deer Swine Technology Workshop, Prairie Livestock Expo, the Sask Pork Industry Symposium and Le Porc Show) that have always been an important part of what has made the Centre successful. These events create a dynamic two-way exchange of information that is important to the industry, staff and students.

Over the past year, dedicated KTT resources have provided the opportunity to create a robust catalogue of resources focusing on reducing producers cost of production. Not only have we continued to produce material producers have come to rely on in Prairieswine.com, Centred on Swine, Annual Research Report, and contributing to various industry publications (Porc Quebec, Canadian Hog Journal, Prairie Hog Country, Better Pork); we continue to develop new resources for the industry.

Feed costs and increasing cost of production continue to be the hot topic over the past year. While feed prices have softened from their highs, they still drive the bus when it comes to profitability, and where producers should focus their efforts. In the fall of 2023, we created a publication "Reducing Your Feed Costs", one that focuses on a number of core areas producers can revisit to ensure they are not giving up opportunities in their feeding program. We then followed this up with a more recent publication, "Managing Energy Cost in the Barn", as energy costs rank third in cost of production. This publication will walk you through opportunities; challenges and solutions producers can focus on to reduce their utility bills, and potentially their environmental footprint.

Another important initiative the KTT team is working on is the creation of communication materials for small-scale pig farmers. Keeping foreign animal diseases like ASF out of Canada's pig herd is the responsibility of the entire pork sector, including small-scale pig farmers. PSC and provincial pork agencies have been working diligently on identifying and working with this ever-growing sector. There is a need to help those producers manage their pigs and adopt best management practices that have a fit with their systems. Prairie Swine Centre has developed the website https://smallscalepigfarming.com/ for this purpose – providing information on housing, fencing, nutrition, pig health, and marketing and slaughtering of pigs. PSC is also working on increasing engagement through social media to small producers and organizing webinars on different topics related to small-scale pig farming.

While we continue to use the three main pillars of communication (electronic, person, print) without the engagement of producers and the greater industry we would not be successful. We welcome feedback from the industry at any time.



smallscalepigfarming.com

" While we continue to use the three main pillars of communication (electronic, person, print), without the engagement of producers and the greater industry we would not be successful. We welcome feedback from the industry at any time. "

Awards of Distinction

Student Awards

- **Jessica Vehof:**
  - 1st Place Winner R.O. Ball Young Scientist Award, Banff Pork Seminar, Jan. 9-11, 2023

- **Miranda Buchinski:**
  - Finalist R.O. Ball Young Scientist Award, Banff Pork Seminar, Jan. 9-11, 2023
  - Recipient - Animal Nutrition Association of Canada Scholarship, May 2023

- **Taiwo Erinle:**
  - Recipient - Saskatchewan Innovation & Opportunity Doctoral Scholarship, Sep. 2023 - Aug. 2025
  - Recipient - Department of Animal and Poultry Science Graduate Scholarship, Sep. 2023

- **Bria Bently**
  - Recipient - ANAC-SK Branch Conference travel Award, April 2023

- **Abby Tillotson**
  - 1st Place Winner Saskatchewan Pork Industry Symposium Student Competition, Nov. 7-8, 2023

Developing an indigestible protein index to investigate the effects of dietary protein in pigs

O.O. Babatunde[1], L.A. Rodrigues[1], J.K. Htoo[3], S.M. Mendoza[4], and D.A. Columbus[1,2]

Olufemi Babatunde

Dan Columbus

APPLICATION FOR PRODUCERS

Ask your nutritionist to look at indigestible protein rather than total protein content of your nursery diets to reduce potential negative effects of high protein content, especially when feeding plant-based diets.

SUMMARY

It is unclear what causes the inconsistent negative effects of high protein diets in nursery pigs, but it could be due to protein source or indigestible protein (IDP) content. A literature search and meta-analysis was done that included ninety-four studies reporting growth performance [average daily gain (ADG), average daily feed intake (ADFI), gain:feed (GF), initial and final body weight (BW)] and duodenal histomorphometrics [villus height (VH), crypt depth(CD), and villus height:crypt depth ratio (VCR)] variables of pigs fed different protein content (CP) and sources in the diet. Diets were recalculated to generate the IDP content from each study. Studies were grouped by similarity in performance in two clusters [C1= mid-late nursery phase (9-18 kg) and C2= immediate post-weaning phase (6-9 kg)]. Quadratic response plateau (QRP) models were fitted to assess the interrelationships between ADG, ADFI, GF, VH, CD, and VCR with the dietary CP or calculated IDP content within cluster. The results suggest that dietary IDP may be a better indicator of potential negative dietary effects than total protein, particularly in the immediate post-weaning phase. Dietary IDP is affected more by the inclusion of plant-based ingredients than animal-based ingredients, most likely as a result of lower digestibility of protein in plant-based ingredients.

INTRODUCTION

Enteric pathogens, such as E. coli and Salmonella, are a major cause of post-weaning diarrhea. High protein diets likely increase susceptibility to enteric pathogens and are a predisposing factor in the development of post-weaning diarrhea. While much work has been done on the concept of dietary protein content and performance and health of nursery pigs, it is still not clear what factors are primarily responsible for the negative response to high protein diets. While there is a general trend for reduced incidence of diarrhea with decreasing dietary protein content, this is not consistent across studies when examining the same protein content, suggesting a factor other than simply total dietary protein content is involved, such as protein type or indigestible protein (IDP) content. Dietary indigestible protein content (i.e., protein not absorbed in the small intestine) is available for microbial fermentation in the hindgut and may have negative effects on gut health. Having said that, while the production/presence of fermentation metabolites have been suggested as a potential mechanism for the negative effects of protein, their actual contribution to intestinal health remains unclear in addition to a lack of consensus on how to evaluate intestinal health in general.

The concept of indigestible protein content is relatively new and, therefore, has not been specifically examined in past studies. Currently, diet formulations are based on meeting nutrient requirements and, in the case of nursery pig diets, to limit crude protein content. The objective of this study was to develop and validate, by investigating performance and gut structure outcomes, an index of indigestible protein content (IDP) in weaned pigs. This study was the first to characterize and validate the effect of indigestible protein on measures of animal health and performance. We hypothesized that the dietary IDP would be more predictive of performance and gut health outcomes than dietary CP content, as the IDP portion of dietary protein intake is available for fermentation and production of harmful metabolites.

The overall goal of this and upcoming studies is to provide mitigation strategies to mitigate negative effects of indigestible protein and enhance the ability to utilize feedstuffs common in Saskatchewan while improving sustainability of pork production.

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3 Evonik Operations GmbH, HanaupWolfgang, Germany
4 Evonik Corporation, Kennesaw, GA, USA

EXPERIMENTAL PROCEDURES

A thorough literature search provided ninety-four studies of pigs fed different protein content (CP) and sources in the diet that reported growth performance [average daily gain (ADG), average daily feed intake (ADFI), gain:feed (GF), initial body weight (BW) and final BW] and duodenal histomorphometrics [villus height (VH), crypt depth (CD), and villus height:crypt depth ratio (VCR)]. Ingredient composition of each diet within each study was incorporated into a common dataset of ingredient nutrient composition, with values obtained from NRC (2012) and Evonik AminoDat. Nutrients reported by studies included dry matter (DM), CP, fiber (CF), standard ileal digestible Lys (SID Lys), and net (NE) energy. The same nutrients were recalculated (DM-c, CP-c, CF-c, SID Lys-c, and NE-c). An index of IDP was generated by subtracting the standard ileal digestible protein (SID CP-c) from CP-c. The inclusion of plant and animal protein sources as well as synthetic amino acids were recorded.

Studies were grouped by similarity in performance in two clusters (C1 and C2) by hierarchical clustering on principal components (HCPC). The effects of cluster were investigated. Quadratic response plateau (QRP) models were fitted to assess the interrelationships between ADG, ADFI, GF, VH, CD, and VCR with the dietary CP or calculated IDP content within cluster.

RESULTS AND DISCUSSION

Pigs in cluster 1 and 2 had an average initial BW of 9.78 and 6.54 kg, respectively, corresponding to piglets in the mid-late nursery phase (9-18 kg) and the immediate post-weaning phase (6-9 kg), respectively. Growth performance parameters such as ADG, ADFI, and GF of pigs in C2 were lower than pigs in C1, and duodenal VH and CD were higher in C2 pigs than in C1 pigs because pigs in C2 were younger and the intestinal morphology changes as pigs grow older.

Figure 1 shows the expected linear relationship between the reported dietary CP content in each study and the CP-c and SID CP-c. A linear and quadratic relationship was observed between CP content in each study and calculated IDP content in diets, indicating that IDP increased with greater dietary CP content, regardless of the source of protein. Dietary CP content above 23 % resulted in a marked increase in IDP content of diets. However, it is uncommon for commercial swine diets to have CP inclusion levels above 22 % due to the high cost of protein-rich ingredients. When sources of IDP in diets were investigated, plant-based protein sources (e.g., soybean meal, wheat, barley) contributed the highest proportion of IDP in diets vs. animal-based protein sources and synthetic amino acids.

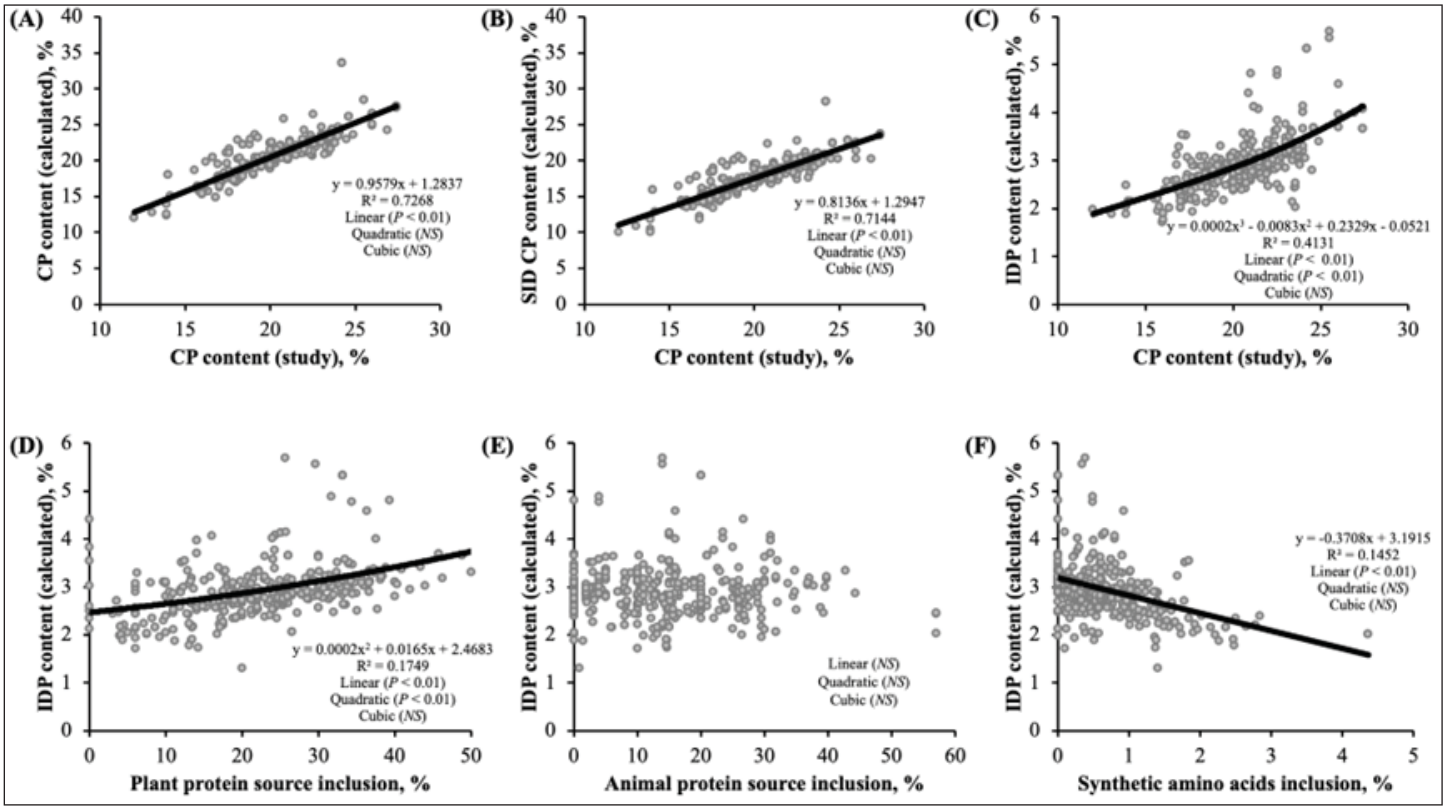

Figure 1. Calculated dietary protein (CP; A), standard ileal digestible CP (SID CP; B) and indigestible protein (IDP; C) contents according to CP content reported by individual studies. Calculated IDP content according to the inclusion of plant-based protein sources (D), animal-based protein sources (E), and synthetic amino acids (F).

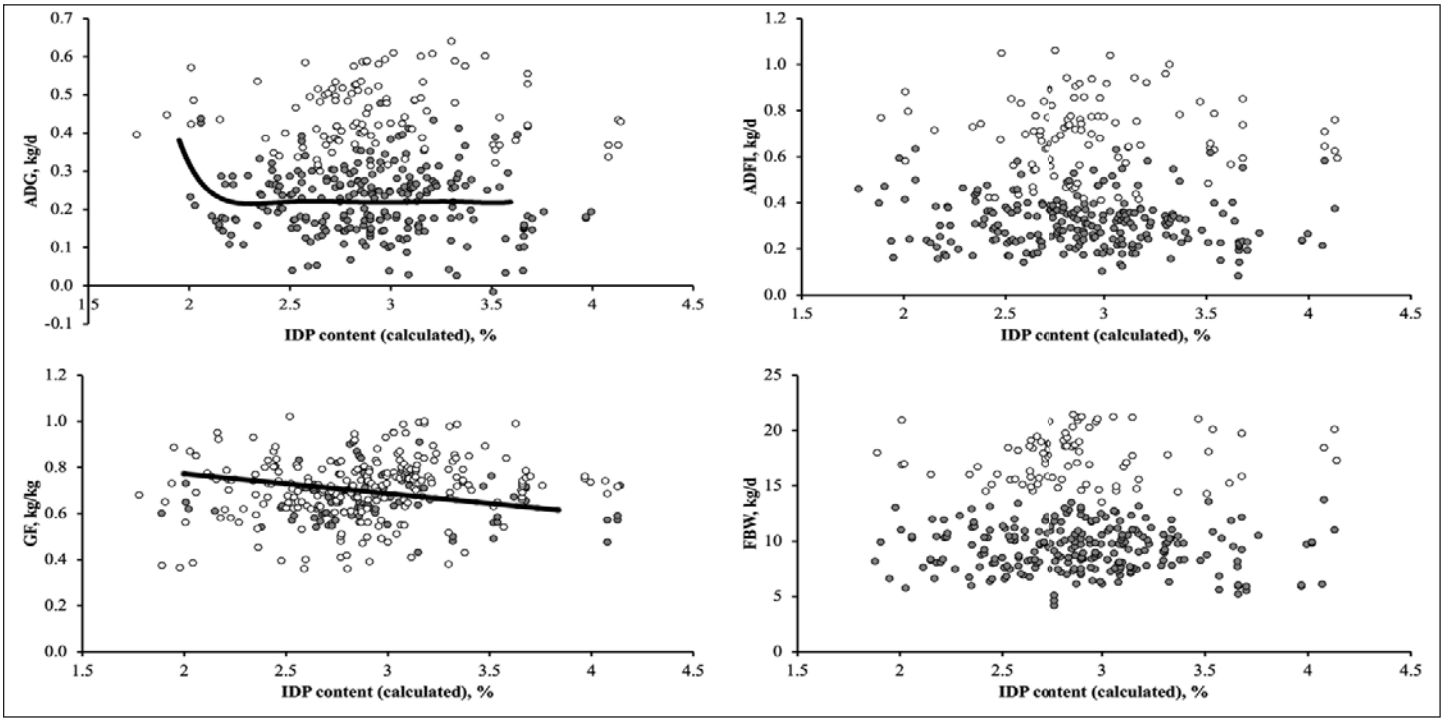

Figure 2. The quadratic break-point model analysis estimates for performance variables as a function of calculated indigestible protein content (IDP) in Cluster 1 (white circles) and 2 (dark grey circles) pigs. The quadratic break-point model was significant (y = 2.68x2 - 11.75x + 13.11) for average daily gain (ADG; solid black line; P < 0.05) in Cluster 2 pigs only, with breakpoint of 2.20 % IDP content for minimum ADG at 0.22 kg/d (P < 0.01). There was no breakpoint or plateau achieved (P > 0.05) for gain:feed ratio (GF), which was significant for linear term in Cluster 2 pigs only (y = -0.09x2 + 0.94; solid black line; P > 0.05). There was no breakpoint or plateau achieved (P > 0.05) for average daily feed intake (ADFI) or final body weight (FBW) in Cluster 1 or 2 pigs which were not significant for linear, quadratic, or cubic term (P > 0.05).

There was a tendency for CP content to affect ADG and CD in pigs. An increase in CP gradually reduced ADG until a plateau was reached at 23.8% CP and 0.27 kg/d ADG. Our linear mixed model and QRP did not reveal any effects of CP content on other performance parameters. There was no relationship between dietary CP and duodenal morphology except for CD. An increase in CP resulted in a gradual reduction in CD until a plateau was reached at 17.4% CP and 223.8 µm crypt depth.

Based on IDP content, there was an interaction between IDP and cluster for ADG and GF, where an increase in the IDP content resulted in a sharp decline in ADG of pigs in C2 with a breakpoint at 2.2 % and a linear decrease in GF with no plateau (Figure 2). This suggests that the IDP index is more accurate than CP content in detecting relationships between negative effects of protein and performance parameters, particularly in piglets in the immediate post-weaning phase. An interaction was observed between IDP content and cluster for CD, where increasing IDP resulted in an increase in the duodenal CD in C2 pigs (Figure 3). No effects were observed on VH and VCR. An increase in CD is indicative of stress in the gut environment. The inclusion of high IDP diets during the immediate post-weaning phase could lead to the microbial breakdown of proteins in the hindgut resulting in the production of harmful metabolites such as branched-chain fatty acids, ammonia, biogenic amines, phenols, and hydrogen sulphide.

"An increase in dietary indigestible protein suggests a greater amount of protein is available as substrate for microbial fermentation in the hindgut."

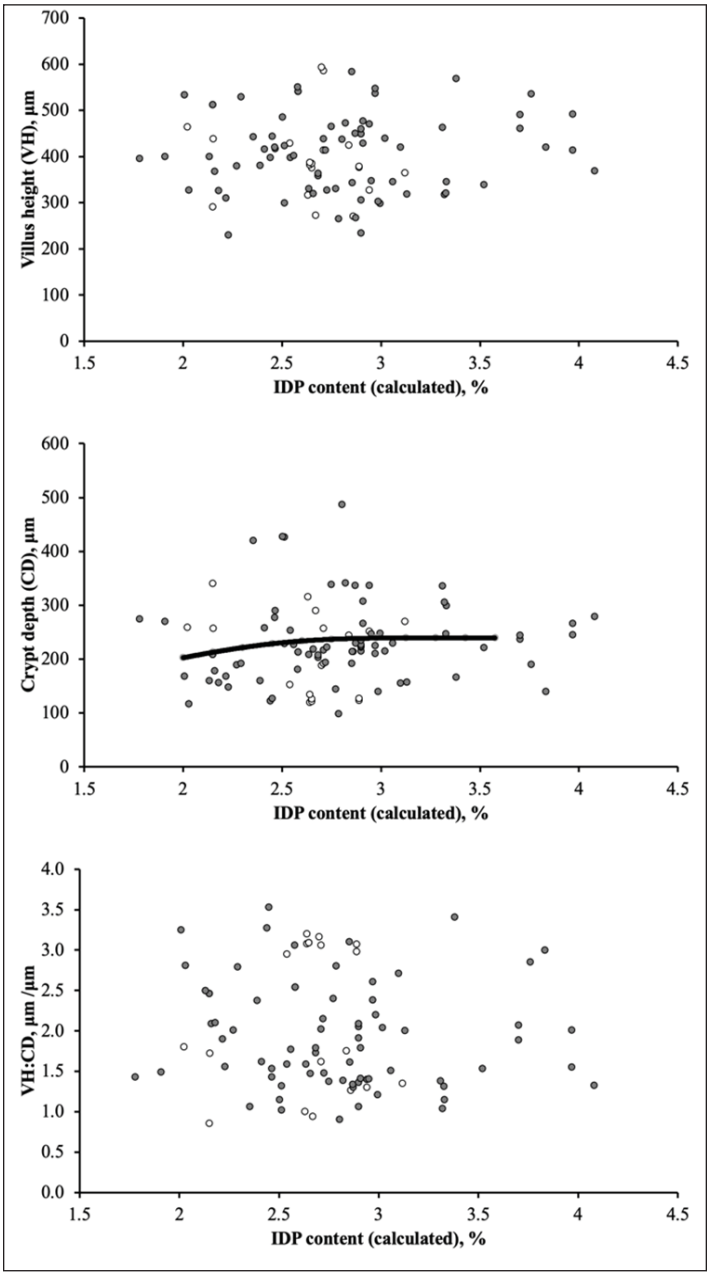

Figure 3. The quadratic break-point model analysis estimates for duodenal histomorphometric variables as a function of calculated indigestible protein content (IDP) in Cluster 1 (white circles) and 2 (dark grey circles) pigs. The quadratic break-point model was significant (y = -38.45x2 + 228.90x – 101.60) for crypt depth (CD; solid black line; $P < 0.05$) in Cluster 2 pigs only, with breakpoint of 2.97 % IDP content for maximum CD at 239.10 µm ($P < 0.01$). There was no breakpoint or plateau achieved ($P > 0.05$) for villus height (VH) or VCR in Cluster 1 or 2 pigs which were not significant for linear, quadratic, or cubic term ($P > 0.05$).

IMPLICATIONS

- Dietary IDP may be a better indicator of potential negative dietary effects than total protein, however, data on protein effects in the hindgut are limited. Considering IDP is a measure of the amount of protein that is not digested prior to the terminal ileum, an increase in dietary IDP suggests a greater amount of protein that is available as substrate for microbial fermentation in the hindgut.
- Dietary IDP is affected more by the inclusion of plant-based ingredients than animal-based ingredients, most likely as a result of lower digestibility of protein in plant-based ingredients.
- It appears that younger animals (i.e., immediately post-weaning) are more likely to experience negative effects of IDP.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Government of Saskatchewan Agriculture Development Fund, Evonik Operations GmbH, and Mitacs Accelerate. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council, and the Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

Impact of fibre on performance and intestinal health of pigs fed a high indigestible protein level

T.J. Erinle[1,2], O.O. Babatunde[1], J.K. Htoo[3], S.M. Mendoza[4], and D.A. Columbus[1,2]

Taiwo Erinle

Dan Columbus

APPLICATION FOR PRODUCERS

Talk to your nutritionist about the addition of a fibre blend in your nursery diets to improve gut health, especially if you feed diets high in indigestible protein.

SUMMARY

Dietary indigestible protein (IDP) may be a better indicator of potential negative dietary effects than total protein. This is likely because IDP is available as substrate for microbial fermentation in the hindgut resulting in the production of harmful metabolites. Fermentation of fibre, on the other hand, is generally considered to result in production of beneficial metabolites and may benefit piglets fed high dietary IDP content. This study examined the effect of fibre blend in nursery pigs fed a high dietary IDP level on performance and intestinal health. Piglets were fed a high level (3.8%) of indigestible protein, either without fibre supplementation (IDP4), or with supplementation of one of four dietary fibre fractions (DFF) at different ratios of soluble (SDF) to insoluble (IDF) fibre (1:1, 1:3, 1:5, and 1:7 for DFF1, 2, 3, and 4, respectively).

Although there was no effect on growth performance, fibre fraction supplementation improved fecal consistency score, reduced diarrhea incidence, and improved certain parameters of gut health. Overall, the results suggest that the addition of fibre, regardless of soluble to insoluble ratio, has a beneficial impact on piglet gut health in nursery pigs fed high IDP levels.

INTRODUCTION

It is still unclear what factors are primarily responsible for the negative response to high protein diets. While there is a general trend for reduced incidence of diarrhea with decreasing dietary protein content, this is not consistent across studies when examining the same protein content, suggesting a factor other than simply total dietary protein content is involved, such as protein type or indigestible protein (IDP) content. A meta-analysis of existing literature suggested that dietary IDP may be a better indicator of potential negative dietary effects than total protein. Considering IDP is a measure of the amount of protein that is not digested in the small intestine, an increase in dietary IDP suggests a greater amount of protein that is available as substrate for microbial fermentation in the hindgut resulting in the production of harmful metabolites such as branched-chain fatty acids, ammonia, biogenic amines, phenols, and hydrogen sulphide.

Unlike with protein, fermentation of fibre is generally considered to result in production of beneficial metabolites, such as short-chain fatty acids, that promote gut health and limit pathogen growth. As with protein, the impact of dietary inclusion of fibre on nursery pig performance and intestinal health has been inconsistent, likely due to differences in the physicochemical properties and fermentability of different fibre sources. Inclusion of a non-structural/soluble fibre source may provide intestinal bacteria an alternative substrate for fermentation whereas inclusion of a structural/insoluble source of dietary fibre may reduce the impact of indigestible protein through increased digesta flow through the gut and reduced adhesion of pathogens.

This study was the first to examine the effect of fibre content in pigs fed a high dietary indigestible protein level. The overall goal of this study was to provide mitigation strategies to mitigate negative effects of indigestible protein and enhance the ability to utilize feedstuffs common in Saskatchewan while improving sustainability of pork production.

EXPERIMENTAL PROCEDURES

After weaning (d25), piglets were fed a high level (3.8%) of indigestible protein, either without fibre supplementation (IDP4), or supplemented with dietary fibre fractions (DFF) at 4 different ratios of soluble (SDF) to insoluble (IDF) fibre (1:1, 1:3, 1:5, and 1:7 for DFF1, 2, 3, and 4, respectively), using fructo-oligosaccharide (inulin®) as SDF and lignocellulose (opticell® C2) as IDF.

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Growth performance was measured weekly. Fecal samples were collected weekly to score for diarrhea as follows: 1. Normal (solid/firm); 2. Pasty (semi-solid); 3. Moderately fluid (loose); 4. Highly fluid (watery). A score above 2 was considered as diarrhea. On d 9 and 28, myeloperoxidase (MPO) activity, a pro-inflammatory bio-indicator, was determined on fecal samples. On d 9, one mid-weight pig was selected per pen, bled to collect blood samples, and eviscerated to obtain intestinal tissues, digesta, and fecal samples.

RESULTS AND DISCUSSION

Pigs fed high IDP without fibre had higher fecal consistency score (FCS, P <0.001) and were observed to have diarrhea (score >2) throughout the experimental duration (Figure 1A). Among pigs consuming DFF diets, FCS showed linear and quadratic responses (linear, P = 0.049; quadratic, P = 0.049), with consistently lower FCS observed in pigs fed DFF 2, 3, and 4. Diarrhea incidence was significantly higher in pigs fed IDP4 compared to all DFF pigs (treatment, P = 0.002; contrast, P <0.001; Figure 1B). There was linear and quadratic effect of DFF on diarrhea incidence (linear, P <0.001; quadratic, P <0.001). There was no effect of DFF supplementation on fecal MPO level.

From d22 to d28, pigs fed IDP diets without fibre (IDP4) tended to have greater feed intake (ADFI), weight gain (ADG) and feed efficiency (G:F) than pigs fed IDP diets with DFF supplementation. However, there was no effect of fibre fraction supplementation on overall ADFI, ADG, and G:F.

Plasma redox and inflammatory biomarkers (MDA, D-Lac, SOD, GPx, DAO, haptoglobin, and MPO), serum biomarkers of acute-phase response (IL-6, IL-1β, and ALB, respectively), and plasma urea nitrogen (PUN) are presented in Table 1.

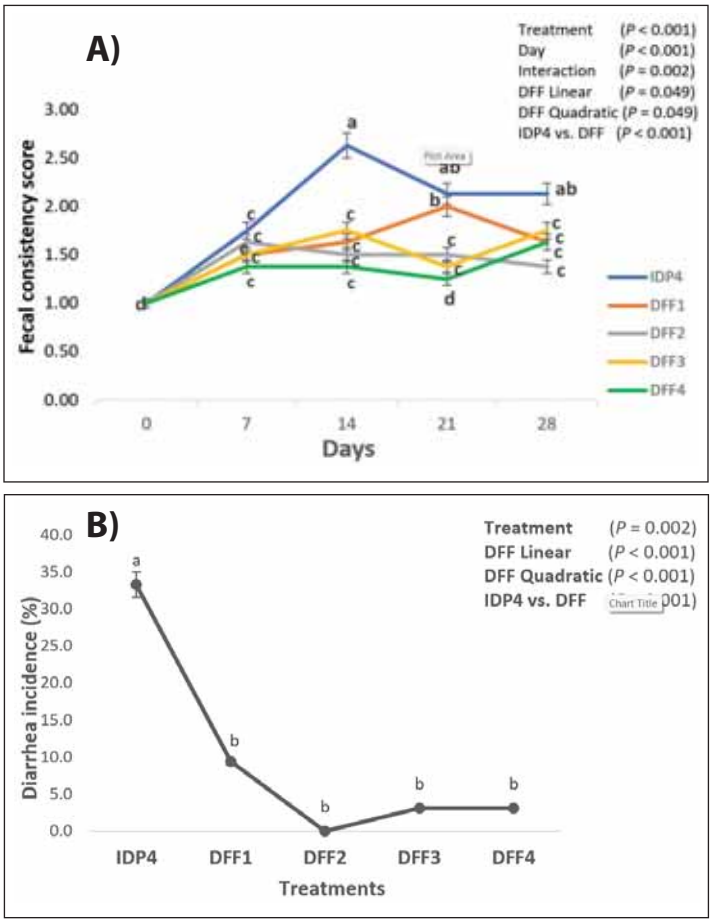

Figure 1. Fecal consistency score (A) and percentage diarrhea incidence (B) in piglets fed a high level (3.8%) of indigestible dietary protein, either without (IDP4) or with supplementation of one of four dietary fibre fractions (DFF) with different ratios of SDF:IDF (1:1, 1:3, 1:5, 1:7 for DFF1, 2, 3, and 4, respectively). The diarrhea incidence was calculated using the following equation; Diarrhea incidence (%) = (number of pens with diarrheic pigs / total number of pens per treatment) × 100. Treatments with different superscripts differ (P<0.05).

Table 1. Blood parameters of piglets fed a high level (3.8%) of indigestible dietary protein, either without (IDP4) or with supplementation of one of four dietary fibre fractions (DFF) with different ratios of SDF:IDF (1:1, 1:3, 1:5, 1:7 for DFF1, 2, 3, and 4, respectively).

Parameters[1]	Treatments					Day		SEM[2]	P-values					
	IDP4	DFF1	DFF2	DFF3	DFF4	d9	d28		Trt	Day	Interaction	DFF Lin.[3]	DFF Quad.[4]	IDP4 vs. DFF[5]
MDA, mol/μL	0.37	0.34	0.40	0.33	0.33	0.30b	0.41a	0.02	0.659	0.049	0.526	0.646	0.648	0.636
Plasma MPO, nmol	248	246	245	241	233	243	243	2.13	0.362	0.968	0.612	0.097	0.097	0.253
PUN, nmol/μL	227	217	223	240	242	243a	216b	3.95	0.235	0.040	0.635	0.031	0.031	0.709
D-Lac, nmol/μL	15.1	16.7	18.0	16.5	14.4	22.0a	10.3b	0.87	0.330	0.002	0.528	0.142	0.143	0.351
SOD, U/mol	2.04ab	1.92b	1.91b	2.55a	2.05ab	2.25a	1.93b	0.07	0.029	0.077	0.255	0.122	0.124	0.666
GPx, nmol/min/ml	53.9	54.1	55.6	53.3	52.3	44.0b	63.7a	1.40	0.768	0.001	0.656	0.347	0.347	0.980
DAO, mU/mL	0.91	0.92	0.91	0.90	1.06	1.19a	0.69b	0.06	0.881	0.020	0.537	0.475	0.475	0.804
Haptoglobin, g/L	1.35	1.15	1.19	1.11	1.19	1.70a	0.69b	0.09	0.774	0.004	0.174	0.961	0.960	0.239
IL-6, ρg/mL	26.8a	21.4b	22.5ab	22.9ab	23.0ab	26.5a	20.1b	0.55	0.022	0.005	0.765	0.265	0.265	0.002
IL-1β, ρg/mL	8.15a	6.70ab	6.53b	6.45b	6.59b	5.87b	7.90a	0.19	0.024	0.007	0.991	0.797	0.797	0.002
ALB, g/L	48.8	45.8	46.5	42.3	46.1	49.1a	42.7b	4.26	0.186	0.025	0.587	0.663	0.666	0.102

[1] MDA, Plasma malondialdehyde; MPO, Myeloperoxidase; PUN, Plasma urea nitrogen; D-Lac, D- Lactate; SOD, Plasma superoxide dismutase; GPx, Plasma glutathione peroxidase; DAO, Plasma diamine oxidase; IL-6, Serum interleukin-6; IL-1β, Serum interleukin-1β; ALB, Serum albumin
[2] SEM, Standard Error Mean
[3] Linear response
[4] Quadratic response
[5] Contrast; IDP4 versus all DFF treatments

SOD, IL-6, and IL-1β were influenced by dietary treatments. Plasma SOD was highest in DFF3-fed pigs, lowest in DFF1 and DFF2 pigs with IDP4 and DFF4 being intermediate. Serum IL-6 and IL-1β were more elevated in pigs fed IDP4 compared to DFF diets (contrast; P = 0.002). Serum IL-6 was observed to be lowest among pigs fed DFF1, while IL-1β was lowest among pigs fed DFF 2, 3, and 4. Contrary to PUN, plasma MPO showed linear and quadratic tendencies to increase with DFF levels (linear, P = 0.097; quadratic, P = 0.097).

Both cecal and colonic ammonia-nitrogen concentration was greater for IDP4 pigs than pigs fed DFF diets (treatment, P <0.001; contrast, P <0.001; Table 2). However, there was no linear and quadratic effect of DFF on cecal and colonic NH3-N concentrations.

IMPLICATIONS

The results suggest that the addition of fibre, regardless of soluble to insoluble ratio, has a beneficial impact on piglet gut health.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Government of Saskatchewan Agriculture Development Fund, Evonik Operations GmbH, and Mitacs Accelerate. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council, and the Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

Table 2. Cecal and colonic ammonia-nitrogen (NH3-N) concentration of piglets fed a high level (3.8%) of indigestible dietary protein, either without (IDP4) or with supplementation of one of four dietary fibre fractions (DFF) with different ratios of SDF:IDF (1:1, 1:3, 1:5, 1:7 for DFF1, 2, 3, and 4, respectively).

Parameters[1]	Treatments					SEM[1]	P-values			
	IDP4	DFF1	DFF2	DFF3	DFF4		Treatment	DFF Lin.[2]	DFF Quad.[3]	IDP4 vs. DFF[4]
Cecal NH3-N, µg/mL	2947a	1717b	1771b	1838b	1827b	47.84	<0.001	0.441	0.442	<0.001
Colon NH3-N, µg/mL	2509a	1833b	1987b	1984b	1962b	31.23	<0.001	0.251	0.251	<0.001

[1] SEM, Standard Error Mean
[2] Linear response
[3] Quadratic response
[4] Contrast; IDP4 versus all DFF treatments

Transepithelial ion transport in the stomach of pigs exposed to gastric ulcer conditions

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APPLICATION FOR PRODUCERS

By increasing our understanding of gastric ulcers, ongoing research in this area will help in developing effectic diagnosic, prevention and management strategies.

SUMMARY

Gastric ulcers in pigs increase significantly when stressful events occur. However, the exact causes of these gastric ulcerations remain unclear. Gastric acid production is known to be influenced by anionic secretion. An Ussing chamber study was conducted to evaluate the agonist-induced electrogenic secretory responses in the different sections of the stomach of pigs exposed to gastric ulcers. Changes in short-circuit current (Isc) in pigs euthanized 48h after an out-of-feed event significantly decreased following the activation of secretion via the adrenergic agonist in the cardia, and the cholinergic agonist in the pars and pylorus. There were no significant secretory responses in the other segments. Since bumetanide failed to inhibit the basolateral cotransporter 1 (NKCC1), the changes in the stimulatory Isc could be attributed to bicarbonate secretion.

"Gastric ulcers are accountable for about 1 to 2% of mortality among market hogs. "

INTRODUCTION

Gastric ulcers are prevalent in modern, intensive pig production, posing challenges to growing pigs and resulting in financial losses. Gastric ulcers are accountable for about 1 to 2% of mortality among market hogs. Most factors associated with gastric ulcers are linked to an increase in gastric acid secretions in the stomach or a decrease in the capacity of the mucus to provide protection.

Gastric acid secretion, mainly hydrochloric acid, is secreted from gastric parietal cells located in the stomach and helps in food digestion and controls harmful bacterial pathogens. The disruption (activation or inhibition) of gastric secretion in the stomach has been suggested to cause gastric ulcers.

This study, therefore, aimed to investigate electrogenic secretory response in the 4 regions of the pig stomach to determine its contribution to gastric secretion and ulcers when pigs are fed diets containing air-classified pea starch (ACPS) diets with an out-of-feed event.

We hypothesized that pigs fed 40% ACPS diets and exposed to an out-of-feed event would have increased electrogenic secretory response.

EXPERIMENTAL PROCEDURES

Pigs were fed diets with 40% air-classified pea starch (particle size 10-20 µm) and exposed to an out-of-feed event, both recognized as potential factors contributing to gastric ulcer formation.

Sixteen pigs (initial BW of 90.6±2.2 kg), were fed for 14d and divided into 4 treatment groups (control, 24h, 48h, 72h). The control group had feed throughout the trial period. For the treatment groups, feed was removed on d13 at 7 am and reintroduced on d14 at 7 am. After the "out-of-feed" event, feed was reintroduced and pigs were selected and euthanized after 24h, 48h and 72h to make up the 3 treatment groups. All animals were stunned with a captive bolt shot and stomach tissue was then harvested immediately after slaughtering for Ussing chamber studies. The stomach was opened by an incision along the greater curvature, rinsed with chilled (4°C) Krebs Ringer Bicarbonate buffer (pH 7.4), and transported immediately to the laboratory.

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Upon arrival in the laboratory, the four main segments; pars oesophagea, cardia, fundus and pylorus, had the muscle layers removed (stripped) from the peritoneum with forceps. Twelve Ussing chambers (Figure 1) were available for each animal with 3 chambers per section. Pieces of the stripped segments were mounted on 1.5 cm^2 Ussing chamber inserts and inserted into the Ussing chamber. Each chamber contained 5 ml Krebs Ringer Bicarbonate buffer solution on each side. Transepithelial potential differences were short-circuited to 0 mV 3M KCl salt bridges connected to Ag-AgCl electrodes. The ends of the salt bridges were located near the tissue on both the mucosal and serosal sides.

Figure 1. Ussing chamber systems set up in the lab.

The mounted tissues were allowed to equilibrate with the buffer for about 20 minutes before the addition of drugs. The resistance and tissue viability were determined using a 1mV pulse every 30 seconds. The baseline short-circuit current (Isc) and potential difference (PD) values were measured after equilibration. The resistance was also calculated using Ohm's law.

After equilibration and when a steady state was reached, an adrenergic agonist, isoproterenol (10 µM), was added to the serosal side to increase cyclic AMP (cAMP) and stimulate cAMP-dependent channels (such as CFTR; cystic fibrosis transmembrane conductance regulator), followed by the addition of 100 µM carbachol, a cholinergic agonist, to the serosal side of the tissue after a steady state has been reached. After a steady state had been reached, 10 µM forskolin and 1mM of 1M 3-isobutyl-1-methylxanthine (IBMX) were added to the mucosal and serosal sides of the tissue. This was aimed to cause an irreversible and sustained elevation in cAMP to fully activate cAMP-activated secretion. When a steady state was reached, 0.1 mM bumetanide was added to the serosal side to inhibit the serosal Na+/K+/2Cl- co-transporter 1 (NKCC1). Electrophysiological responses were expressed as the differences (ΔIsc) between the initial and minimal or maximal Isc values with the addition of an activator or inhibitor, respectively.

RESULTS AND DISCUSSION

Changes in short-circuit current (Isc) in pigs euthanized 48h after the out-of-feed event significantly increased to 17.9±2.02 µA/cm2 from 4.8±1.6 µA/cm2 in the control group following the activation of secretion via the adrenergic agonist (isoproterenol) in the cardia (Fig. 2) suggesting an increase in the anionic transport through CFTR.

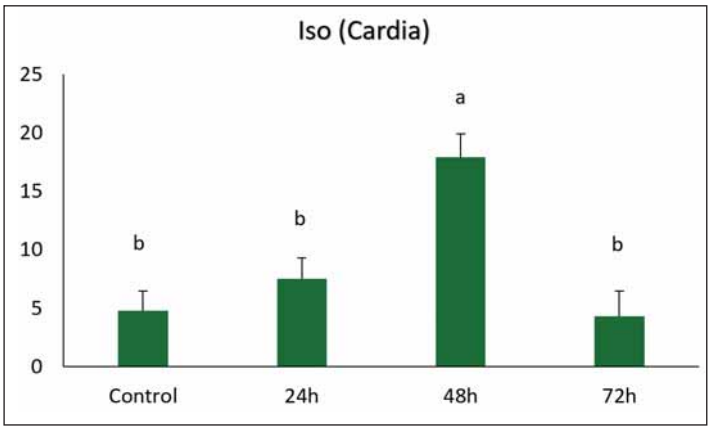

Figure 2. Changes in Isc response in the cardia to the addition of ion channel activator, isoproterenol (P<0.05).

Following the inclusion of carbachol, there was an increase in calcium-activated Isc cholinergic activation in the pars (Fig. 3) and pylorus (Fig. 4) tissues and a tendency to increase in the cardia (Fig. 5) of the 48h group of pigs.

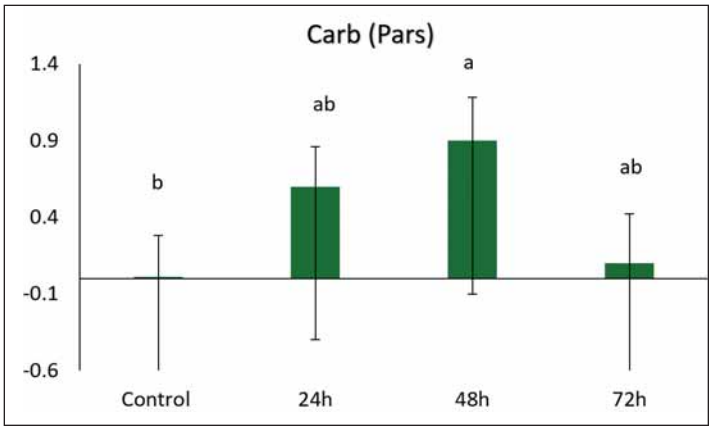

Figure 3. Changes in Isc response in the pars oesophagea to the addition of ion channel activator, carbachol (P<0.05).

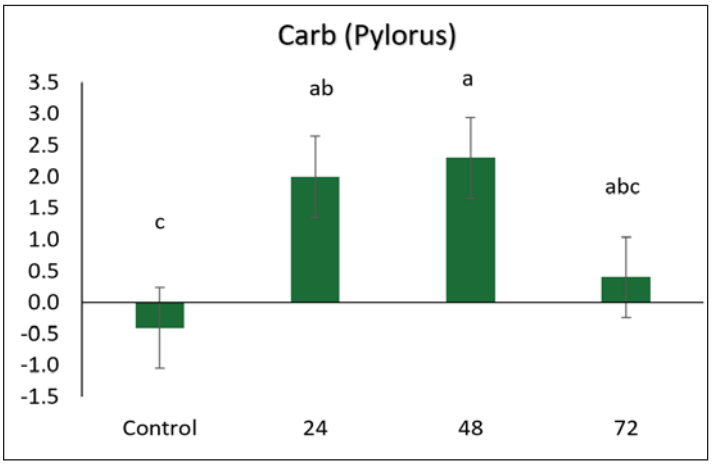

Figure 4. Changes in Isc response in the pylorus to the addition of ion channel activator, carbachol (P=0.58).

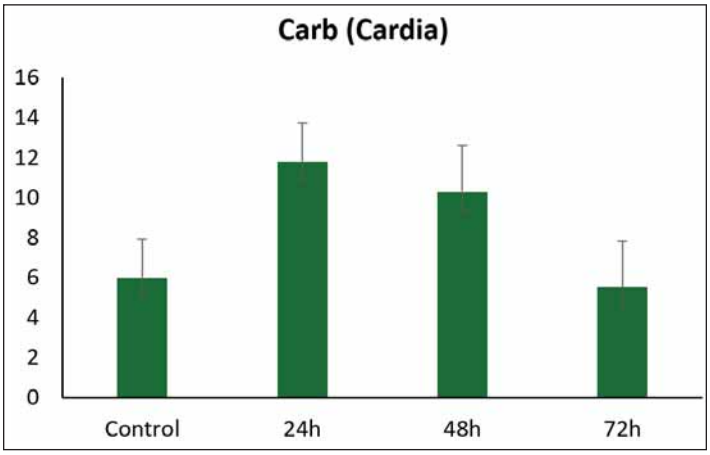

Figure 5. Changes in Isc response in the cardia to the addition of ion channel activator, carbachol (P=0.09).

Carbachol binds to both nicotinic and muscarinic acetylcholine receptors, which leads to an intracellular influx of Ca2+. This triggers a rapid activation of calcium-activated ion channels. No significant Isc changes were detected when bumetanide, an inhibitor of NKCC1 (a basolateral cotransporter) was added to the pars and cardia (Fig. 6). This suggested that the anionic secretion could be linked to bicarbonate (HCO3-) since CFTR is also a bicarbonate channel.

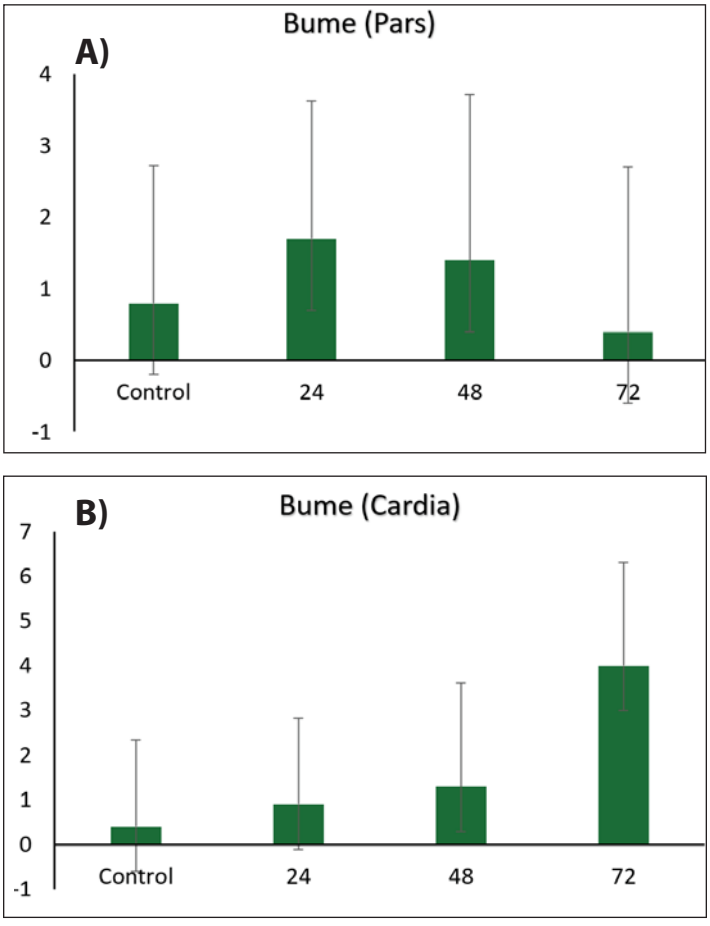

Figure 6. Changes in Isc response in the pars oesophagea (A) and cardia (B) to the addition of NKCC1 inhibitor bumetanide (P>0.10).

There were no significant secretory responses in the other segments and other pharmacological drugs added. Additionally, there were no significant differences between the control (no out-of-feed event) and the 24h and 72h (after out-of-feed event) in any of the parameters measured. Secretory responses were not compared between segments.

IMPLICATIONS

We demonstrated that 48 h after an out-of-feed event a significant increase in electrogenic anionic secretory response occurs in pigs fed with 40% ACPS diets. We also report for the first time that during gastric ulcer conditions, the pars oesophagea becomes an actively secreting tissue which sheds light on the complex mechanisms involved in the pathophysiology of gastric ulcers and may have implications for the diagnosis and treatment of this condition.

ACKNOWLEDGEMENTS

Financial support for this project was provided by the Government of Saskatchewan. The authors would also like to acknowledge the strategic program funding to Prairie Swine Centre provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council, and the Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

Investment cost and payback period of a modified prototype livestock trailer

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Alvin Alvarado

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APPLICATION FOR PRODUCERS

The use of a mechanically-ventilated trailer with air filtration is a viable option for producers to protect pigs from airborne transmissible diseases and ensures good welfare during transport. Consider talking to your transporter about possible options for air-filtered trailer transport for high value stock.

SUMMARY

The overall goal of the work conducted was to assess the performance of an improved prototype livestock trailer with ventilation, heating, misting and air filtration systems in maintaining a welfare-friendly and pathogen-free environment during transport. Road and disease-challenge tests showed that the trailer's ancillary system was able to maintain acceptable environmental conditions in the animal compartment during transport. In addition, the air filtration system in the trailer was able to protect pigs from exposure to airborne transmissible diseases such as Influenza A virus. Cost analysis showed financial feasibility of an air-filtered trailer, with an estimated payback period of 2.8 years for an assumed price premium of $5 per pig transported in an air-filtered trailer.

INTRODUCTION

Animal transportation has proven to play a vital role in disseminating airborne viruses. In fact, airborne viruses such as Influenza A, PRRS and PED can be transmitted as far as 9 km downwind from a positive barn. Aside from the biosecurity concerns, public demands for enhanced animal welfare in food animal production has increased significantly. The thermal micro-environment within the transport vehicle poses the greatest risk to the animals' welfare and well-being. Therefore, a new prototype trailer fitted with air filtration, ventilation, heating, and misting systems was developed in a previous project to protect the animals from airborne transmissible diseases during transport and improve the thermal environment in the trailer. The aim of the current project was to evaluate the effectiveness of the enhanced filtered trailer in maintaining a pathogen-free and welfare-friendly environment inside the trailer loaded with pigs under actual transport conditions. Also, an economic analysis was done to calculate the cost of the enhanced trailer and the payback period. Lastly, recommendations for commercialization of the trailer were developed.

"Airborne viruses such as Influenza A, PRRS and PED can be transmitted as far as 9 km downwind from a positive barn."

EXPERIMENTAL PROCEDURES

The prototype trailer is a dual (top and bottom) straight-deck trailer, with totally enclosed, positive-pressure fan-ventilated animal compartments. Inlet air must pass through a series of filters before entering the animal compartment. In addition, various features such as hydraulic loading platform, hinged floor and roof, a variety of sensors and electronic controllers, among others, were incorporated into the trailer design (Figure 1). Each deck is divided into two pens (front and rear) by a gate. Each pen has installed pig drinkers, feeders, spray misting nozzles, LED light, and sensors for temperature, relative humidity (RH), air flow, and carbon dioxide gas for environmental monitoring and control system. One video camera was installed on each pen per deck for real-time monitoring of pigs inside the animal compartment. In front of the trailer animal compartment is a separate space which holds the ventilation fans, the bank of filters, electronic controllers, supplemental heaters, power generator set, and data loggers (Figure 2).

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Figure 1. Photos of the prototype trailer showing the exterior of the front and animal compartment (A), its lower and upper decks (B), hinged roof (C) and hydraulic lift gate (D).

Testing and evaluation of the prototype transport trailer comprised of road tests and disease-challenge tests. The disease-challenge tests consisted of two test conditions: 1) with the trailer filtration system in operation (Treatment), and 2) without the filtration system (Control). For each test, a group of 10 pigs were transported to an IAV-positive barn site, and then the trailer was exposed to the exhaust air from the barn for 14 hours by connecting a duct from a nursery room exhaust fan to the trailer air inlet. The two groups (Treatment and Control) were tested on separate trips to the site using the same prototype trailer. After exposure, the trailer was moved to a location away from the IAV-positive barn, and pigs were cared for following standard guidelines and observed for 14 days for signs of IAV infection.

Cost analysis of the mechanical ventilation and air filtration systems installed in the prototype animal transport trailer was carried out following the completion of the road and disease-challenge tests. A list of recommendations to help facilitate the commercial adoption of the new trailer design was then formulated.

"The prototype trailer is a dual (top and bottom) straight-deck trailer, with totally enclosed, positive-pressure fan-ventilated animal compartments. Inlet air must pass through a series of filters before entering the animal compartment."

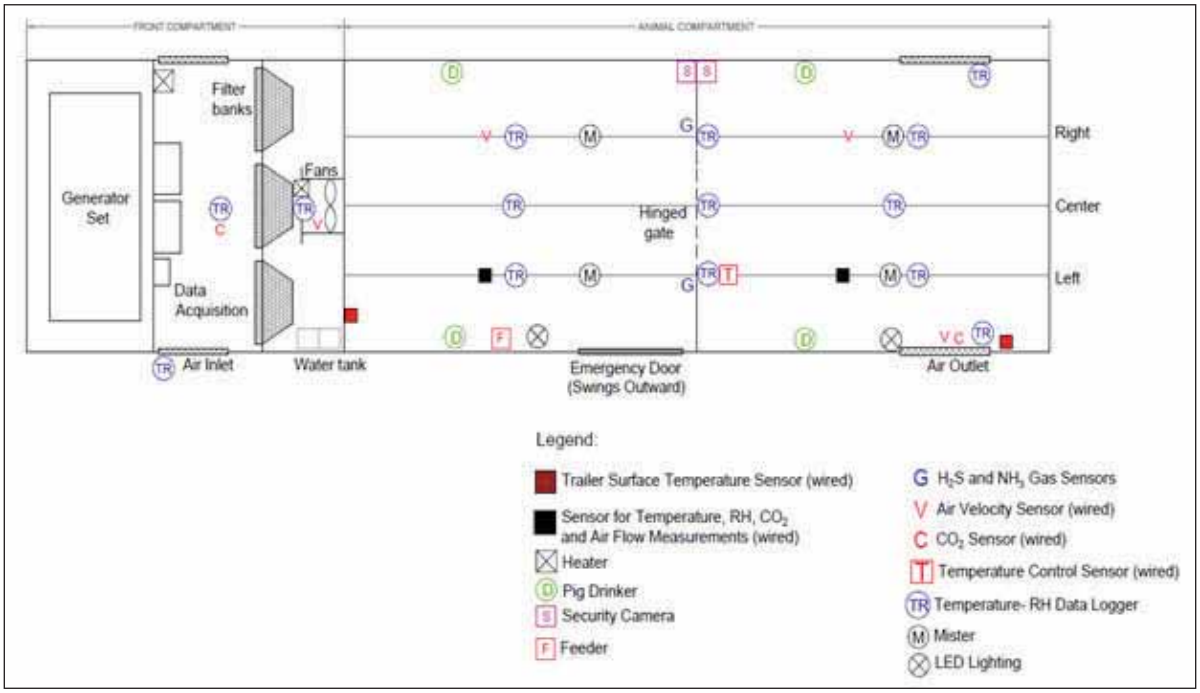

Figure 2. Schematic diagram showing the location of sensors, devices, data loggers and other added features installed in the front and animal compartments of the prototype livestock trailer. Temperature – RH data logger (TR) are portable sensors installed for experimental purposes only.

RESULTS AND DISCUSSION

Road and disease-challenge tests: The 2023 PSC Annual Research Report showed the results of four road tests and two disease-challenge tests. A total of eight road tests and three disease-challenge tests have now been performed. The results were very similar to those presented in last year's Annual Research Report. In short, the trailer's ancillary system was able to maintain acceptable environmental conditions in the animal compartment during the 6-hour transport with 10 pigs on-board the trailer, including temperature, moisture levels and CO_2 concentration. Furthermore, pigs were not under stress and no dead pigs were recorded throughout the eight monitoring trips. Results of the disease-challenge tests showed that the air filtration system in the trailer was capable of protecting the pigs from exposure to airborne transmissible diseases such as Swine Influenza A virus.

Economic analysis: The incremental costs associated with the assembly and operation of a mechanically ventilated trailer fitted with an air filtration system are summarized in Table 1. The major cost components include equipment costs (generator, ventilation control system and fans, filters, heating, misting system, etc.), capital costs associated with trailer assembly, installation costs, filter replacement costs and other operational costs. Actual costs incurred in the construction and assembly of the 20-ft prototype air filtered trailer used in this study served as the basis in the estimation of cost for the full-scale 120-pig (market pigs or gilts) capacity air-filtered trailer. Overall, the estimated total incremental cost for capital, equipment and labor to build and assemble a 120-pig capacity air-filtered trailer is $113,540.

In addition to equipment and installation costs, operational costs related to fuel for the generator set, water for the drinker and misting system, hydraulic oil for the lift gate and data subscription for mobile monitoring of the environment conditions in the trailer, amounted to $14,826. This cost was estimated based on a 10-hr journey (pig transport) conducted at a maximum of two times per week. Another cost included in the analysis was the $657 per year filter replacement cost, which was estimated based on the assumption that the MERV-16 filters will be replaced every 3 years and the MERV-8 pre-filters every 6 months.

Table 1. Costs associated with the assembly and operation of a 120-pig capacity air filtered trailer.

Type of Expense		Estimated Cost
Equipment cost		
Generator set		$15,000
Fans		$3,400
Ventilation system controller		$1,850
Filters and pre-filters		$2,190
Heating system (in-fans)		$1,700
Water and misting system (i.e., drinkers, misters, water lines, tanks)		$3,000
Emergency access/inspection doors		$1,000
Built-in sensors for temperature, RH and CO_2		$1,000
Other material costs for assembly		$3,600
Total equipment cost		*$32,740*
Other capital cost		
Animal container body		$43,300
Hydraulic lift gate and accessories		$11,300
Control compartment		$2,500
Trailer flatbed		$9,200
Total of other capital cost		*$66,300*
Installation cost		
Old prototype trailer		$11,500
Water and misting system		$1,000
Emergency access/inspection doors, feeders		$2,000
Total installation cost		*$14,500*
Total equipment and installation cost		**$113,540**
Filter replacement cost		
Assumed lifespan, yr	10	
Replacement per lifespan	3	
Number of filters	6	
Filter cost, $	$2,190	
Total replacement cost per lifespan, $	$6,570	
Total filter replacement cost per year, $/year		**$657**
Operational cost		
Fuel for genset1, $/year		$13,575
Water for drinker and misting system2, $/year		$51
Hydraulic oil for lift gate, $/year		$600
Data subscription for mobile monitoring, $/year		$600
Total operational cost		**$14,826**

All costs are in Canadian dollar.
1 Diesel fuel cost estimated at $1.81/L. Consumption based on a 5-month heating period and 7-month cooling period (i.e., no heater used, only misting system) per year, and year-round operation of the ventilation system.
2 Water cost was estimated to be $4.24 per 100 cu.ft.

A sensitivity analysis was carried out to determine the payback period for genetic stock transported using the trailer (Figure 3). Payback period calculations were based on a number of assumptions:

1. two trips per week and allowing extra downtime (~10%) for trailer maintenance thus transporting only 90% of the total number of weeks in a year at 120 pigs per trip;
2. cash inflows come solely from price premium received for every pig transported using the air filtered trailer, and;
3. net cash inflows were calculated by subtracting annual operational and air filter replacement costs from cash inflows.

For a premium of $5 per pig delivered, the annual net cash inflow is approximately $40,317 and the resulting payback period for this premium is 2.8 years. Other modest premiums of $3 per pig and $4 per pig will yield payback periods of 6.3 and 3.9 years, respectively.

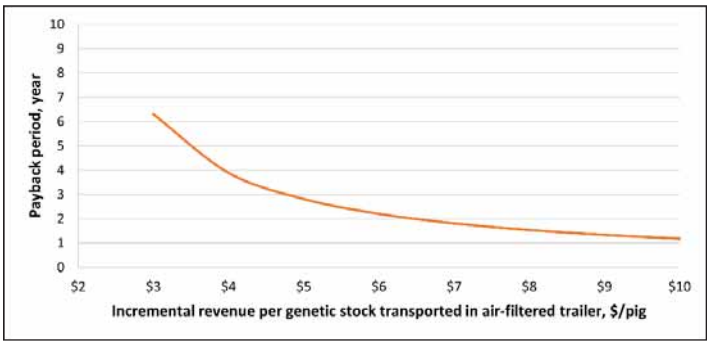

Figure 3. Payback period for investing in a 120-pig capacity mechanically-ventilated trailer fitted with an air filtration system considering a range of premiums (in $/year) for genetic stock transported.

IMPLICATIONS

- Enhancements and modifications to the environmental control and data logging systems in the trailer enabled ease of monitoring the environmental conditions (such as temperature, relative humidity and gases), which allows the operators to assess the real-time conditions of the pigs during transport. The installation of video cameras allowed remote monitoring of pig behavior during transport. This will enable operators to better manage the animal environment, particularly on trips where the trailer may potentially encounter unfavourable environmental conditions.
- The performance of the installed ancillary systems, such as ventilation, heating and misting systems, was proven to be effective in maintaining acceptable air quality and thermal environment for the pigs during transport, even during adverse weather conditions.
- Installing an air filtration system in the trailer can protect pigs from potential exposure to airborne transmissible diseases such as Influenza A virus (IAV) during transport. This study could help pig producers curb the transmission of pathogens and avoid significant economic loss.
- Pigs such as breeding stock transported under biosecure conditions using air-filtered trailers can earn a substantial price premium over conventionally-transported animals, thereby offsetting trailer investment costs. Cost analysis showed financial feasibility of an air-filtered trailer, with an estimated payback period of 2.8 years for an assumed price premium of $5 per pig for every pig transported in an air-filtered trailer.

ACKNOWLEDGEMENTS

Financial support for this research project was provided by the Saskatchewan Agriculture Development Fund and the Canadian Agri-Safety Applied Research Program funded by Agriculture and Agri-Food Canada. The authors would also like to acknowledge the participation of the cooperating farm in this research project, as well as the strategic program funding provided to Prairie Swine Centre by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund.

Optimizing temperature requirements of pigs to reduce energy use in swine production

N. Matuba[1,2], A. Alvarado[1,2], B. Predicala[1,2]

Nolan Matuba

Bernardo Predicala

APPLICATION FOR PRODUCERS

Raising sows and grow-finish pigs at environmental temperatures preferred by the animals can reduce energy cost and greenhouse gas emissions. Previous work with sows has shown a significant cost savings.

SUMMARY

The overarching goal of this research project is to investigate the optimum environmental temperature requirements of sows and grower-finisher pigs to reduce energy costs and greenhouse gases while maintaining their long-term overall productivity and performance. The project consists of four phases; 1) group-housed gestating sows will be kept for 6 weeks either at 16.5 °C (current recommended set-point) or 8 °C (preferred temperature determined in a previous study); 2) determine the preferred environmental temperature of grower-finisher pigs, using the operant mechanism and experimental protocols developed in the previous sow study; 3) grow-finish pigs will be kept for 6 weeks at either the current recommended set-point temperature, or the preferred temperature determined in phase 2; 4) assessment of environmental (carbon) footprint, cost analysis and development of recommendations for practical application of the optimized temperature management in commercial barns. Preliminary results of phase 1 show a reduction in energy consumption of >50% in group-housed gestation rooms with a setpoint of 8 °C vs. 16.5 °C.

INTRODUCTION

Rising cost of energy has caused financial hardship for many producers, with energy costs for a typical 500 sow farrow to finish pig production unit in Saskatchewan estimated to be ~$6.70 per pig sold. Heating costs are a substantial part of the total energy costs, so reducing temperature set-points in the barn to reduce how often the heater is running would help reduce energy costs.

A previous research project showed that group-housed sows could tolerate temperatures up to 8 °C lower than the typical set-point (16.5 °C) currently maintained in most gestation barns, without compromising the welfare and productivity of the animals. However, the impact of raising sows at this lower temperature on their long-term reproductive performance still needs to be evaluated in order to fully assess the economic benefits of adopting this technology across the industry.

Presently, no study has been conducted yet on the feasibility of a similar temperature set-point reduction for grower-finisher pigs. Thus, this project has been conceptualized to fill this gap by conducting a series of experiments to validate and update the current industry recommendations on temperature set-points for grower-finisher pigs and to assess the impact on energy costs and overall pig production performance.

EXPERIMENTAL PROCEDURES

Phase 1: Building upon the findings from the previous project, the goal of this phase is to implement the preferred temperature set-point determined from the previous study in actual sow gestation rooms to assess the impact on energy consumption and the long-term reproductive performance of the sows under conditions that represent actual commercial sow barns. Two identical sow rooms at the PSC pig production barn configured for group housing system will be used. One room will be designated as Control with temperature maintained at 16.5 °C (which is the typical set-point currently applied in commercial sow gestation barns) while the other room designated as Treatment will have temperature maintained at the sows' preferred temperature determined from the previous study (8 °C). A total of 3 sow trials will be conducted, with each room housing 45 sows per trial. Each trial will last for 6 weeks.

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Phase 2: The aim of this phase is to determine the preferred environmental temperature of grower-finisher pigs, using the operant mechanism and experimental protocols developed in the previous ADF study. Two fully instrumented, controlled-environment chambers at the Prairie Swine Centre (PSC) barn facility will be used. To train the grower-finisher pigs to control their own environmental temperature, the developed operant mechanism will be installed in each chamber. The mechanism is configured to allow the pigs access to a switch that controls the heating system of the chamber as well as a small radiant heater which provided an immediate feedback reward. In addition to the functioning heat control switch, a 'dummy' switch that does not operate the radiant heater (i.e., unrewarded activity) will also be installed close to the real switch to distinguish between deliberate behavior by the pigs to control the room temperature and random interaction with the mechanism. As proven in the previous ADF study, this set-up will allow the pigs to demonstrate their preferred environmental temperature by enabling them to control the operation of the heating and ventilation equipment installed in the room. A total of 5 replicate trials will be carried out in the environmental chambers during winter months, with each chamber housing 5 grower-finisher pigs. The duration of each replicate trial is 3 weeks with the first week dedicated to allowing pigs to acclimatize to the chamber and to learn to use the operant mechanism, while the remaining 2 weeks is designated for data collection.

Phase 3: After the preferred environmental temperature of the grower-finisher pigs is established from the previous phase, the goal of this phase is to implement the preferred environmental temperature in actual grow-finish rooms to assess the impact on energy consumption and the pigs' performance under actual commercial barn conditions. Two identical grow-finish rooms at the PSC barn will be used, one room will be designated as "Pre-set" with temperature maintained at the typical set-point applied in grow-finish barns using a typical controller, while the other room designated as Treatment will have temperature maintained at the pigs' preferred temperature determined from phase 2. A total of 3 trials will be conducted, with each room housing 100 pigs per trial. Each trial will last for 6 weeks.

Phase 4: Following the actual in-barn experiments, an environmental footprint assessment will be performed using a sustainability assessment tool developed in a related study to determine the resulting carbon footprint from the application of the preferred temperature set-points in gestation and grow-finish barns. In addition, a feasibility analysis will be conducted to determine the costs and requirements for the proper implementation of the optimized temperature management approach in a typical commercial swine production facility. The data collected from this study, together with the information on all the expenditures and costs incurred during actual in-barn implementation including the purchase of materials and equipment, and labour and operating costs, will be used in the economic analysis. Recommendations for practical application of the optimized temperature management in commercial barns will also be developed.

RESULTS

Phase 1 trials are currently underway. Some of the measured parameters from the first trial conducted from March 6 to April 17, 2024, are presented below.

A. Room temperature

Figure 1 illustrates the average air temperature across various spatial locations within each room. In the Control room with set-point maintained at 16.5 °C (which is typical for commercial gestation barns), the measured air temperature ranged between 15.5 and 16.9 °C over the duration of the trial. In comparison, the Treatment room (with temperature set-point maintained at 8 °C, which was determined as the sow's preferred temperature based on a previous study) exhibited air temperatures ranging from 7.4 to 10 °C.

B. Relative humidity

Figure 2 shows the average relative humidity (RH) in both rooms over the duration of the completed trial. The RH values in the Control room ranged between 57.0 to 60.7% and had an average of 58.6 ± 1.6%. On the other hand, the Treatment room had an average RH of 56.0 ± 0.3% and ranged from 55.7 to 56.4%. Both rooms showed RH levels within the recommended range for swine barns, which is between 50 to 65%.

C. Energy consumption (electricity and natural gas)

The electrical energy usage in each room included electricity consumption by the ventilation fans, furnace motor, and room lighting, while the natural gas utilized by the furnace for room heating during the experiment was also monitored (Table 2). For the duration of the trial, the total electrical energy usage in the Control room was measured at 19.12 kWhr while the Treatment room recorded a total usage of 13.77 kWhr. For the total natural gas consumption, the Control room recorded usage of 3,214 BTU, which was more than double the gas consumption in the Treatment room, which totaled 1,355 BTU for the duration of the experiment.

Table 1. Total energy consumption measured from the Control and Treatment rooms during the first trial.

Eelectricity consumption, KWHr		Natural gas consumption, BTU	
Control room	Treatment room	Control room	Treatment room
19.12	13.77	3,214	1,355

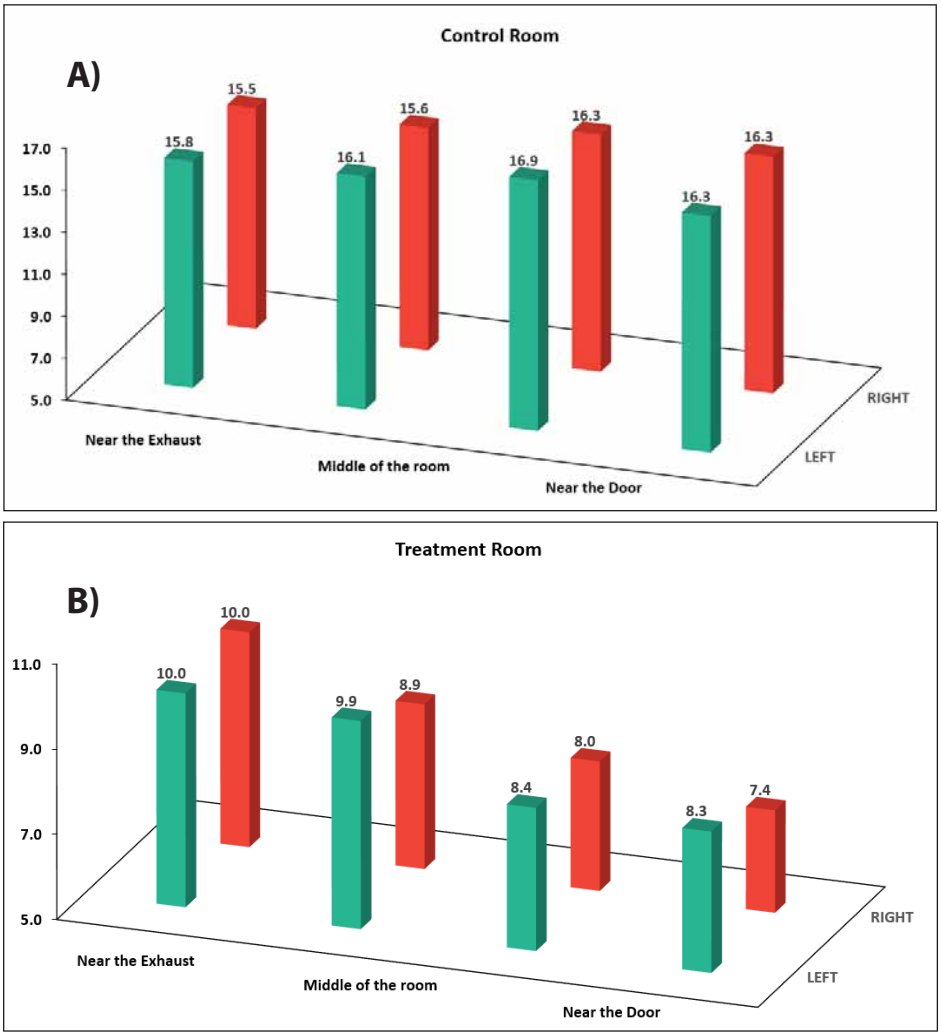

Figure 1. Average air temperature measured at various sampling locations in the Control (A) and Treatment (B) rooms (n = 6,074 to 6,078 temperature readings).

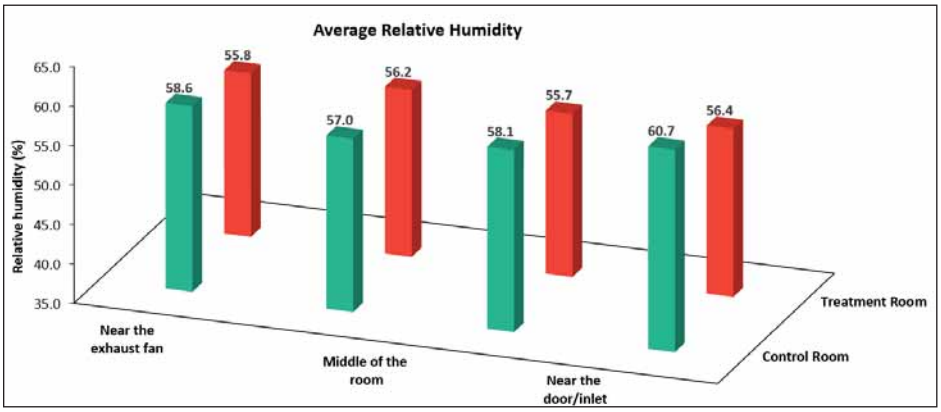

Figure 2. Average relative humidity measured at the occupied space of the sows in the Control and Treatment rooms over the duration of the trial (n = 6,078 to 6,085 RH readings).

IMPLICATIONS

This work has been conceptualized to validate and update the current industry recommendations on temperature set-points for gestating sows and grower-finisher pigs and to assess the impact on energy costs and overall pig production performance. The expected deliverables from this project are: 1. optimized temperature requirements for sows and grower-finisher pigs that reduce barn energy use while maintaining productivity and performance, and 2. economic feasibility of implementing updated temperature management in gestation and grow-finish barns.

ACKNOWLEDGEMENTS

Financial support for this research project was provided by the Saskatchewan Agriculture Development Fund. The authors would also like to acknowledge the strategic program funding provided to Prairie Swine Centre by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

Long term effect of early vs. late enrichment with scented newspaper in growing pigs

A. Tillotson[2], D. Beaulieu[2], Y. M. Seddon[3], and J. Brown[1,2]

Abby Tillotson

Jennifer Brown

APPLICATION FOR PRODUCERS

Consider giving scented newsprint as enrichment to growing pigs to reduce aggression, increase ease of handling, and improve growth performance.

SUMMARY

Environmental enrichment can reduce damaging behaviours like tail biting, but practical information on enrichments for growing pigs is lacking. A previous study showed that scented newsprint was a promising enrichment type. The current study examined the long-term effect of early vs late enrichment with scented newspaper on pig growth and the development of damaging behaviours. A total of 240 piglets received scented newsprint three days per week (Enriched [E]) or no enrichment (Control [C]) from 2-8 weeks of age (Early) and/or from 8 weeks-slaughter (Late) to create 4 distinct treatments: Enriched early and late (EE), Enriched early/Control late (EC), Control early/Enriched late (CE), and Control early and late (CC).

The results showed that the effects of EE and CE treatments had the best performance and the lowest incidence of damaging behaviour. These were followed by the CC treatment, with EC pigs showing the poorest performance in growing and finishing. The EE treatment showed the least pen-mate manipulation and other benefits; thus, we conclude that early enrichment was important in influencing behaviour later in life.

INTRODUCTION

Tail biting is a behavioural problem that impacts pig welfare and the economics of production. Providing enrichment early in life may reduce the frequency of severe tail bites during the finishing stage. Research is needed to determine the best timing of enrichment and the type(s) of enrichment that are most effective.

Moreover, improper or inconsistent use of enrichments may have a negative impact and decrease animal welfare. For example, when pigs are moved from an enriched environment to a barren environment, they can show increased levels of problem behaviours such as tail biting or manipulation of pen fixtures. Also, if a limited amount of enrichment is provided, it can increase competition and aggression. There is limited research looking into the effects of providing enrichments during only a portion of the pig's life, be that early (farrowing/nursery) or late (finishing).

This project aims to identify enrichments that are not only beneficial to the pigs' health and welfare but are also practical and cost-effective for producers to incorporate. A previous study in this project confirmed that pigs prefer enrichment items that are destructible, deformable, and chewable. Based on the high levels of activity observed with scented newsprint, as well as low materials cost, lack of issues with the liquid manure system and the ability of this treatment to retain novelty over time, it was selected for use in the current study. This study examined the long-term effect of early vs late enrichment with scented newspaper on pig growth and the development of damaging behaviour.

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EXPERIMENTAL PROCEDURES

A total of 240 piglets were assigned to one of two treatments from 2 to 8 weeks of age (farrow room and nursery period): Enriched (E) pens received three days per week newsprint scented with a diluted citrus-based product (Phytozen®, Probiotech International Inc., St. Hyacinthe, QC, Canada) that is known to reduce aggression, or Control (C). When pigs moved to the grow-finish pens at 8 weeks of age, half of the Enriched pigs were switched to the Control treatment and vice versa to create 4 distinct treatments: Enriched early and late (EE), Enriched early/Control late (EC), Control early/Enriched late (CE), and Control early and late (CC). All grow-finish pens had a chain to comply with the Code of Practice requirement for enrichment. Growth performance was measured throughout the trial period. Enrichment use, aggression and the frequency of damaging behaviours were recorded. Tail biting scores were taken weekly in the grow-finish phase. A subset of 20 pigs per treatment were subjected to a series of individual behavioural tests. Post-mortem measures such as blood glucose and cortisol, as well as carcass lesions and quality data were taken on 20 pigs per treatment.

RESULTS AND DISCUSSION

Growth: Results for ADG in early life (2-8 weeks) showed no significant difference between C and E treatment pigs. In late life, from 18-21 weeks of age, pigs that received enrichment (CE and EE treatments) had significantly higher ADG compared to those that did not (CC and EC pigs, P=0.011). Feed consumption and feed to gain (F:G) showed no significant effects of early or late enrichment or their interaction.

Handling: In week 9, E pigs had significantly lower handling scores than C (P= 0.014), with no difference in weeks 3, 4, 18 and 21. When pigs were moved between farrowing and nursery there was no difference in handling time, but when moving from nursery to grow-finish, E pigs took less time to move than C (P<0.05).

Table 1. Means of the change in lesion scores* on five body regions 24 hours pre- and post-mixing at weaning in Control and Enriched pigs.

Item	Control	Enriched	SEM[1]	*P*-value
n	119	118		
Front	2.32a	1.69b	0.05	<0.001
Mid	1.37	1.05	0.10	0.258
Hind	1.28a	0.80b	0.16	<0.001
Ears	1.08a	0.75b	0.31	0.006
Tail	0.53a	0.31b	0.15	0.009

* Lesion scoring system: 0=no injuries, 1=less than 5 superficial injuries, 2=5-10 superficial injuries and/or less than 3 deep wounds, 3=more than 10 superficial injuries and/or more than 3 deep wounds (adapted from the Welfare Quality® Assessment for Pigs)
1Standard error of mean
a,b Treatment estimates on the same row with different letters are significantly different at the 5% significance level (P < 0.05)

Behaviour at mixing: Lesion scores measured 24 h after mixing at weaning showed more lesions on C than E pigs. Control pigs had significantly higher lesion scores in the front, hind, ears, and tail regions than enriched pigs (Table 1). Regarding enrichment use, E pigs were observed to spend more time exploring enrichment than C pigs (P=0.017 and P<0.001 for duration and frequency).

In grow-finish, there was a significant difference in enrichment exploration with CE and EE pigs having longer durations and more frequent bouts of exploring the enrichment compared to CC and EC (P<0.001 for frequency and duration). Pigs that had access to newsprint enrichment throughout life (EE) had significantly more feeding bouts compared to all other treatments (P<0.001).

Social behaviour: Table 2 shows that E pigs had better social behaviour parameters than C pigs (fight duration, enrichment exploration and feeding frequency). EE pigs performed significantly fewer pen-mate manipulations in total than all other treatments (P=0.015), CC pigs performed longer durations of belly manipulation, and EC pigs performed longer durations of tail and ear manipulation. Pigs in the EE treatment consistently had the shortest durations of manipulation (Figure 1).

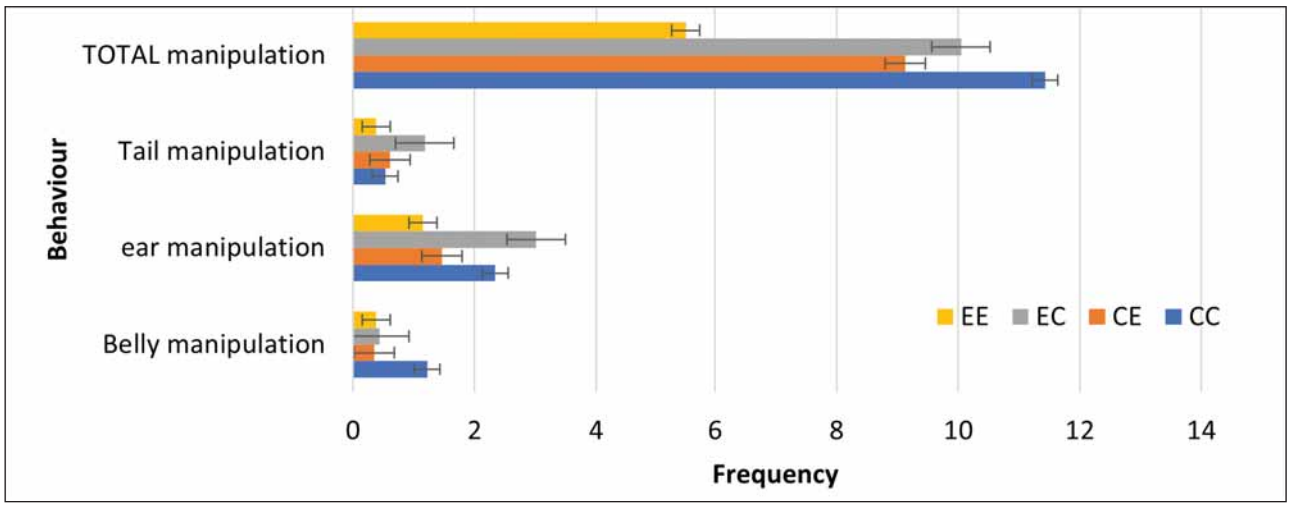

Figure 1. LS means for the effect of early and late enrichment interaction on the frequencies of total, tail, ear, and belly manipulation observed in pigs at 17 weeks of age (50 minutes observation/pig).

Table 2. LS means of behaviours performed by pigs raised in Control (C) or Enriched (E) environments in Early or Late life following mixing when moving into grow-finish at 9 weeks of age

Item	Early		Late		SEM[1]	*P*-value	
	C	E	C	E		Early	Late
n	37	43	43	38			
Fights (duration, s)	55.04	46.26	74.01a	34.31b	1.22	0.573	0.015
Fights (frequency)	5.82b	7.91a	7.03	6.55	1.93	<0.001	0.397
Enrichment exploration (duration, s)	87	107	27b	343a	0.41	0.585	<0.001
Enrichment exploration (frequency)	11.26b	13.24a	5.59b	26.65a	2.02	0.024	<0.001
Feeding (duration, s)	503	542	487	557.69	57.91	0.591	0.327
Feeding (frequency)	12.10b	15.64a	11.24b	16.38a	1.49	<0.001	<0.001

a,b Means within a category on the same row with different letters are significantly different at P< 0.05
1 Standard error of the mean

Lesions in grow-finish: There was a significant interaction between Early and Late environments, showing that EE pigs had significantly lower (better) scores compared to pigs in CC and EC treatments, with CE pigs being intermediate (P=0.032).

Tail biting in grow-finish: Pigs enriched during late life (CE and EE) had significantly reduced tail bite damage between 10-21 weeks compared to CC and EC pigs (P<0.001). EC pigs had the highest average tail bite score, EE had the lowest, and CC and CE pigs were intermediate (Figure 2).

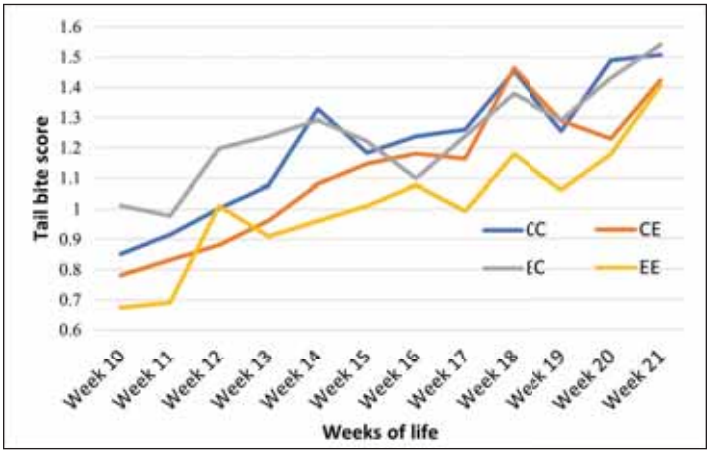

Figure 2. Average tail bite scores from 10-21 weeks of age in pigs in CC, CE, EC, and EE treatments. Scoring system: 0=no evidence of tail biting including redness, bruising, or scabbing, 1=mild/healed lesions, 2=redness of mild puncture wounds, 3=severe redness, deep puncture wound, or swelling. Includes total or partial loss of the tail (adapted from Carroll et al. 2018)

Stress physiology and carcass evaluation: No significant differences were observed between the levels of serum glucose or cortisol in pigs with or without enrichment provision. There was no effect of treatment on carcass lesions. Pigs that received enrichment in early life had significantly higher carcass weight and lean % compared to controls (P=0.040 and P=0.031, respectively).

IMPLICATIONS

Overall, the effects of EE and CE treatments showed the best performance and the lowest incidence of damaging behaviour. These were followed by the CC treatment (minimal enrichment throughout), with CE pigs showing the poorest performance in growing and finishing. The negative result for EC pigs is in agreement with other studies, as it has been determined that going from a positive environment (periodic enrichment) to a more negative environment (no periodic enrichment) has a negative impact on animals' affective state.

Late enrichment (CE and EE treatments) had the greatest benefit for reductions in aggression and tail biting. The EE treatment showed the least pen-mate manipulation and other benefits; thus, we conclude that early enrichment was important in influencing behaviour later in life.

The periodic enrichment of pigs using scented newsprint is deemed a successful treatment. This enrichment had beneficial effects for pigs, as well as being inexpensive and easy to provide.

ACKNOWLEDGEMENTS

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Effects of replenishment rate of enrichments in pigs with undocked tails

J.-Y. Chou[1,2,3], D.A. Sandercock[2], R.B. D'Eath[2], and K. O'Driscoll[1]

Jen-Yun Chou

Jen-Yun Chou is the Research Scientist, Ethology at Prairie Swine Centre. This article consists of results from work that she performed as part of her PhD thesis, when she was affiliated with Teagasc in Ireland, Scotland's Rural College (SRUC), and the Royal (Dick) vet school of the University of Edinburgh in the UK. This article is included to introduce readers to Jen-Yun's previous work, which is also relevant to Canadian pork producers.

APPLICATION FOR PRODUCERS

Replenishing enrichment frequently reduces damaging behaviours, especially if you are dealing with a tail biting episode, or if your pigs have undocked tails.

SUMMARY

This study compared pre-weaning exposure to environmental enrichment or not, and three slat-compatible enrichment replenishment strategies for pigs post-weaning. Forty-eight mixed-sex pens (six males and six females/pen) of undocked pigs were followed from birth to slaughter. Pre-weaning, half the pigs were provided with enrichment materials (a cardboard cup, rubber toy, burlap cloth and bamboo), in addition to a rope for the sows, in all farrowing crates. Post-weaning, all pens were enriched with eight identical items, including an elevated rack supplied with fresh-cut grass, and objects of wooden, bamboo, rubber, and fabric materials presented in various ways. However, three different replenishment frequencies were applied: "Low" (replenished on Monday/Wednesday/Friday), "Medium" (replenished once daily), and "High" (replenished ad libitum).

The high enrichment replenishment rate increased growth and reduced damaging behaviours compared to the low replenishment rate pigs. Overall, these findings show that the provision and regular replenishment of multiple, slat-compatible, enrichment sources can reduce tail damage to manageable levels without the need for tail docking.

INTRODUCTION

Tail biting is a behavioural problem that impacts pig welfare and economics of production. Tail docking reduces the severity of tail biting but doesn't prevent it entirely. An important risk factor for tail biting is the availability of adequate manipulable materials as environmental enrichment. When managing tail biting in undocked pigs, combining the provision of loose materials in a small quantity with other point-source enrichment items is more effective than simply providing loose materials in a fixed location (such as in a rack).

Besides the rearing environment during the growing and finishing stages, there is some evidence that shows the preweaning environment has an impact on the risk of tail biting. More research is needed to determine the importance of early-life enrichments on damaging behaviour later in life.

The Code of Practice for the Care and Handling of Pigs recommends providing continual access to a range of novel suspended toys along with free toys on the pen floor. However, from a practical perspective it might be difficult to replenish enrichments every time the pigs finish them.

This project aimed to compare pre-weaning exposure to environmental enrichment or not, and three replenishment strategies to manage slat-compatible enrichment for pigs post-weaning. It was hypothesized that early exposure to an enriched environment and a high enrichment replenishment rate would reduce tail biting behaviour and tail lesions. An additional aim was to also calculate the economic costs and benefits of this complex enrichment strategy.

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EXPERIMENTAL PROCEDURES

Forty-eight mixed-sex pens (six males and six females/pen, 576 pigs in total) of undocked pigs were followed from birth to slaughter. Pre-weaning, half the pigs were provided with enrichment materials (a cardboard cup, rubber toy, burlap cloth and bamboo), in addition to a rope for the sows, in all farrowing crates. Post-weaning, all pens were enriched with eight identical items, including an elevated rack supplied with fresh-cut grass, and objects of wooden, bamboo, rubber, and fabric materials presented in various ways (Table 1 and Figure 1). However, three different replenishment frequencies were applied:

- "High" (ad libitum): The fresh cut grass was checked 3 times daily (around 0900–1000 h, 1400–1500, and 1800–1900 h) and immediately replenished if depleted, so that it was effectively provided ad libitum. All other destructible items were replaced immediately once it was noted during inspection that they were depleted.
- "Medium": The fresh cut grass was replenished with a reduced quantity once daily if depleted and other destructible items were replenished 48 h after depletion.
- "Low": The fresh cut grass was replenished only on Monday/Wednesday/Friday if depleted with the same reduced quantity as "Medium," and other destructible items were replenished 1 week after depletion.

Individual pigs were weighed on days 0, 49, 91, and 113 post-weaning. Direct behaviour observations were conducted twice weekly at pen level (10 min/day/pen), and tail and ear lesion scores of individual pigs were also recorded every other week. These measurements were taken during the post-weaning period. The cost of all enrichment materials used was calculated.

Table 1. List of items provided for all pigs during the weaner and finisher stage.

Item	Size	Method of provision
Nursery period		
2 × Easyfix® Luna 117	Shape as a sphere in the middle with a diameter of 0.12m and 12 legs (each around 0.12m long)	Loose on the floor
Spruce (Picea sitchensis) post	1.2m × 0.05m × 0.04m	Placed in a dispenser on the wall (the bottom end touching the floor)
Pine (Pinus sylvestris L.) block	0.2m × 0.05m × 0.05m	Suspended on a chain
Fresh-cut grass	N/A	Loose in an elevated rack
Cardboard tube	Length around 0.33m with a diameter around 0.1m	Suspended on a chain
Rubber pipe	Length around 0.3m with a diameter around 0.05m	Suspended on a chain
2 × Ayous (Triplochiton scleroxylon) thin sticks	0.15m × 0.03m × 0.005m	Suspended together on a Chain
Finisher period		
Larch (Larix decidua) floor toy	Shape as a squared block in the middle with a perimeter of around 0.27m and six legs each with a length of around 0.1m	Loose on the floor
Spruce floor toy	Shape as a squared block in the middle with a perimeter of around 0.3m and six legs each with a length of around 0.1m	Loose on the floor
Larch post	1.2m × 0.08m × 0.04m	Placed in a dispenser on the wall (the bottom end touching the floor)
Spruce block	0.33m × 0.05m × 0.04m	Suspended on a chain
Fresh-cut grass	N/A	Loose in an elevated rack
Burlap sack	0.5m × 0.76m	Suspended
Easyfix® Astro 200	Four legs (each around 0.2m long) extending from a central holding point	Suspended on a chain
Bamboo	Around 0.3m with a diameter of 0.07m	Suspended on a chain

Figure 1. Examples of different enrichments provided to the pigs

RESULTS AND DISCUSSION

Growth: Pre-weaning treatment did not have an effect on average daily gain (ADG) in any stage. Post-weaning, ADG was higher in the finishing stage ($P < 0.05$) and overall ($P = 0.06$) in "High" than "Low" pigs.

Lesions: There was no effect of pre- or post-weaning treatment on tail lesion scores either in terms of damage or blood scores. Pre-weaning enrichment resulted in a lower ear lesion score ($P = 0.04$). No difference in lesion scores was found between post-weaning treatments.

Behaviour: There was no effect of pre-weaning treatment on any of the behaviors observed. After weaning, "High" pigs performed less damaging behaviour (tail/ear biting, other biting, belly-nosing, mounting and aggressive behaviour) than "Low" pigs ($P = 0.01$).

Post-mortem examinations: No difference was found between treatments in any of the postmortem measures (i.e. tail lesions, level of tail amputation, the presence or absence of tail amputation, cold weight, and the percentage of lean meat, muscle, and fat).

Tail biting: Although sporadic tail biting occurred, only 0.69%of the pigs had their tails bitten severely enough that they became shorter than half of a normal undocked tail. No difference was found between treatments (four outbreaks in "High" pens, five in "Medium" pens and three in "Low" pens).

Cost estimation: The average enrichment cost for the post-weaning period was <€2 (<$3) per pig. The highest enrichment cost in all three treatments was the wooden floor toys, followed by grass in "High" and "Medium" pens.

IMPLICATIONS

Early exposure to point-source enrichment items in the preweaning stage did not exert a strong influence on pigs' later life performance or damaging behaviors, compared to postweaning enrichment provision. A high rate of enrichment replenishment post weaning promoted better growth in the finisher stage. It did not affect the tail lesions scored, however, it did reduce the occurrence of damaging behaviors observed and improved growth rate in the finisher stage, while the overall cost of enrichment materials was not higher compared with the lower rates of replenishment. This study suggests that it is possible to find a practical and feasible way to keep tail biting in undocked pigs on fully slatted floors at a manageable level by using an enhanced enrichment strategy which includes a good quantity and quality of point-source enrichment items.

ACKNOWLEDGEMENTS

This project was funded by the Teagasc Walsh Fellowship in Ireland. SRUC also receives funding from the Rural & Environmental Science & Analytical Services Division of the Scottish Government. The authors would also like to acknowledge the support from the staff at the Pig Research Facility in Moorepark, Teagasc, Ireland and the help from several visiting students.

Sow housing during the post-weaning and early pregnancy periods

J.-Y. Chou[1], and T.D. Parsons[1]

Jen-Yun Chou

Jen-Yun Chou is the Research Scientist, Ethology at Prairie Swine Centre. This article consists of results from work that she performed as part of her post-doctoral fellowship, when she was affiliated with the University of Pennsylvania in Philadelphia, PA, USA. This article is included to introduce readers to Jen-Yun's previous work, which is also relevant to Canadian pork producers.

PennVet New Bolton Center University of Pennsylvania

APPLICATION FOR PRODUCERS

Post-weaning sow housing recommendations and requirements may change in the future. This research helps us understand the welfare aspects of different housing systems.

SUMMARY

Research to date is limited on how best to house and manage sows during the post-weaning and early gestation periods from a welfare perspective. A systematic literature review (part 1) on this topic found only a small number of studies (n = 27) that met our systematic search criteria. Compared to stalls, group housing requires mixing of animals and always triggers more aggression and skin lesions at the time of mixing. What type of housing yields the best overall welfare outcome remains unclear as none of the studies explored the mental wellbeing of sows during this period.

INTRODUCTION

Sows and boars are an important focus in farm animal welfare assessments as they typically live the longest lives. For sows, the time between the end of lactation (post-weaning) and the implantation of embryos (early gestation) is very dynamic from both a physiological and husbandry perspective. However, research to date is limited on how best to house and manage sows during this critical period of their production cycle from a welfare perspective. Post-weaned sows are still commonly housed in individual stalls for at least a week, and often longer, on most farms. Housing sows individually during this critical period ensures adequate feed intake, reduces the risk of injuries due to mixing aggression with unfamiliar sows when their physicality is more fragile, and facilitates insemination. However, the impact of this confinement on sow behaviour and welfare is not well understood as the stall deprives the sow of both adequate movement and social contact.

"The impact of confinement on sow behaviour and welfare is not well understood."

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EXPERIMENTAL PROCEDURES

A systematic review used Web of Science to make in-depth comparisons among welfare-based studies that focus on sow housing during the post-weaning and early pregnancy period to identify important knowledge gaps. This review describes in more detail the studies that used sow-based welfare measures, such as lesions, stress, behaviours and any other psychological evaluation.

RESULTS AND DISCUSSION

Our systematic review found relatively few studies (n = 27) on the effects of housing post-weaning and during early pregnancy that address its impact on sow welfare. The majority of the relevant literature has focused on reproductive performance. Those papers examining welfare found that group housing after weaning usually generated more agonistic interactions (social behaviour related to fighting) and elevated cortisol concentration compared to individual housing, especially when feeding method generates competition, such as floor feeding, an unprotected feeding stall, or queuing in front of ESF stations.

Body lesions also were more prevalent due to mixing, but some studies showed increased space allowance during regrouping can reduce aggression and the subsequent lesions. Other studies found no difference in terms of aggression or skin lesions between different group structures (static or dynamic) and a limited number of studies addressing the timing of mixing did not report consistent differences. Social rank and parity had some influence on agonistic interactions and consequently the severity of lesions.

IMPLICATIONS

The systematic review defined a critical knowledge gap regarding the full impact of housing on the welfare of post-weaning and early gestation sows. This gap, and thus the true welfare impact of sow housing, will only be addressed by the use of novel, more holistic assessment methods that also capture the psychological state of the sow.

ACKNOWLEDGEMENTS

This project was funded by both the Pennsylvania Center for Poultry and Livestock Excellence and the Pennsylvania Pork Producer Council's Strategic Investment Program. The authors would also like to thank the staff at the Penn Vet Swine Teaching & Research Center for their assistance in conducting the on-farm trial.

Promoting play behaviour in grow-finish pigs

K. Steinerová[1], S. E. Parker[1], J. A. Brown[2], and Y. M. Seddon[1]

Karolína Steinerová

Yolande Seddon

APPLICATION FOR PRODUCERS

Consider providing a variety of novel enrichments intermittently to growing pigs to provide opportunities for pigs to play. This play behaviour is a rewarding experience for pigs that can enhance their quality of life through improved welfare.

SUMMARY

Play behaviour has been associated with excitement and fun, suggesting that playing animals experience pleasurable states. To determine if the provision of play opportunities could enhance the quality of life of pigs, this study investigated if play can be promoted and sustained in pigs beyond the natural period of expression (2-6 weeks of age) in a commercial setting. Growing pigs (n = 288, 10 weeks of age), housed in standard partly slatted pens, were assigned to either a Control treatment with no play interventions (CON, 1 m^2/pig); or to a Novelty (NOV) or Play pen (PLP) treatments, with play promotion between 10 and 21 weeks delivered through play sessions 3x/week. Play treatments received the intermittent provision of destructible novel objects provided either in the home pen (NOV, 1 m^2/pig), or in an enclosed 'play pen' area providing extra space (PLP, 2.9 m^2/pig).

The results showed that play was successfully promoted and sustained until the finishing period and equally expressed regardless of extra space. Pigs with play opportunities expressed indicators that play is a rewarding and motivating behaviour and could enhance the quality of life of farmed pigs when supported.

INTRODUCTION

To improve the quality of life of farmed pigs, negative welfare states should be replaced or balanced with joyful activity, for example opportunities for play, which may provide positive affective engagement for animals and support positive welfare states. In pigs, play is naturally expressed between 2 and 6 weeks of age and declines with age.

The main objective was to investigate whether play can be promoted and sustained beyond the natural window of expression, in grow-finish pigs (10–21 weeks of age) in a commercial setting. The secondary aim was to determine whether play was positive which was explored through linking play opportunities with behavioural indicators. The effect of play on physiological and production (growth) measures was also explored.

EXPERIMENTAL PROCEDURES

A total of 288 growing pigs (~35 kg) were housed in standard partly slatted pens (8 pigs/pen, 1 m2/pig) with point-source enrichment consisting of an untreated spruce lumber piece with a rope attached to a single chain. Pigs were assigned to one of three treatments from 10 to 21 weeks of age: i) Control (CON), ii) Novelty (NOV), and iii) Play pen (PLP). The Control treatment did not receive play interventions. Play was promoted in NOV and PLP treatments, collectively called play treatments, during intermittent play sessions that consisted of novel objects given in the home pen (NOV) or within a specific play pen (PLP, 2.9 m2/pig, solid concrete floor). Treatment pens (NOV and PLP) received a total of six, 30-minute play sessions, provided three days/week (Monday, Wednesday, Friday), two times/day (10 am/1 pm). Novel objects were rotated on a weekly schedule to reduce habituation and consisted of six items (cardboard, straw, plain popcorn, cotton rope, lumber, burlap) provided in different combinations. For each play session, the experimenter first distributed novel objects in the play pen, then entered the room and gave the novel objects to NOV treatment pens and then released PLP treatment pigs into the play pens, one group at a time. PLP pigs could not re-enter the room and their home pen during the play session. After 30 min, PLP treatment pigs were returned to their home pen, one group at a time, and the remains of the novel objects were cleared from the home pens of NOV treatment. The play pens were only cleaned after the PM play session of the day.

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Two gilts and two barrows were randomly selected from each pen (144 pigs) for behavioural observations at 4 phases: 1) a pre-play phase (PRE) recorded on a day without play sessions; 2) an anticipatory phase (ANT) of two minutes recorded before an AM play session, where anticipatory behaviour was stimulated with an experimenter walking back and forth in the room (conditioned stimulus) before the play session (unconditioned stimulus) commenced; 3) an active phase (ACT) capturing the AM play session; 4) a post-play phase (POST) starting one hour after completion of the PM play session lasting for 30 min. Saliva was sampled from the same pigs to determine the physiological response to play, with cortisol and alpha-amylase. The body weight of all pigs was measured at the start and end of the trial to calculate average daily gain (ADG).

RESULTS AND DISCUSSION

Promotion and sustainability of play behaviour (Figure 1): Pigs in PLP and NOV played more frequently ($p = 0.002$) and for a longer duration of time ($p < 0.001$) across weeks compared to CON. NOV and PLP did not differ in play frequency and duration, except for week 21 when PLP played more frequently. In all treatments, the greatest frequency of total play occurred at 11 weeks, decreasing in weeks 16 and 21 in CON, while NOV and PLP sustained the level of play between weeks 16 and 21. Object play was more frequent in pigs with play opportunities than CON pigs across all weeks. Compared to CON, NOV played for a greater duration of time in all weeks while PLP played longer in weeks 11 and 21, but not 16.

A student interacting with PLP pigs after a play session

"Pigs in play pen treatment and novelty treatment played more frequently and for a longer duration of time across weeks compared to control."

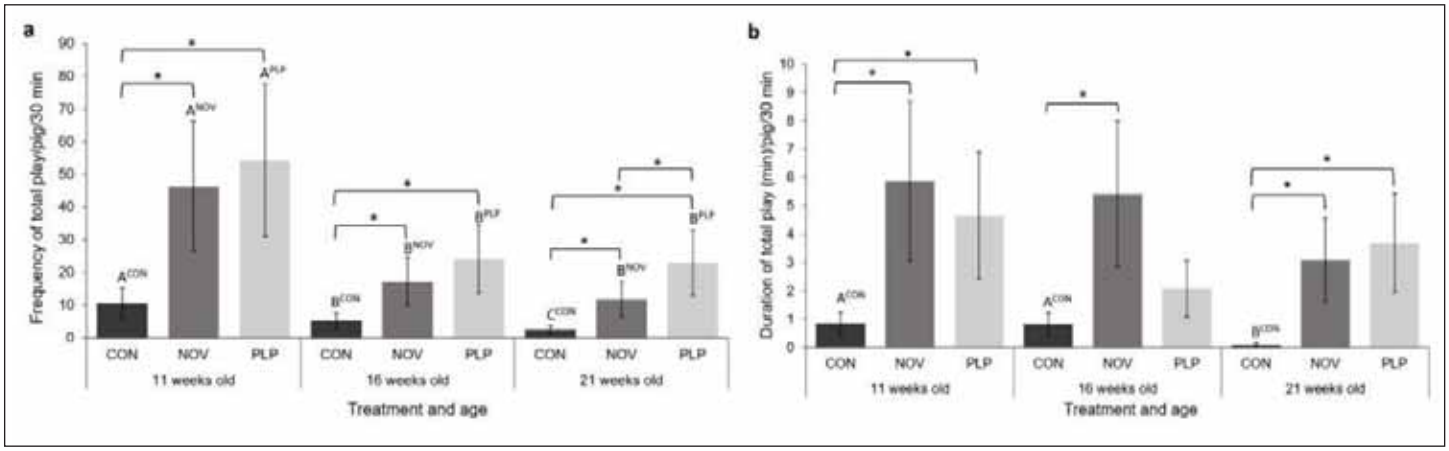

Figure 1. Frequency (a) and duration (min, b) of total play behaviour (locomotor, social, and object play) per pig (n = 159) in Control (CON), Novelty (NOV), and Play pen (PLP) treatments (12 pens/treatment) in the active phase (30-min play session) at the age of 11, 16 and 21 weeks. Predicted means and lower and upper 95% confidence intervals (CIs) are presented. * The asterisks (*) above the bars denote significant differences between treatments within week and the letters above the bars (A, B, C) denote significant differences within treatment across weeks. For clarity, where group letter above the bar was omitted, there was no significant difference. The threshold of significance for multiple comparisons (Bonferroni correction) for differences between treatments within week and within treatment across weeks (18 comparisons) was $p \leq 0.003$.

Figure published in Steinerová, K., Parker, S. E., Brown, J. A., & Seddon, Y. M. (2024). The promotion of play behaviour in grow-finish pigs: The relationship between behaviours indicating positive experience and physiological measures. *Applied Animal Behaviour Science*, 275, 106263. https://doi.org/10.1016/j.applanim.2024.106263.

Behaviours indicating positive experience (Table 1): Play treatments expressed more anticipatory behaviour and behavioural indicators associated with a positive experience (ears relaxed and forward, tail wagging, barks) compared to CON.

Agonistic behaviours (Figure 2): In the ACT phase, PLP pigs performed the least agonistic behaviour, while NOV was intermediate, and CON had the highest frequency. In CON, agonistic behaviour increased in the ACT compared to the PRE phase, while in PLP aggression decreased in the ACT phase compared to the PRE and POST phases. Agonistic behaviour in NOV did not differ across phases (Figure 2a). Play treatments interacted with objects for a greater amount of time during the ACT phase compared to other phases, while CON did not differ across any phase (Figure 2b).

Physiological response to play – measures of cortisol, alpha-amylase, and ADG: Cortisol was elevated only in NOV compared to CON after the play session, but alpha-amylase and growth rate did not differ among treatments.

PLP pigs in a playpen: playing with cardboard during a play session

Table 1. Frequency of ear and tail postures per pig (n = 159) in Control (CON), Novelty (NOV) and Play pen (PLP) treatments (12 pens/treatment) in the active phase (30-min play session) across weeks. Predicted means and lower and upper 95% confidence intervals (CIs) are presented.

Posture	CON		NOV		PLP	
	Mean	95% CIs	Mean	95% CIs	Mean	95% CIs
Ears relaxed						
Week 11	0.27a	0.04–0.50	3.52b	1.49–5.54	2.82b	1.20–4.43
Week 16	0.54	0.22–0.86	1.94	0.93–2.96	2.22	1.09–3.34
Week 21	0.58a	0.24–0.92	1.70ab	0.80–2.60	2.96b	1.48–4.44
Ears forward	2.43a	2.07–2.80	3.01ab	2.57–3.46	3.28b	2.81–3.75
Ears backward						
Barrows	2.33a	1.66–2.99	1.29a	0.86–1.72	0.29b	0.14–0.45
Gilts	2.49a	1.75–3.23	1.53ab	1.02–2.04	0.74b	0.44–1.03
Ears mixed	0.17	0.08–0.25	0.19	0.09–0.30	0.13	0.05–0.21
Tail wagging						
Week 11	0.44	-0.09–0.99	1.33	-0.15–2.82	0.87	-0.08–1.81
Week 16	0.07	-0.02–0.16	0.56	0.13–0.99	1.22	0.34–2.10
Week 21	0.09	0.02–0.20	0.35	0.05–0.65	0.67	0.16–1.17
Tail motionless	4.62a	4.18–5.06	5.75b	5.22–6.27	4.26ac	2.83–4.68

*Different superscript letters denote significant differences between treatments within week or sex (a, b, c; bolded). No significant differences within treatment across weeks or sexes found. The threshold of significance for multiple comparisons (Bonferroni correction) for difference between treatments (ears forward/mixed, tail motionless; 3 comparisons) was $p \leq 0.02$, between treatments within week and within treatment across weeks (ears relaxed, tail wagging; 18 comparisons) was $p \leq 0.003$, between treatments within sex and within treatment across sexes (ears backward, 9 comparisons) was $p \leq 0.006$.

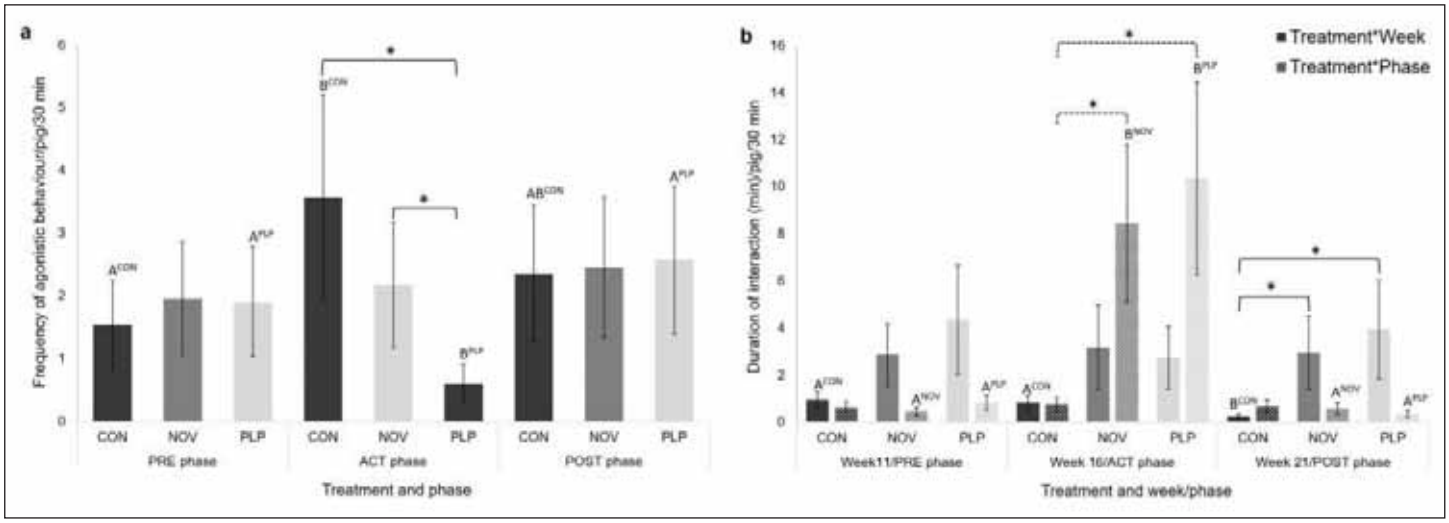

Figure 2. Frequency of agonistic behaviour across phases (PRE-play 30-min, ACT: active 30-min play session, POST-play 30-min, a), and duration (min) of interaction behaviour across phases and weeks 11, 16 and 21 (b) per pig (n = 159) in Control (CON), Novelty (NOV) and Play pen (PLP) treatments (12 pens/treatment). Predicted means and lower and upper 95% confidence intervals (CIs) are presented. * The asterisks (*) above the bars denote significant differences between treatments within phase or week and the letters above the bars (A, B, C) denote significant differences within treatment across phases or weeks. For clarity, where group letter above the bar was omitted, there was no significant difference. The threshold of significance for multiple comparisons (Bonferroni correction) for differences between treatments within phase or week and within treatment across phases or weeks (18 comparisons) was $p \leq 0.003$.

Figure published in Steinerová, K., Parker, S. E., Brown, J. A., & Seddon, Y. M. (2024). The promotion of play behaviour in grow-finish pigs: The relationship between behaviours indicating positive experience and physiological measures. *Applied Animal Behaviour Science*, 275, 106263. https://doi.org/10.1016/j.applanim.2024.106263.

IMPLICATIONS

The present study demonstrated that play behaviour can be promoted and sustained in grow-finish pigs in a commercial setting, regardless of whether extra space is available, as long as pigs are intermittently provided with novel enrichment. The fact that play was increased in the standard production pen with 1 m^2/124 kg pig, similar space allowance to the minimal space allowance of 0.95 m^2/100 kg pig in the Pig Code of Practice, indicates that promotion of play is a promising proof of concept to improve welfare of farmed pigs. The findings indicate that play is a highly positive behaviour for pigs, fostering positive welfare states. Incorporating this concept into husbandry routines and utilizing lower cost materials for novel objects like cardboard can minimize extra labor and costs, as would automating the delivery of materials, supporting its application on commercial farms. These findings hold significant implications for supporting the development of animal-friendly husbandry systems and for improving the quality of life of intensively farmed pigs.

"Promotion of play is a promising proof of concept to improve welfare of pigs."

ACKNOWLEDGEMENTS

Funding for this project was provided by Natural Sciences and Engineering Research Council (NSERC), University of Saskatchewan, Alberta Pork, BC Pork Producers Association, Conestoga Meat Packers Ltd, Hylife Ltd, Les Eleveurs de porcs du Québec, Manitoba Pork Council, Maple Leaf Foods, Olymel S.E.C./L.P., Ontario Pork Producers Marketing Board, and PEI Hog Community. The authors would also like to acknowledge the strategic program funding provided to the Prairie Swine Centre by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council, and the Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

Rearing pigs with play opportunities: Effects on disease resilience in pigs inoculated with PRRSV

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Yolande Seddon

APPLICATION FOR PRODUCERS

Rearing pigs in an environment with opportunities to play improves resilience against common production challenges and results in better growth performance. Play can be stimulated with intermittent provision of various novel enrichment such as cardboard, paper or burlap, and extra space.

SUMMARY

Positive emotions can reduce disease susceptibility during infectious challenges in humans, and emerging evidence suggests similar effects in farm animals. Because play behaviour may support a positive emotional state in pigs, this study investigated whether rearing pigs with regular intermittent play opportunities enhances disease resilience when challenged with porcine reproductive and respiratory syndrome virus (PRRSV). Litters were assigned to either play (PLY; n=5 litters) or control (CON; n=4 litters) treatments at birth. In PLY, play was promoted with extra space and enrichment items for three hours daily from five days of age (doa). At weaning (25±2 doa), 28 pigs (14/treatment) were selected for a disease challenge. The pigs were transported to a disease containment facility and at 43±2 doa (day 0 post-inoculation, DPI) inoculated with PRRSV. Play opportunities for PLY continued every other day until euthanasia of all pigs at 65±2 doa (22 DPI).

Results suggest that PLY pigs developed increased resilience to PRRSV compared to CON. Play pigs continued to play during infection, demonstrating less sickness behaviour and emphasizing the rewarding properties of play. This study demonstrates that rearing pigs in an environment supporting positive experiences through provision of play opportunities can enhance resilience against common modern production challenges, underscoring the value of positive welfare in intensive pig farming.

Inoculated PLY pigs with PRRSV during a play opportunity.

INTRODUCTION

Positive emotions have been associated with improved health in humans, and emerging evidence suggests similar effects in farm animals. Emotions and immunity work in synergy, and there are indications that a positive affective state has a beneficial effect on disease resilience. Resilience, defined as the ability of the animal to minimize the impact of environmental, social and disease challenges and quickly return to pre-challenge status, is imperative to sustain efficient pig production. An environment promoting positive experiences and the satisfaction of pigs' behavioural needs may improve pig resilience against common stressful challenges such as disease, transport, and injury. In pigs, positive emotions could be facilitated by offering opportunities to engage in a rewarding activity promoted by a stimulus-rich environment. Our previous study reported that play can be promoted and sustained in pigs beyond the period of its natural expression (2-6 weeks) in a commercial setting regardless of extra space, as long as pigs were provided with a rotation of novel enrichment, making it an attainable approach for promoting positive experiences on conventional farms. However, how play opportunities influence resilience during a disease challenge is unknown. The objective of the current experiment was to identify whether rearing pigs with play opportunities improved their disease resilience when challenged with PRRSV.

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EXPERIMENTAL PROCEDURES

Nine litters (n = 127 piglets) were assigned to either play (PLY; n=5 litters) or control (CON; n=4 litters) treatments at birth. The PLY treatment was reared with regular play opportunities from five days of age, whereas the CON treatment was reared under standard production conditions (farrowing pen: 0.3 m2/pig) without play opportunities. In PLY, play was promoted daily in a session consisting of 3 hours of continuous access to extra space in a playpen (1.8 m x 1.8 m; 0.5 m2/pig total space including the farrowing pen, Figure 1a) with the same seven types of destructible and durable enrichment items. The playpens were situated behind the farrowing pen gate in the corridor and had solid flooring. The entire litter was released to the playpen by opening the back gate of the farrowing pen. At weaning (25±2 doa), 28 pigs (14/treatment) were selected for a disease challenge. Individual pig-based factors shown to influence disease outcomes and immune response, such as growth and back test assessing the pig's coping strategy (low resistance [LR], medium resistance [MR] and high resistance [HR]), were accounted for in the selection, as well as sex, sow and the frequency of play at d21. The pigs were transported to a disease containment facility and at 43±2 doa (day 0 post-inoculation, DPI) inoculated with PRRSv. Play opportunities for PLY continued every other day until euthanasia of all pigs at 65±2 doa (22 DPI).

RESULTS AND DISCUSSION

Skin lesions (Figure 1): Skin lesions indicate agonistic encounters. The treatments did not differ in skin lesion score pre- nor one-day post-weaning, perhaps due to the large size of the pens. Following transport to the disease challenge facility, the skin lesion score increased but was substantially lower in PLY pigs compared to CON. PLY pigs might have spent more time exploring the transport trailer bedded with straw, and less time manipulating other pigs. Pre-inoculation (-2 DPI), the score declined again with PLY maintaining a lower score than CON until the end of the experiment (21 DPI). At 21 DPI, PLY, but not CON, had a lower skin lesion score compared to pre-weaning (Figure 1).

Viral load and respiratory distress: PRRSV viral load did not differ between treatments and peaked in the first week post-inoculation and then gradually declined. Regarding clinical signs, PLY pigs had a lower probability of moderate and severe respiratory distress and had a shorter duration of respiratory distress than CON pigs.

Growth performance (Figure 2): PLY pigs had higher average daily gain through the infection and were more feed efficient than CON pigs. There was no effect of treatment on average daily feed intake.

"Play pigs grew better during the infection and were more feed efficient."

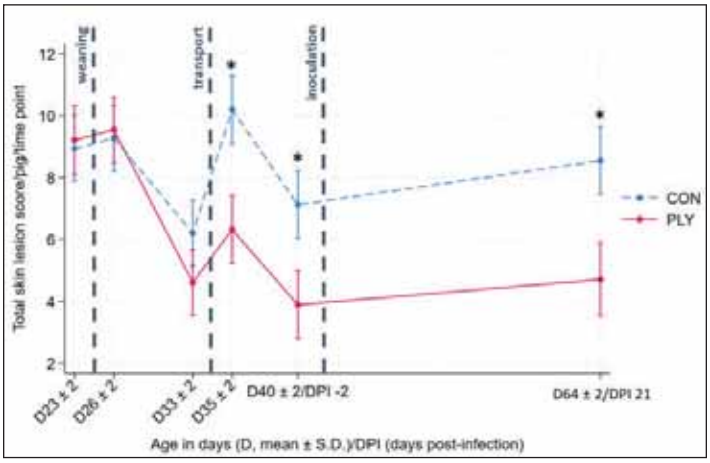

Figure 1. Total skin lesion scores in Play (PLY, solid line) and Control (CON, dashed line) treatments per pig (n = 28) at different time points: pre-weaning (age: D23 ± 2; mean ± S.D.), post-weaning (D26 ± 2), before transport (D33 ± 2), after transport (D35 ± 2), pre-inoculation (-2 DPI, DPI; D40 ± 2), and 21 DPI (D64 ± 2). Data are presented as predicted means with 95% confidence intervals.

Footnote: 'X' between two variables signifies an interaction effect. Significant differences between treatments within a day are denoted on the graph with an asterisk (*).

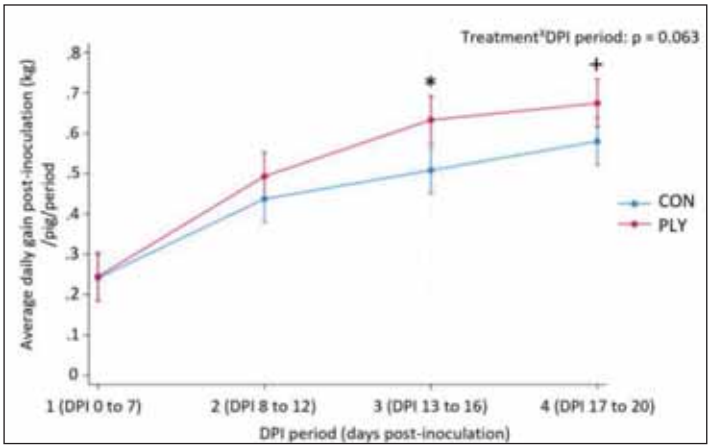

Figure 2. Average daily gain (ADG) post-inoculation (kg) per pig in Play (PLY, solid line) and Control (CON, dashed line) treatments during periods 1 (DPI 0 to 8; days post-inoculation), 2 (DPI 8 to 13), 3 (DPI 13 to 17; n = 27■ in periods 1, 2, 3), and period 4 (DPI 17 to 21; n = 26•). Data are presented as predicted means and 95% confidence intervals.

Footnote: 'X' between two variables signifies an interaction effect. Significant differences between the treatments within DPI period or DPI are denoted on the graphs with an asterisk (*). + p = 0.027 (close to the significant threshold). ■Datapoints from all DPI periods of one deceased PLY pig due to secondary bacterial infection, and •a datapoint from DPI period 4 of the CON outlier pig were excluded from this analysis.

Immune response: The pigs demonstrated a typical immune response to PRRSV, with the lowest levels of white blood cells, neutrophils, lymphocytes, and monocytes in the first week post-inoculation and a rebound in the second week until euthanasia at 22 DPI. The number of monocytes, the progenitor of macrophages that is the primary PRRSV replication site, differed between treatments. PLY pigs had fewer monocytes on 8 DPI, and by 21 DPI they returned to baseline, whereas CON had elevated monocyte counts. This can be suggesting lower inflammatory response in PLY.

Play behaviour (Figure 3): During the play opportunities, PLY pigs were more active pre-inoculation as well as during the infection compared to CON. Within the initial 10 min of a play session, PLY pigs engaged in locomotor, social and object play to some extent in all days pre- and post-inoculation. Play pigs continued to play during infection, demonstrating less sickness behaviour and emphasizing the rewarding properties of play.

IMPLICATIONS

The results indicate that the pigs reared with play opportunities were less affected by PRRSV. The ability to mitigate the detrimental effects caused by a pathogen, as seen in PLY pigs, indicates improved disease resilience. These findings underscore the value of positive experiences for farmed pigs, demonstrating their potential to enhance pigs' resilience towards coping with various challenges encountered in modern production environments, thereby improving pig health and welfare.

ACKNOWLEDGEMENTS

Funding for this project was provided by Natural Sciences and Engineering Research Council (NSERC), University of Saskatchewan, Alberta Pork, BC Pork Producers Association, Conestoga Meat Packers Ltd, Hylife Ltd, Les Eleveurs de porcs du Québec, Manitoba Pork Council, Maple Leaf Foods, Olymel S.E.C./L.P., Ontario Pork Producers Marketing Board, and PEI Hog Community. The authors would also like to acknowledge the strategic program funding provided to the Prairie Swine Centre by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council, and the Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

"Pigs reared with play opportunities were less affected by PRRSV, indicating improved disease resilience."

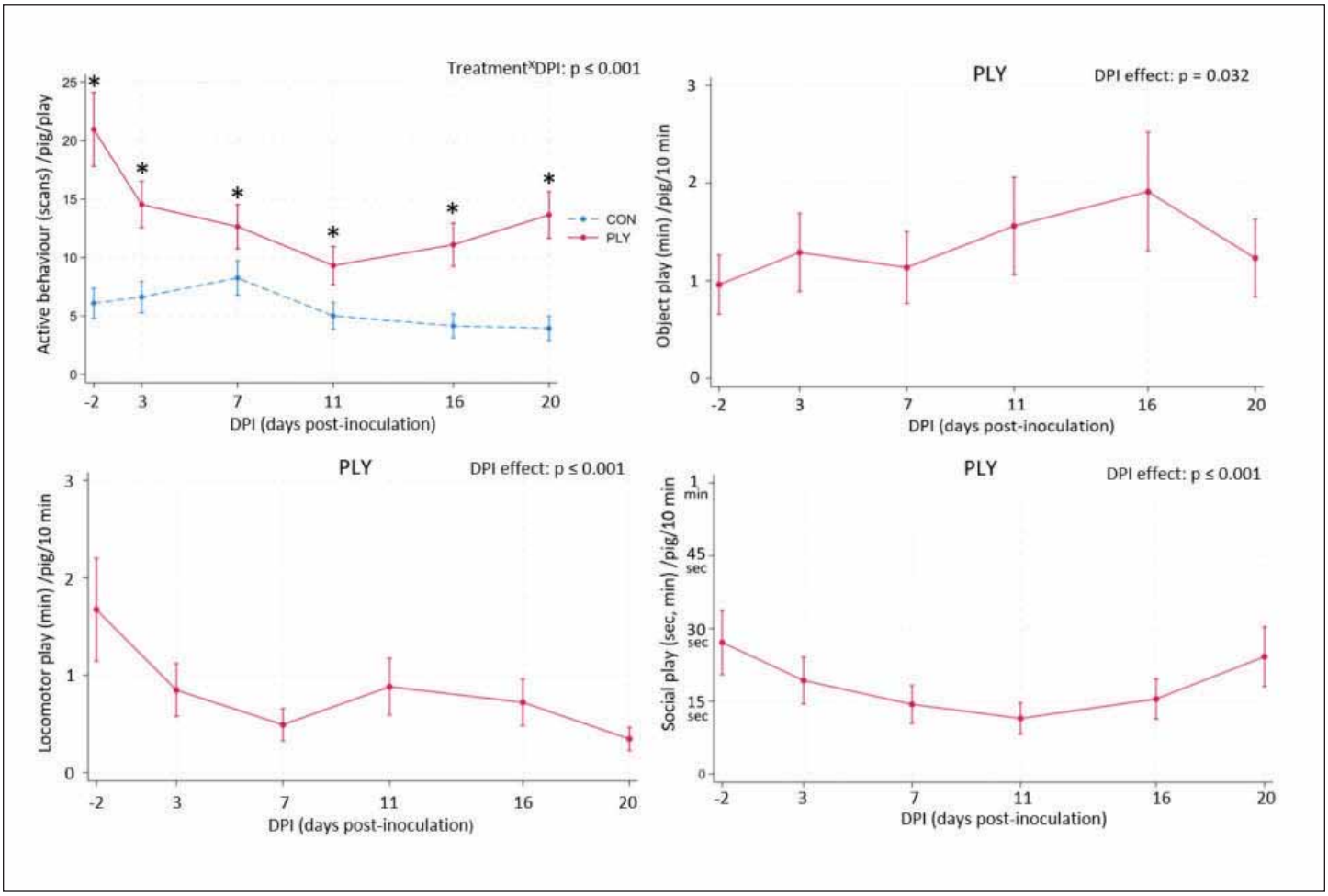

Figure 3. Active behaviour during the play sessions (a) in Play (PLY, solid line) and Control (CON, dashed line) treatments per pig (n = 28) and duration of object (min; b), locomotor (min; c) and social (sec, min; d) play in PLY (n = 14) within the initial 10 min of the play sessions on -2, 3, 7, 11, 16 and 20 days post-inoculation (DPI). Data are presented as predicted counts and 95% confidence intervals.

Footnote: 'X' between two variables signifies an interaction effect. Significant differences between the treatments within DPI (a) are denoted on the graph a with an asterisk (*).

The influence of straw enrichment on hair hormone levels, behaviour, and productivity

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APPLICATION FOR PRODUCERS

Determining the chronic stress levels of your herd by shaving hair and sending it in for hormone analysis could be useful when you're looking at making changes in your management or environment to improve welfare, and to support research on verification of good animal care practices. Shaving hair is non-invasive and relatively easy to do. Currently, more research is needed to determine whether hair hormone levels are valuable biomarkers of chronic stress.

Nursery pigs are enjoying the area of the pen that has a solid mat, either with or without straw provision

SUMMARY

A trial was conducted to see if hair hormone concentrations are a good biomarker for chronic stress in pigs. The objective of this study was to determine if different rearing environments, designed to be standard, or improve pig welfare, influenced the hair hormone concentrations of cortisol, cortisone, DHEA, and their ratios. Pigs (n = 192) were raised from birth to slaughter in standard fully slatted barren pens (Control) or slatted pens enriched with daily straw provisions (Straw). Straw enrichment did not influence hair hormone concentrations or their ratios at 12 and 20 weeks of age. Pigs raised with straw had a lower frequency and duration of negative behaviours (aggression) and a higher frequency of positive behaviours (foraging, play) than control pigs at some, but not all, stages throughout the growing life. Pigs raised with straw had lower skin lesion scores on d27, d56 and d137, improved ADG in the nursery and less tail bites. The behaviour and skin lesion data suggests that pigs raised with straw had improved welfare at some, but not all stages of production, but hair hormones were no different between the populations of pigs. Continued research will look at whether this lack of effect was due to the hair hormone concentrations not being sensitive enough to detect welfare differences, or because provision of straw may not have resulted in great enough changes to reduce chronic stress, or because pigs don't experience high levels of chronic stress to begin with.

INTRODUCTION

Cortisol and dehydroepiandrosterone (DHEA) are two hormones released during the stress response and have been suggested as biomarkers of stress in swine. These hormones can be measured in blood, urine, saliva, hair, and feces. The measurement of these hormones in blood and saliva has been used to evaluate acute stress, but measures of chronic stress are lacking. Hormones within hair may provide insights into the levels of stress over a longer period of time as the hormones integrate into the hair during growth. Hair also has the advantage of being non-invasive and having a painless sample collection, in addition to being easily stored for later analysis. Besides cortisol, additionally measuring the hair cortisone concentration has been suggested as a more sensitive measure of stress in pigs.

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Rootable materials for enrichment such as straw allow pigs to partake in highly motivated species-specific behaviours such as exploration and foraging. Straw was tested as the treatment for improved housing conditions as providing straw may not only be beneficial by reducing unwanted behaviours, but also by promoting positive welfare states through providing an outlet for the highly motivated behaviours. Providing such occupational activities that can promote positive states and reduce negative behaviours such as biting of pen mates can support a reduction in chronic stress.

A study was conducted to measure the hair hormone concentrations of cortisol, cortisone, DHEA, and their ratios to explore their potential as biomarkers of chronic stress through comparing pigs raised in barren environments versus those enriched with straw. The objective of this study was to determine if straw as environmental enrichment influenced hair hormone concentrations, suggesting a reduction in chronic stress.

EXPERIMENTAL PROCEDURES

Pigs (n = 192) were raised in two batches (May-September and August-January) from birth to slaughter and were divided into two treatments; standard fully-slatted pens (control) or fully-slatted pens enriched with daily straw provisions. Pens of control pigs were housed in barren housing with no additions to the farrowing environment. Control pens received point-source enrichment in the form of one metal chain in the nursery period and two metal chains in the grower period, at shoulder height, one with a 61 x 122 cm piece of wood attached for growers only. Pens of enriched pigs received the same point source enrichments plus daily straw provision (Table 1). Straw was provided on top of a solid rubber mat that was also installed in control pens.

Table 1. Amount of straw provided per pen of enriched pigs on a daily basis throughout the trial.

Stage of production, age in days	Daily amount of straw provision per pen
Lactation, 3-10 d	500 mL
Lactation, 10-24 d	2.6 L
Nursery, 25-52 d	20 L
Grow-finish, 53 d – slaughter	40 L

At 12 and 20 weeks of age 64 pigs had hair shaved off the left rump. Hair was analysed for concentrations of cortisol, cortisone and DHEA, and the cortisol:DHEA and cortisone:cortisol ratio calculated. Behaviour and postures were recorded post-weaning (d24), at the end of the nursery (d52), beginning of the grower stage (d53 and d56), the middle of the grower stage (d88) and the end of the finisher stage (d137).

Skin lesions were recorded pre- and post- weaning (d23 and d27) pre- and post- grower move (d52 and d55) and prior to slaughter (d137) using a score of zero to three, with zero indicating no lesions and three indicating severe lesions. Body weights were collected to calculate average daily gain (ADG) at birth and at the entry and exit of each stage of production (d23, d54, d88, d137).

RESULTS AND DISCUSSION

Hair hormone concentrations: Treatment did not influence hair hormone concentrations or their ratios both at 12 and 20 weeks of age. There was an interaction (P=0.020) between treatment and batch for DHEA concentration in hair at 12 weeks; in batch 1, pigs enriched with straw had lower DHEA concentrations than control pigs, whereas in batch 2, the opposite was true. Cortisol was higher in batch 1 than batch 2 for both treatments, reflecting potential seasonal differences in hormone concentrations.

Negative behaviour: Pigs raised with straw had a lower frequency and duration of aggression on the day pigs were moved into the grower unit (d53) but there was no treatment effect at other time points. Control pigs had a higher frequency of belly nosing on d52 and d88 and a longer duration of belly nosing on d88 than pigs with straw, with very low occurrence at all other timepoints in both groups, with levels too low to run statistical analysis. There were also not enough occurrences of oral manipulation of pen mates throughout the trial to do statistical analyses, except on d52 when there was no effect of treatment on frequency or duration of oral manipulations.

Positive behaviour: Pigs with straw tended ($P<0.10$) to have a higher frequency of exploratory behaviour directed towards the straw or environment on d24 and d56 and had significantly ($P<0.05$) higher frequency of exploratory behaviour on d88 and d137 compared to control pigs. Duration of exploratory behaviour was longer for pigs with straw vs. control pigs on d56, d88 and d137. The frequency and duration of play behaviour was higher for pigs with straw than control on d53, but no different between treatments on d52 and d54. Play was not observed at levels great enough for statistical analyses on d24, d27, d88 and d137.

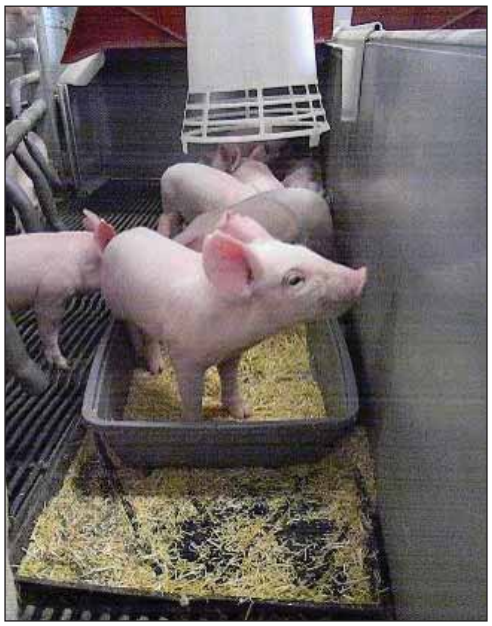
Postures: Treatment did not affect the proportion of pigs laying down until d88, when a higher proportion of control pigs were laying down compared to pigs raised with straw, whereas on d137 control pigs tended to lay down less than pigs with straw. A higher proportion of straw raised pigs were standing on d24, and d88 (tendency) than control pigs, whereas on d137 the opposite was true (tendency). Treatment did not affect the proportion of pigs sitting, except on d137 when there was a tendency for control pigs to sit more.

Shaving hair off a pig

Skin lesion scores and tail bites: Control pigs had higher skin lesion scores than pigs with straw on d27, d56 and d137, whereas treatment did not affect skin lesion scores on d23 and d52 (Table 2). Tail bites were only observed in the last four weeks of the trial (d109-d137); the percentage of bitten pigs being 5.21% of control pigs vs. 1 % of straw reared pigs.

Table 1. Skin lesion count (the sum of skin lesion scores of the head, ears, body, and tail using a rating of 0 (mild lesions) to 3 (severe lesions) of pigs reared in a barren environment (Control) or enriched with straw (Straw) at different time points throughout life. Results are presented as the mean, with 95% confidence intervals in brackets.

Item	Treatment		*P*-value
	Control	Straw	
Pre-weaning (d23)	0.44 (0.19, 0.69)	0.78 (0.44, 1.12)	0.12
Post-weaning (d27)	2.28 (1.87, 2.70)	3.13 (2.64, 3.62)	0.01
End of nursery (d52)	1.59 (1.11, 2.08)	1.97 (1.50, 2.44)	0.28
Start of grow-finish (d56)	2.47 (2.11, 2.82)	3.44 (3.02, 3.85)	0.001
End of grow-finish (d137)	0.94 (0.72, 1.15)	1.41 (1.17, 1.64)	0.01



Farrowing room setup for pigs raised with straw enrichment

Growth rate: Pigs raised with straw tended to have a higher average daily gain in the nursery period compared to control pigs (0.484 kg vs 0.441 kg, respectively). Treatment did not affect ADG at other time periods.

Grower room setup for pigs raised with straw enrichment

IMPLICATIONS

Daily provision of straw from birth to slaughter did not affect hair hormone concentrations or their ratios. It is unclear whether this lack of effect was due to the hair hormone concentrations not being sensitive enough to detect welfare differences, or because provision of straw may not have resulted in great enough changes to reduce chronic stress, or because pigs don't experience high levels of chronic stress to begin with. The behaviour and skin lesion data suggests that pigs raised with straw had improved welfare at some, but not all, stages throughout their growing life. Future research is required, particularly studies including physiological and behavioural measures as a means for cross validation to determine whether cortisol, DHEA and the cortisol:DHEA ratio are valuable biomarkers of chronic stress, and studies looking at the effect of different rearing environments on stress and welfare in swine.

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Patience J (Host) (2023) with **Dan Columbus** - Episode 37: Functional nutrients and their effects on pigs' immune and gastrointestinal health [Audio interview] Swine it Canada Podcast, Wisenetix, Clearwater, FL.

Cochrane B (Host) (2023) with **Dan Columbus** - Saskatchewan Pork Industry Symposium offers opportunity for pork producers to interact with researchers. [Audio interview] FarmScape Online, Wonderworks Canada Inc, Boissevain, MB.

Cochrane B (Host) (2023) with **Dan Columbus** - Undergraduates, graduates, postdoctoral fellows to present at Saskatchewan Pork Industry Symposium. [Audio interview] FarmScape Online, Wonderworks Canada Inc, Boissevain, MB.

WCVM Explores Effect of Early Life Management on Lifetime Welfare and Productivity of Pigs; Siba Khalife - Western College of Veterinary Medicine [Tuesday 09 May, 2023]

Artificial Intelligence Being Used to Track and Improve Swine Welfare; Dr. Martyna Lagoda – Western College of Veterinary Medicine [Thursday 05 Oct, 2023], Farmscape.ca

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Scientists Harness Play to Improve Swine Welfare, Improved Health, Increased Productivity; **Dr. Yolande Seddon** - Western College of Veterinary Medicine [Thursday 02 Feb, 2023]

Research Shows Pigs Can be Stimulated to Engage in Play; **Dr. Yolande Seddon** - Western College of Veterinary Medicine [Friday 13 Jan, 2023]

Public Scrutiny of Animal Care can be Expected to Increase, **Dr. Yolande Seddon** - Western College of Veterinary Medicine [Wednesday 27 Dec, 2023]

NSERC Industrial Research Chair in Swine Welfare Research Program to be Highlighted at Banff Pork Seminar, **Dr. Yolande Seddon** - Western College of Veterinary Medicine [Tuesday 19 Dec, 2023]

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Board of Directors

As a non-profit organization, Prairie Swine Centre is governed by a Board of Directors consisting of volunteers from the pork industry. Prairie Swine Centre wants to thank the individuals who make up the current Board of Directors. They support the Centre by sharing their expertise, by giving advice, and by connecting us with the right people in the industry. They bring valuable experiences to PSC from the perspectives of producers, government, university and related industries and their insights help PSC to achieve our goal of providing value to our customers.

The Board of Directors consists of the following individuals:

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Financial Support

Prairie Swine Centre wants to recognize the individuals and agencies that supported the Research and Knowledge Transfer program this year. The support is essential to the ongoing developments that keep Canadian pork producers at the fore front of applied technology.

In addition to the many industry and government funding agencies, the University of Saskatchewan uses the facilities and services at Prairie Swine Centre for research and teaching.

The following organizations have provided funding or donations and in-kind to support public research at the Centre throughout the 2023 fiscal year.

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