2019 Annual Research Report

PRAIRIE SWINE CENTRE

Sask PORK
ALBERTA PORK
Manitoba Pork
ONTARIO PORK
Saskatchewan Ministry of Agriculture
UNIVERSITY OF SASKATCHEWAN

Our Mission

"We provide solutions through knowledge, ensuring a profitable and sustainable pork industry for our stakeholders and staff."

PRAIRIE SWINE CENTRE

Table of Contents

Chairman's Report

Developing collaborations for a stronger Canadian pork industry

This past year has been an exciting and very busy year for the Prairie Swine Centre. Murray Pettit has settled into his role as CEO and has begun to put his stamp on the daily workings of the Centre.

Murray and his team have worked hard on developing a strategic plan for the Centre and have developed some very good short and long term goals. These goals have been developed through the voice of the customer. Murray conducted many face to face interviews with key stakeholders of the Canadian Pork industry to gain a clear understanding of what is most important to them and how the Prairie Swine Centre can be part of the solution. The PSC board wants to recognize the effort and focus of these initiatives, their impact to the future success of the PSC and ultimately the Canadian Pork Industry.

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 me move into 2020 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, and Ontario. 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 such 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 2019. In particular I would like to recognize past Board Chair James Reesor and thank him for his tremendous dedication to the PSC.

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

Don Down
Chairman of the Board

Left to right: *Javier Bahamon, Neil Ketilson, Zenon Forster, Rodelle Genoway, Andrew Van Kessel, Murray Pettitt, Fred Fast, Nicole Rozon, James Ressor, Don Down, Brad Marceniuk*

Missing: *John Harding, Robet Tyler, Nancy Johns, Vincent Cloutier*

President's Report

Creating our future - with a focus on yours.

Over the last year we at PSC have developed our new 5 year strategic plan to lead us into the future. This process involved strategic planning sessions and interviews with producers and other participants throughout the Canadian pork value chain. The feedback gathered during these meetings have helped guide the development of the research priorities in this plan and is critical to ensure PSC continues to focus on those areas that most need our attention. As always, our goal is to contribute to the success and sustainability of the Canadian pork industry by providing solutions through knowledge and information.

As we follow our new strategic plan, our efforts will continue to focus on nutrition, ethology and engineering research in addition to a few new initiatives. One of the most exciting are the collaborative efforts being taken by PSC, the Canadian Centre for Swine Improvement (CCSI) and the Centre de développement du porc du Québec inc. (CDPQ). Our three organizations all serve the Canadian swine industry in different ways and in different regions, and we intend to bring additional benefits to the industry by working together on specific projects to achieve more together than any one of our organizations can achieve alone. In that way we will leverage the support already provided by the pork producers and create additional information and value for the industry. Those efforts have already begun and we look forward to updating the industry on our efforts shortly.

It is critical that PSC maintain its close linkages with the Canadian swine industry to ensure we can continue to provide relevant and useful research results. We enjoy meeting with many of you at various activities throughout the year but I would also strongly encourage you to directly reach out to us when we can be of assistance.

I wish to thank all PSC staff for all of their contributions towards generating the applied research results the industry has come to expect from us. Their dedication to excellence is reflected in this report. I would also like to thank the PSC Board of Directors for trusting me to lead this excellent team.

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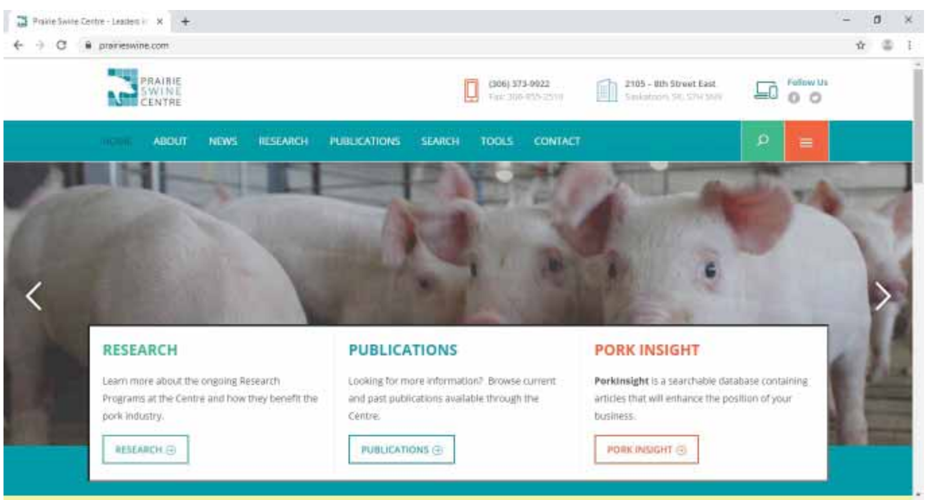
Murray Pettitt
President

MANAGEMENT

Knowledge Transfer Report

Over the past 25 years a great deal of credit goes to the original advisory committee in realizing the importance of Technology Transfer in delivering a successful research program that continues to deliver practical, relevant, and timely information. As one of the original pillars of the Centre, the Technology Transfer program has seen many changes since its inception, while the three core areas of communication (personal, electronic, and print) remain the same, the level of importance dedicated to each method has changed significantly over time.

As the pork industry has changed so to has the Technology Transfer program adapted to the needs and economic pressures of the hog industry. Today approximately 40% of Canada's hog production is classified as vertically integrated, colonies represent approximately 30% of production with the balance of production being held in various sized operations. How we communicate with the industry is, and needs to be different than the way we communicated with the industry in the past.



A Ipsos-Reid survey of agricultural producers provides some valuable insight on the type and how producers collect information for their operation. The two most common sources of information were print (72%) and websites (50%), while social media ranked very low comparatively (2%). Do these numbers speak to an aging producer demographic? Or are tools like Twitter and Facebook seen more a personal network rather somewhere people look for credible information?

The survey also indicates the type of information producers are looking for is information on new technologies and products. On the surface this makes sense as we are in the commodity production business. By being one of the first adopters of a new technology we inherently maintain or increase our competitive advantage against our nearest competitor.

Where and how do producers gather information? A vast majority of producers (58%) get their information from aggregate news sites like Farms.com, ThePigSite, SwineWeb, MeatFYI or PorkInsight. According to the stats they access this information from desktops (70%), laptops (49%), and mobile devices (43%).

As we continue to assess how to best communicate with the pork industry we need to ensure there is a specific communication plan for each one of our target markets. The ultimate goal of Technology Transfer, is Technology Adoption. Ensuring the industry is implementing those recommendations that have been produced by the research programs at Prairie Swine Centre that improve profitability & competitiveness or address sustainability (welfare & environmental). The real trick becomes how do we measure implementation of recommendations, technologies, and products.

Ken Engele
Manager, Knowledge Transfer

We are always assessing the most effective way in driving research results out to the industry. We always welcome feedback from the industry at any time. Over the course of the next 18 months you will see several new initiatives rolled out to engage the industry on a different level.

MANAGEMENT

Production Report

This past fiscal year production focus was on maintaining high sow productivity while paying closer attention to the management of the sow's body condition and feed consumption both during gestation and lactation periods. The caliper can be a very useful tool as an objective measurement of sow condition; however some of the sows were getting thin and trending toward being under conditioned. Regular daily and weekly observations of sow's behaviour and body condition as well as monthly feed calibration /density check helped us to find that delicate balance of maintaining optimal body condition during gestation period where sows feed requirements are met while maintaining ideal body condition. We will continue to use caliper as a guideline, but address sow individual needs during the winter months specifically.

- In the past six months we have seen improvement in the average litter size where piglets are more uniform and robust. That in turn helped lower our pre-wean mortality and pigs wean per sow is gradually improving.
- Despite all the efforts we are still facing challenges of higher post wean mortality.

This year we had a few research projects to accommodate (10 extra sows farrowed on site plus a nursery trial that limited number of production pens available) and in turn our weaning routine was interrupted, including creep feeding prior to weaning. We are also weaning more pigs per sow and that is contributing to higher density issues in the nursery where smaller pigs are not thriving.

Having nurseries at full capacities doesn't leave a lot of room for having an extra open pen for sick animals. Smaller pigs are grouped together and provided enrichments. Staff observed that having enrichments in the runt pens does help with overall well-being, socializing and feed intake of the pigs.

We continue the balancing act between the high productivity and meeting research needs on a daily basis. Working closely with VIDO as well as U of S research clients and our own team of scientists sure makes the barn a very busy place.

We are fortunate to have a great group of people who are persistent in finding a solution so we can continue to provide the best services possible.

Our researcher clients require consistent and large supplies of pigs of all ages to be available to meet their needs. With an eye on being a competitive pork producer, we operate our sow herd to achieve high reproductive performance, thus we focus on keeping the barn operating at capacity.

As of May 31st we have sold 8,102 animals and by the end of this fiscal year we should be over 8,800 animals sold. That is over 1,216 animals sold above the target. To manage our high production we have been selling a weekly supply of three different size animals, totaling about 40-45 animals, to an abattoir in the Osler area. Production rooms are filled to accommodate the sales and by the time pigs reach 55 kg the room is at the proper density. This still leaves additional animals to accommodate sales to University of Saskatchewan.

Tatjana Ometlic
Assistant Manager, Operations

Since January 2019 we had several research experiments started in grow finish, gestation, farrowing and nursery rooms. In order to follow the space requirements from the Canadian Code of Practice while sustaining a high productivity herd, we have recently revisited our targets. After carefully reviewing current needs and numbers we decided to drop our breeding target from 15 to 14 sows bred per week. Over the past year our weaning numbers are consistently getting higher making it more difficult to have a proper stocking density, thus post weaning mortality is higher and more space is needed in grow finish to accommodate the numbers. All of this is more challenging when

Table 1. *Production targets for fiscal year 2018-2019*

Category	Target/week	Rolling Average (Jan – May, 2019)
# Bred	15.0	15.4
# Sows farrowed	13.7	14.3
# Pigs born alive	178	200.2
Average born alive	13.0	14.0
# Piglets weaned	158.5	180.2
Pre-wean mortality	10.0%	10.37%
Post-wean mortality	2.0%	3.1%
Grow-finish mortality	4.0%	1.8%
# Sold/week	158.0	169.8

Table 2. Production parameters for calendar years 2016, 2017, 2018 and the first 21 week of 2019: (Pig Champ)

	2016	2017	2018	Jan-May 2019
Number of sows farrowed:	750	760	744	296
Conception rate %:	92.5	91.8	90.6	95.1
Farrowing rate %:	92.2	92.0	90.8	89.1
Average born alive/litter:	14.2	14.2	14.0	14.3
Farrowing index:	2.49	2.48	2.48	2.46
Number weaned/sow:	12.6	12.4	12.4	12.7
Pre-wean mortality %:	11.2	12.1	12.0	11.3
Pigs weaned/sow/year:	29.5	30.1	29.5	29.4

multiple research projects are ongoing and there is not enough space available to house all of the pigs due to pen size requirements.

We had our quarterly herd health visit in March with Dr. Henry Gauvreau and at that time addressed some of the arising issues in our herd.

Challenges we had since the last herd health were: increased numbers of abortions, sow discharges, higher numbers of still born pigs, sow body condition and nursery mortality/density.

Dr.Gauvreau made his recommendations and gave some insight to the problems we were having. About 2% of all sows confirmed pregnant may abort for wide variety of reasons; most of which we are not able to determine the cause. Shorter day-length can disrupt the normal hormonal balance of the female and result in spontaneous abortions. We also had an exceptionally cold winter that made it very difficult to maintain environmental factors that most likely contributed to some of the issues, such us draftier and cooler conditions in the barn. Some other possible reasons could be infectious abortions that are more complicated than just abortions. We may see an increase in stillborn piglets, mummies, discharges, weak born piglets and increase in pre-wean mortality.

We discussed using Borgal as the regular nursery treatment antibiotic instead of Nuflor. Borgal is less expensive and is a good broad -spectrum antibiotic. The Strep.suis and E.coli, identified in recent PDS submissions, are sensitive to Borgal.

We had our RWA audit on April 22nd. Once again, our auditor was impressed with the excellent job our staff does in taking care of every single pig and how well everything is documented.

He was most impressed with the low percentage of pig treatments in the farrowing rooms. On average there are only 2-5% pigs treated per room. High herd health is definitely making the RWA program work well and our average live weight at shipping is 139 kg.

In April we had our local University Animal Care Committee facility inspection that went very well. The only comment was regarding teeth clipping in new a born piglet that is still a practice on our farm. We have tried multiple times to eliminate this practice but so far have not been successful. To date the disadvantages (facial abscesses, increased mortality, abscessed sow underline) outnumber the benefits and we have continued with the teeth clipping. We are committed to keep trying to eliminate teeth clipping.

In May we had our Canadian Council of Animal Care facility inspection, which happens every three years. We are still waiting on their report, but confident that there won't be any major issues. Having enrichment in place for every sow was suggested. We are anticipating that some of those requirements will be in the report, as well as interior painting of the Sow Research Barn.

This May we welcomed our Summer Students: four in the Nutrition group, three in the Ethology and one student is to be shared between Production and Nutrition Group. All the biosecurity and Animal Handling Training was completed April 29th. Nutrition studies are already undergoing in farrowing rooms and Ethology studies began the first week of June.

We also welcomed aboard our volunteers that accepted positions as casual weekend staff. That way we always have a pool of people to cover weekend shifts that are hard to fill otherwise.

With the resent development and outbreaks of ASF, FMD and PEDV we reviewed our bio-security protocols and have enhanced our inspections and requirements for all of our external clients and staff coming to the site/facility. We are committed to keeping our herd healthy and everyone is on top of biosecurity.

Despite all the challenges we are facing every day presents new opportunities as we continue to provide the industry with quality research that our staff is very passionate about.

Practical Alternatives for Managing Castration Pain in Piglets

E.L. Davis[1,3], J.A. Brown[1,2,] and Y.M. Seddon[1,3]

Summary

The objective of this project was to evaluate drugs and administration procedures to help identify effective and practical pain control strategies for piglets at castration across three different studies. Results indicate the analgesic, ketoprofen, has a positive effect on reducing pain following castration when given 30 minutes to 1 h before castration. Drug provision immediately before castration appears to be better than providing no pain control. Older piglets showed a clearer response when given pain control than young piglets, and could be used as a model for young pigs when evaluating pain control options.

Introduction

The Canadian Veterinary Medical Association (CVMA) and Canadian Pork Council (CPC) have provided some guidance on appropriate drugs and dosage to be used during castration, however, several questions remain. The NSAID drug Metacam has received regulatory approval for treating pain at castration, but options such as ketoprofen and acetaminophen may also be effective. Castration is typically performed at 3 to 5 days of age however some studies have suggested that it may be less stressful in older pigs - but clear evidence is lacking. Timing of drug administration has also been questioned; providing pain control 30 minutes prior to castration may be more effective than at the time of castration. However, this would require producers to handle pigs twice, coordinating injection and castration times at processing. The overall objective of this project was to study the effectiveness of procedures for controlling post-procedural pain in piglets at castration. Three specific objectives were: 1. to compare the effectiveness of different analgesics; 2. to study the effect of piglet age at castration on pain responses, and; 3. to study the timing of drug administration.

Experimental Procedures

Study 1. Comparison of the effectiveness of three NSAIDs

Three NSAID analgesics were compared for their effectiveness at reducing pain responses following castration: meloxicam, ketoprofen, and acetaminophen. A total of 167 male piglets were randomly assigned to one of five treatments. Data collection was completed in two parts with behavioural observations and physiological measures of stress (serum cortisol) measured in 106 and 61 piglets, respectively. Treatments consisted of:

- Castration with meloxicam (Metacam ® 0.4 mg/kg [0.3 ml/kg]) (CAM),
- Castration with ketoprofen (Anafen ® 3 mg/kg [0.3 ml/kg]) (CAA),
- Castration with acetaminophen (Pracetam ® 60 mg/kg [1.0 ml/kg]) (CAP),
- Castration control (CA), and
- Sham castration (SCA).

Study 2. Effect of age at castration on pain responses following castration

A total of 117 male piglets were randomly assigned within litter, with three castration treatments applied to piglets at either 3 days (Y), or 10 days of age (O). Piglets that received ketoprofen (Anafen ® 3 mg/kg [0.3 ml/kg]) received the drug intramuscularly at 30 min prior before castration.

- Castration with ketoprofen (A),
- Castration control (C), and
- Sham castration control (S).

Study 3. Determination of optimal timing of analgesic administration

Male piglets from 35 litters (n = 175) were randomly assigned to one of five treatments. Piglets were handled twice in treatments where the analgesic (or saline) was administered one hour prior to castration, and once where the analgesic (or saline) was administered at the time of castration. A total of 7 litters per treatment was used, with each treatment represented and randomly assigned within each litter.

- Castration with ketoprofen, administered 1 hour before castration (HK),
- Castration with ketoprofen, administered immediately before castration (IK),
- Sham castration with saline administered 1 hour before (HS),
- Sham castration with saline administered immediately before (IS), and
- Castration control, saline administered immediately before castration (IC).

Behavioral Observations

In all studies, behavioural observations were taken on piglets using a specially designed handling chute developed as an objective behavioural measure of pain in castrated piglets. The length of time required to navigate the chute has been shown to be significantly longer in piglets castrated without pain control, compared to those handled but not castrated.

In study three, piglet behaviour in the farrowing crate was recorded after castration. Each litter of piglets was videotaped and observed at six time points: 0, 15, 30, 120 min, 24, and 25 hours post-treatment, with each observation period lasting 10 minutes. The frequency of 'event' behaviours was recorded in six 10 min continuous video recordings, beginning immediately after treatment, and at 15, 30 and 120 min, and 24 and 25 hours after treatment. Scan sampling of postural behaviours as well as location in the farrowing crate were recoded at 1 minute intervals over 10 minutes, resulting in 11 observations per piglet per video recording.

Blood Collection for Cortisol

A first blood sample was collected the day before castration, when pigs were selected and assigned to treatments. A second blood collection was taken at 45 minutes post treatment. During blood sampling, piglets were restrained within the farrowing crate under a heat lamp using a wooden board. One-by-one, male piglets were removed by a trained technician and held upside down underneath the left arm. Blood was then collected from the lacrimal caruncula of the eye, with 5 ml of blood being collected in a 10 ml collection tube. Once the initial baseline sample was collected, the piglet was marked, weighed, and replaced in the farrowing crate. The time taken to collect blood was recorded for each sample.

Ketoprofen can reduce cortisol levels following castration, similar to changes seen with meloxicam in other studies

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Body Weight

All piglets in study 2 were weighed at five time points: at selection on day 2-3 of age, on day 6-7 (3 days after younger animals received treatments), day 9-10 (before older animals received treatments), day 13-14 (3 days after older animals received treatment) and at weaning (approx. 28 days of age).

Results and Discussion

Study 1. Comparing the effectiveness of three NSAIDs

Comparing overall navigation times, castration control (CA) piglets had a significantly slower navigation time than castration with ketoprofen (CAA) piglets (Figure 1), in addition CAA piglets also had a significantly faster navigation times than castration with acetaminophen (CAP) and sham castration (SCA) piglets. There was a trend for CAA piglets to navigate the chute faster than those given metacam (CAM).

Overall, the results of this comparison of NSAID drugs were not conclusive: a direct comparison using meloxicam and ketoprofen with a larger sample size and including measures of cortisol response and behaviour in the farrowing pen is recommended. A dose-response study would also be beneficial to confirm the appropriate dosage.

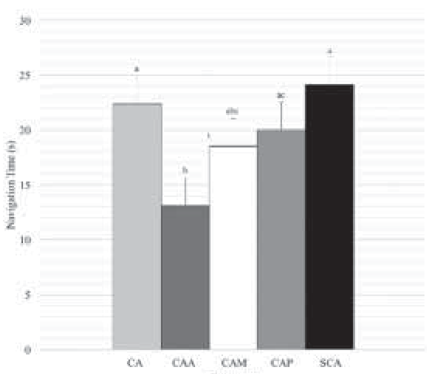

Figure 1*: Study 1. Overall navigation time after treatment. Average of chute runs at 15, 40, 60 and 120 minutes post-treatment (LS means ± SEM in sec) for pigs given one of five treatments. Treatments: CA: castration control; CAA: castration with ketoprofen; CAM: castration with meloxicam; CAP: castration with paracetamol; and SCA: and sham castration. Bars with different superscripts are significantly different, P ≤0.05.*

Study 2: The effect of piglet age at castration on pain responses following castration

No significant differences in navigation time were found between drug or age treatments, nor any interaction between treatments and run time. At 15 min post-castration, 10 day old castrated piglets (OC) had the longest chute navigation time, with 10 day old sham and ketoprofen treated piglets (OS, OA) having numerically lower navigation times.

Piglets that were sham castrated (YS, OS) showed no significant change in cortisol concentration over time, whereas castrated piglets (YC, OC) showed a large increase in cortisol at 45 minutes post-treatment. Piglets given ketoprofen showed significantly lower cortisol concentrations compared to castrates at 45 minutes post-treatment, indicating a benefit of analgesia when provided at 30 min before castration. A significant interaction was found between treatment and age. Younger piglets had higher cortisol levels overall, and older pigs showed reduced cortisol concentrations when provided pain control while younger pigs did not (Figure 2).

In Study 2, no effect of age at castration on weight gain was found. Overall, the results of Study 2 indicate that it may be easier to measure benefits of pain control in older piglets. Thus, for future studies evaluating pain control methods could potentially use older piglets as a model for younger animals.

Study 3: Determining the optimal timing of analgesic administration

Navigation time in the handling chute showed no significant effect of treatment (Figure 3). However, the 15-minute chute time for CA was numerically the longest, while analgesic (HK, IK) and sham treated piglets (HS, IS) had shorter navigation times. Across all treatments a significant effect of time was found, with longer navigation times observed at the 15-minute time point, and shortest navigation times at 0 min (i.e. immediately after castration). The shorter navigation times at 0 min may be due to fear responses following handling.

Regarding piglet behaviour in the farrowing crate, no significant effects of treatment were found for any behaviour in the repeated measures model, however tail wag showed a tendency for a treatment by time interaction (P= 0.083). Tail wag behaviour was subsequently analyzed separately for each observation period. Significant treatment effects were found for tail wag in the 20 and 120 min observation periods (20-30 min and 120-130 min after treatment). In the 20-30 min period, tail wagging was more frequent in pigs that were castrated (CA, HK and IK treatments) than in pigs that were sham castrated (HS and IS; P= 0.001). In the 120-130 min period, CA, IK and IS pigs did more tail wagging than HK and HS pigs. The results confirm earlier work by Hay et al (2003) which found greater tail wagging behaviour in castrated piglets compared to controls.

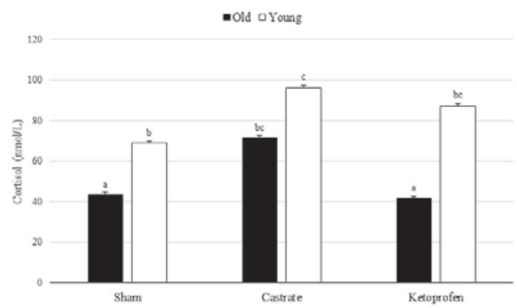

Figure 2*: Study 2. Interaction effects of treatment and age on cortisol concentrations (LS means ±SEM, nmol/L). Treatments included Sham castration, Castration control and Castration with ketoprofen. Ages: Old: castration at 10 days of age, Young: castration at 3 days of age. Bars with different superscripts are significantly different (P < 0.05).*

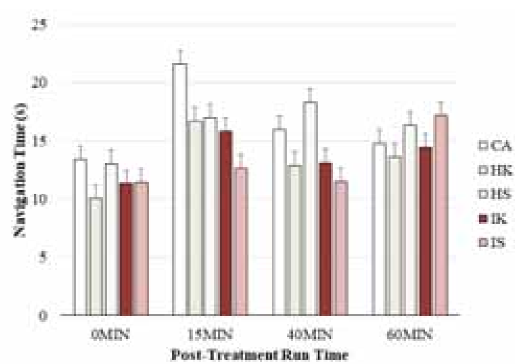

Figure 3*: Study 3. LS Means (± SEM) for chute navigation times (s) for castration treatments at four time points. There was no effect of treatment over time. Treatments: CA: castration control, HK: castration with ketoprofen given1 h before, HS: sham castration with saline given 1 h before, IK: castration with ketoprofen given immediately before, IS: sham castration with saline immediately before.*

Cortisol samples collected at 30 minutes after treatment in Study 3 showed a significant effect of treatment. Castrated controls (CA) had significantly higher cortisol levels than all other treatments, IK pigs were intermediate (lower than CA but higher than the remaining treatments), followed by sham treatments (HS and IS), and HK cortisol levels were lowest, indicating a clear benefit of providing pain control one hour before castration. The similar cortisol results for HS and IS sham treatments suggests that handling the piglet twice (HS) vs once (IS) did not result in significantly more stress on piglets.

Implications

Results of the project indicate that ketoprofen can reduce cortisol levels following castration, similar to changes seen with meloxicam in other studies. Providing ketoprofen 1 h before castration was more effective in terms of lowering cortisol levels than administering the drug immediately before castration. Giving pain control immediately before castration resulted in lower cortisol levels compared to castration with no pain control, but providing the drug 1 h earlier was significantly better. When comparing older and younger piglets, older piglets (castrated at 10 days of age) showed a significant benefit of pain control in terms of reduced cortisol levels, while those castrated at 3 days of age showed no significant benefits. The results indicate that it may be easier to measure benefits of pain control in older piglets. Results from the chute navigation studies were unreliable and did not provide any clear recommendations. While Ketoprofen may be a suitable alternative to meloxicam for treatment of pain following castration, a product claim for a ketoprofen specific for pain control at castration is needed before producers under CQA and PQE programs can readily implement it in their procedures.

Acknowledgements

We would like to acknowledge the financial support for this project from the Saskatchewan Agriculture Development Fund and Sask Pork. 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.

Motivated for Movement?
Exercise and the Gestation Environment on Sow Performance and Welfare

M. Tokareva[1], J.A. Brown[2,3], E.A. Pajor[4], D. MacPhee[1], A.D. Beaulieu[2,3], G. Adams[1], D. Janz[1], Y.M. Seddon[1,2]

Summary

Currently, there is a lack of scientific evidence to base recommendations on what constitutes an acceptable greater freedom of movement for sows and gilts. In addition, the benefit to sow welfare is unknown when opportunities of greater freedom of movement are provided. This project set out to to determine the motivation of stall-housed sows and gilts to exit stalls, and to identify the strength of this motivation through comparing it to the motivation of the same animals to access additional feed; in addition to determining how levels of satiety influence the motivation of sows to exit the stall.

Introduction

The Canadian Code of Practice for the Care and Handling of Pigs requires that from July 1, 2024, all mated gilts and sows must be housed in groups, or individual pens. Mated gilts and sows may also be housed in existing stall barns if they are provided with the opportunity to turn around or exercise periodically, or other means that allow a greater freedom of movement. However, what constitutes a greater freedom of movement and the suitable options to meet this Code requirement must be clarified, by July 2019, as informed by scientific evidence. In addition, what measurable benefits providing periodic access to a greater freedom of movement can bring to the sow will also be determined. This project will address key questions regarding the above-mentioned knowledge gaps. Results will contribute information to aid decision making during the Code of Practice revision process.

Experimental Procedures

Experiment 1

A total of 24 animals, n = 12 young (gilts) and n = 12 older sows (parities 2-4, 3.25 ± 0.83, mean ± S.D.) were studied for their motivation to exit the gestation stall and gain access to the alleyway between stalls. An operant panel was constructed on which two identical buttons were fixed (Figure 1). Both buttons can be programed by a microcomputer to count the number of presses made to each. One button was designated as active button (AB), and push counts to this button result in a reward for the sow. The other was designated as a dummy button (DB), acting as a control measure, and press counts made to this button did not contribute to obtaining a reward for the sow. Sows were trained and tested in two phases, in one phase, the reward for active button (AB) presses (Figure 2) was the gate opening with the sow being allowed to roam the alley for three minutes (Figure 3) with the second phase being a reward of 0.2kg of feed. The order of training and testing for stall exit or extra feed was balanced, with half of the sows trained to exit first, and half trained to receive extra feed first. Once trained, sows were tested on an ascending fixed ratio (FR) schedule, where the number of AB button presses required by the sow was increased by 50% each day, starting at FR of 9, and increasing daily to a maximum FR of 365. This produced a testing schedule of FR 9, 14, 21, 32, 48, 72, 108, 162, 243, and 365. The highest number of button presses a sow makes to the active button is known as the highest price paid (HPP).

Experiment 2

A total of 42 sows (parity 2-3) were tested for their motivation to exit the stalls and assigned to one of three treatments: i) Sows given ad-libitum access to a high fibre feed in addition to their standard gestation ration (Ad-libitum HF); ii) Sows given access to half of their ad-libitum high fibre feed intake once per day additional to their standard gestation ration (0.5 HF), three hours prior to motivation testing; and iii) Sows given no additional feed, and fed only their standard gestation ration (Control). Sows were tested daily for their motivation to leave the stall on an ascending FR scale.

Experiment 3

A total of 180 sows are being studied over three treatments: i) Stalls: sows housed in stalls throughout gestation; ii) Exercise: sows housed in stalls but given weekly exercise; iii) Groups: sows housed in groups after insemination. Sows in the exercise group are given weekly exercise once per week, consisting of walking two laps around the gestation room (around 10 minutes/sow). Measures include sow behaviour (postures, activity, stereotypies), cortisol measurement in hair, as a measure of stress levels longer-term over gestation, sow productivity, piglet characteristics and viability and measures of placental characteristics. At the time of writing, data collection is currently ongoing.

Figure 1. *The operant panel containing two identical buttons, a central divider, and a light to indicate when the panel is active.*

Figure 2. *Sow pressing the active button*

Figure 3. *Sow walking in alley between stalls*

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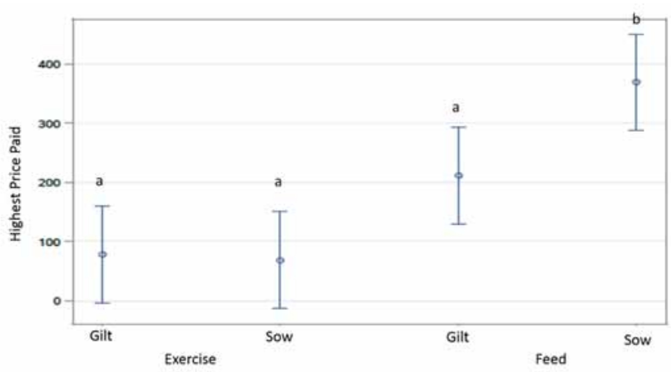

Figure 4. *The highest price paid (HPP) for sows (n =12) or gilts (n = 12) to access time out of the stall, or a feed reward (least squares means and 95% confidence limits). Where superscripts differ, P<0.05.*

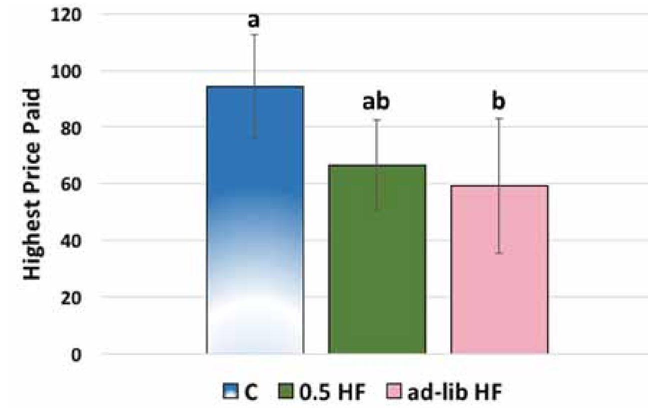

Figure 5. *Highest price paid (HPP) for sows tested for their motivation to exit the stall when provided their standard gestation ration (Control, C, n = 14), provided with half of their ad-libitum daily high fibre feed intake in addition to their gestation ration (0.5 HF, n = 14) and provided ad-libitum access to a high fibre feed in addition to their gestation ration (ad-lib, n =14), (mean ± S.E.M.). Where superscripts differ, P<0.05.*

Results and Discussion

Experiment 1

Sows showed a significantly greater HPP (highest price paid) for feed than movement, but for gilts it did not differ. Sows had a greater motivation to access feed than gilts. However, gilts and sows did not differ in their motivation to access movement, (Figure 4). Prior training experience did not influence the HPP for feed or movement by sows or gilts, and the latency (time taken) to press the AB was not influenced by prior stall experience or reward type.

Experiment 2

Sows that received high fibre feed fed ad-libitum had a significantly lower HPP to exit the stall, than sows fed only their standard gestation ration (Figure 5). Sows that were fed a high fibre feed at 50% of their ad-libitum intake were no different in their HPP than sows fed a control diet, or high fibre ad-libitum (Figure 5). The large standard deviations per treatment group reflect the effect of individual differences in sow response.

Implications

Results so far indicate that sows and gilts have a level of motivation to obtain time out of the stall, as measured in HPP. The motivation for both rewards is equal in gilts, however, sows have a greater level of motivation to access additional feed than movement. This may be related to their recovery from lactation during the testing. The motivation of sows to exit the stall is reduced when high fibre feed is provided to sows in the stall. Provision of a higher fibre feed to stall-housed sows may be one method to increase the welfare of stall-housed sows. These results should be considered alongside the results of experiment 3, exploring the effect of providing periodic exercise to stall-housed gestating sows throughout gestation. Considering the results of the experiments together will provide pertinent information to help support informed decision making surrounding the Code of Practice requirement that sows housed in stalls post 2024 be provided with periodic access to a greater freedom of movement.

Acknowledgements

We would like to acknowledge the financial support for this research project from the Saskatchewan Agriculture Development Fund, Sask Pork and Alberta Pork. 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.

Effects of Enrichment Objects on Piglet Growth and Behaviour

Hayley Bowling[1], Cyril Roy[2], and Jennifer Brown[2]

Summary

The purpose of this study was to perform an initial evaluation of pigs' preferences for several enrichment objects and examine their effects on piglet growth and welfare during the nursery period. Thirty litters were selected at farrowing and assigned to three treatments: enrichment provided post-weaning (EN), enrichment provided both pre- and post-weaning (EFN), and no enrichment provided (Control). Enrichment consisted of a series of object enrichments, with three or four enrichments provided at once, and rotated twice weekly. Enrichment had no effect on growth during the nursery phase, but enrichment given before weaning (EFN) resulted in reduced pen-mate manipulation and a tendency for reduced aggression. The suspended enrichments were most frequently contacted compared to objects placed on the floor. Enriched pigs showed greater exploration at 21 d post-weaning compared to Controls, and pigs in the EN treatment had fewer skin lesions on the head and shoulders at 25 d post-weaning. Physical enrichment objects show promise for improving piglet welfare and are feasible for implementation in intensive operations.

Introduction

Most commercially-reared pigs in North America are housed in pens with slatted flooring and limited opportunity for species-specific behaviours. As of 2014, The Canadian Code of Practice requires that pork producers provide "multiple forms of enrichment" to all pigs (NFACC, 2014) however the requirements for enrichment provision are not clearly defined.

Environmental enrichment has been defined as modifications to the environment of captive animals which result in improvement in their biological function (Newberry, 1995). When considering swine production, previous research has shown

Enrichment given before weaning (EFN) resulted in reduced pen-mate manipulation and a tendency for reduced aggression

that enrichment has the potential to improve weight gain, increase play behaviour, and reduce aggression and fear.

Providing enrichment to finisher pigs has been studied to a greater extent and is relatively common in practice since damaging behaviours can be more prevalent and have a significant impact on growth and production in this stage. However, it may be especially important to provide more stimulating environments to piglets during lactation and in the nursery. The rearing environment of young pigs is critical to their development both physically and cognitively as they grow and develop social and exploratory behaviour during the early stages of life. The environment in which piglets are raised has been shown to impact their behaviour, welfare, and growth later in life (see Beattie et al. 2000; Telkänranta et al. 2014).

The use of substrate enrichment in commercial production is often limited due to concerns over manure management and biosecurity. The use of object enrichments may be more practical and biosecure than straw or other substrates, especially in fully slatted pens.

This was a preliminary study to examine the effects of multiple enrichments on the growth and behaviour of nursery pigs. The objectives were to, 1. Evaluate the feasibility and attractiveness to piglets of several enrichment objects, and 2. Compare the effects of pre- and post-weaning enrichment treatments on piglet behaviour and growth in the nursery (up to 8 weeks of age).

Figure 1. *Three of the enrichment objects tested. Left to right: the "Bite-Rite" and "PorkyPlay" (commercial enrichment objects) and knotted cotton rope.*

Experimental Procedures

Thirty litters (318 piglets) were randomly assigned to three treatments at approximately 3 days of age.

- Enrichment provided in farrowing and nursery (1 to 8 weeks of age: EFN)
- Enrichment provided in the nursery only (4 to 8 weeks of age: EN)
- No enrichment provided (Control)

Pigs were weaned at ~28 d of age, with litters that received the same treatment being mixed together in nursery pens (10-11 pigs/pen). Enrichment objects were provided 3-4 at a time and the set was rotated twice weekly. The enrichments used included: Black PVC pipe (diameter: 7.5 cm, length: 30 cm), knotted cotton rope, timothy hay cubes, "Bite-Rite" (Ikadan Systems, Ikast, DK), "PorkyPlay" (Ketchum Manufacturing Inc. Brockville , ON) and rubber mat (30 cm x 30 cm) (Fig. 1).

All pigs were weighed at ~3 d of age, at weaning, and at 8 weeks of age. Six focal pigs per pen received scores based on the severity of skin lesions on three regions of the body before weaning, 24 h post-weaning, and 4 weeks post-weaning. Piglet behaviour was recorded using one-hour videos, with the behaviour of pigs being recorded using scan sampling. Piglet interactions with enrichment were recorded at 8 and 10 d post-weaning in the enriched pens, and transcribed using 3-min scan sampling (all pigs). Behaviour at weaning and 21 d post-weaning was recorded in all pens, and transcribed using 5-min scan sampling (focal pigs only). A Human Approach Test was conducted at 9 and 22 d post-weaning; the latency for one pig and three different pigs to contact the observer were measured and the results of all 4 tests were averaged for each pen. Data were analyzed using mixed model and Glimmix models in SAS 9.1, with treatment as a main effect and block as the random effect.

Results and Discussion

No treatment differences in body weight or ADG were found (P > 0.10). This may be due to the rapid growth occurring in all pigs during the nursery stage. Continued monitoring of pig growth during grower and finisher periods would be of interest but was not possible in this trial.

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Of the six enrichments tested, rope was the most frequently contacted enrichment, followed by the hanging 'PorkyPlay' ($P < 0.05$) (Figure 2). Overall, the cotton rope received the most interactions followed by the commercially available toys and the rubber mat. This result agrees with previous research on grower-finisher pigs (Van de Weerd et al. 2003).

Post-weaning enrichment was associated with reduced skin lesions, with pigs in the EN treatment having fewer skin lesions on the head and shoulders at 4 weeks post-weaning compared to EFN and Control ($P = 0.004$). In the human approach test, enriched pigs (EFN, EN) tended to contact the human more quickly than Controls ($P = 0.075$), indicating reduced fear of humans.
Pre-weaning enrichment (EFN) was associated with decreased pen-mate manipulation ($P = 0.004$) and a tendency for reduced aggression at weaning ($P = 0.074$) than EN and Control pigs (Table 1). Both pre- and post-weaning enrichment (EFN, EN) treatments resulted in increased exploratory behaviour at 21 d post-weaning compared to Controls (Table 2).

In addition to the behaviours indicated in Tables 1 and 2, the frequency of play behaviour was also recorded, however, frequencies observed were very low and were not included in analysis.

Implications

Providing enrichment to piglets before weaning and/or in the nursery increased exploratory behaviours, reduced pen mate manipulation and tended to decrease agonistic behavior compared to controls which received no enrichment. Hanging enrichment objects such as cotton rope or commercially available toys may be a viable alternative to substrate enrichments. It should be noted that multiple enrichments were provided at once in this experiment, and were rotated twice weekly.

Although the study was limited in size and the number of observations, these findings suggest that young pigs benefitted from object enrichment. Future studies should continue through the grower and finisher stages to determine if long term benefits are achieved.

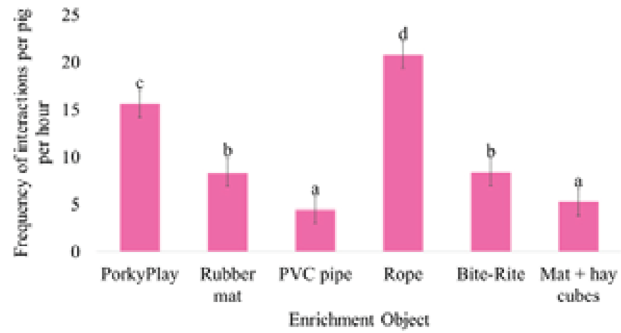

Figure 2. *Frequency of enrichment interaction (LS means ± SEM). One hour videos were transcribed using 3 minute scan sampling.*

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Table 1. *Piglet behaviour at weaning. Six focal pigs per pen observed for 1 hour after mixing using scan sampling at 5 min intervals.*

Behaviour (% of observations)	Treatment			P-value
	EFN	EN	Control	
Walking	2.5	2.0	2.7	0.287
Sleeping	44.4	42.5	51.3	0.326
Enrichment interaction	13.0	12.5	-	0.825
Aggression	1.2	2.9	2.4	0.074
Awake inactive	18.4	13.5	18.1	0.075
Pen-mate manipulation	0.6b	2.2a	2.7a	0.004
Pen exploration	10.4	13.2	14.5	0.076
Eating	8.1	8.9	6.1	0.516
Drinking	1.6	1.7	2.0	0.738
Other	1.1a	1.3a	0.1b	0.021

abValues within a row with different superscripts are significantly different ($P < 0.05$).

Table 2. *Piglet behaviour at 21 d post-weaning. Six focal pigs per pen observed for 1 hour after enrichment rotation using scan sampling at 5 min intervals.*

Behaviour (% of observations)	Treatment			P-value
	EFN	EN	Control	
Walking^{2}	0.3	0.1	0.4	-
Sleeping	69.0	74.3	81.8	0.284
Enrichment interaction	12.6	7.6	-	0.080
Aggression^{2}	0.5	1.2	0.5	-
Awake inactive	3.1	3.6	5.3	0.113
Pen-mate manipulation	1.9	1.8	4.5	0.101
Pen exploration	6.0^{a}	6.7^{a}	3.2^{2}	0.012
Eating	4.7	4.0	3.6	0.575
Drinking	1.2	0.3	0.6	-
Other	1.3	0.6	0.1	-

ab Values within a row with different superscripts are significantly different ($P < 0.05$).
z Frequency of behaviour was too low; not used in analysis

Evaluation of a Prototype Air-Filtered Transport Trailer

B. Predicala[1], A. Alvarado[1], J. Cabahug[1], S. Kirychuk[2]

Summary

In response to the need by the industry for a livestock vehicle that addresses increased animal welfare and biosecurity during transport, a prototype air-filtered trailer was developed. Design parameters were gathered from a stakeholders' survey and initial design configuration options were narrowed down using computer simulation. The final design featured a trailer with two separate compartments: a front compartment that houses generator set, a bank of six air filters, ventilation controller, supplemental heater, and two axial fans; and a livestock compartment with solid aluminum walls, two decks with a hinged upper deck floor and a roof that can be lifted open, and a hydraulic loading platform.

Based on this design, the prototype trailer showed overall reduction of 96.9% in concentration of aerosolized model virus (bacteriophage Phi X174) inside the animal compartment relative to upstream of the filter (MERV-8 pre-filter and MERV-16 main filter). In addition, monitoring of two trips showed the mechanical ventilation system was able to maintain the desired thermal conditions within the animal compartment. A supplemental heating unit helped to ensure the temperature (animal compartment) did not go lower than 10°C during the trips under winter conditions. Events during the trip such as slowing down or full stops affected environmental conditions inside the trailer, although the desired conditions were quickly restored once the trip resumed.

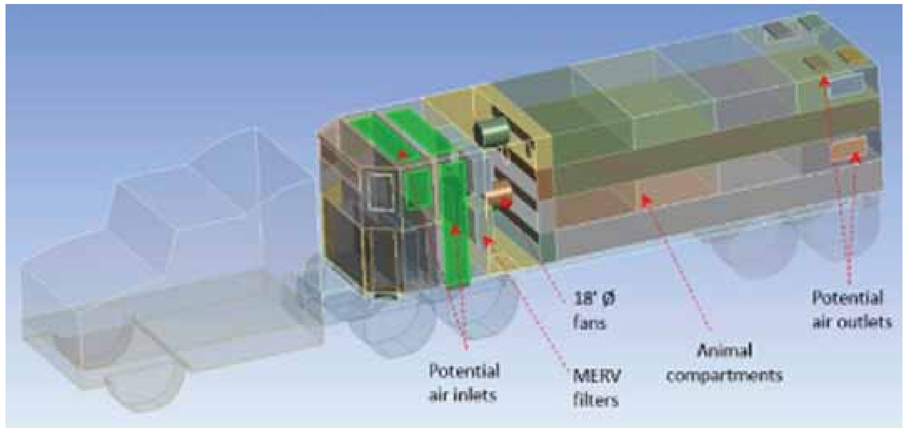

Figure 1. *Diagram of the model of the new trailer equipped with air filtration system*

Introduction

Pig production is a major industry in Canada (Dorjee et al., 2013) and its success over the years relied heavily on the availability of highly improved breeding stock. Breeding stock production is typically located in areas where disease pressure is low and biosecurity perimeters are wide. However, being able to take advantage of these biosecurity benefits also requires that breeding stock would need to be transported to other pig dense regions. While in transit, the potential exists where breeding stock may be exposed to airborne disease contamination. Several Canadian studies have provided evidence that introduction of infected animals, particularly gilts and sows into farms, was one of the common reasons for the spread of PRRSV in the country (Kwong et al., 2013; Rosendal et al., 2014; Thakur et al., 2015). Thus, it is imperative that measures be developed to prevent infection of these animals during transport and consequently close the biosecurity gap through which potential infection can be introduced to commercial herds. In addition, the livestock transport industry is also facing growing pressure to provide more herdsman-friendly and welfare-friendly vehicles (i.e., capable of providing stable, acceptable environmental conditions, reduced incidence of fatigued animals) in response to growing public awareness of animal welfare issues. Therefore, we need to re-visit the design of livestock trailers currently in use in the industry to address these issues by incorporating new design features that improve worker safety and animal welfare.

Experimental Procedures

This project was carried out in four phases: survey of relevant stakeholders in livestock transport, computer simulation of various trailer design configurations to select the best design option, design and assembly of a new trailer prototype, and testing and evaluation of trailer performance.

A questionnaire which gathered inputs on the observed strengths and deficiencies of commercial swine transport trailers was distributed to a number of relevant stakeholders involved in pig transport. Responses gathered from the survey were summarized and formed the basis for the initial design of the new trailer, including desired features and preferences in the new trailer design.

The prototype trailer showed overall reduction of 96.9% in concentration of aerosolized model virus

Computer simulations were done using the commercially-available computational fluid dynamics (CFD) software ANSYS. To create a baseline case for latter comparisons with new trailer design, simulation was done on a conventional straight deck trailer (two decks and five compartments in the upper deck and six in the bottom deck). Six trailer design options based on alternative locations and different number of air inlets and air outlets, which are the main drivers of air movement in mechanical ventilation systems, were evaluated in summer and winter conditions.

Top designs were selected based on (1) ventilation effectiveness, and (2) the capability to meet the environmental requirement of pigs during transport. Heat removal effectiveness (HRE) was used to evaluate the ventilation effectiveness of each design option. The best design configuration for the air-filtered trailer from simulations was implemented in the construction of the prototype trailer.

The performance of the air-filtered trailer was evaluated during stationary and road tests. Specifically, its ability in preventing airborne pathogen introduction, and the effectiveness of the ventilation system in providing an acceptable micro-climate to pigs during transport were examined.

Figure 2. *Photos of the animal compartment showing (A) its lower and upper decks, (B) hinged roof, (C) gate that partitions each deck into two compartments, (D) air exhaust damper, (E) hydraulic loading platform, (F) hydraulic system showing motor, pump, controller and power supply, and (G) exterior of the assembled compartment.*

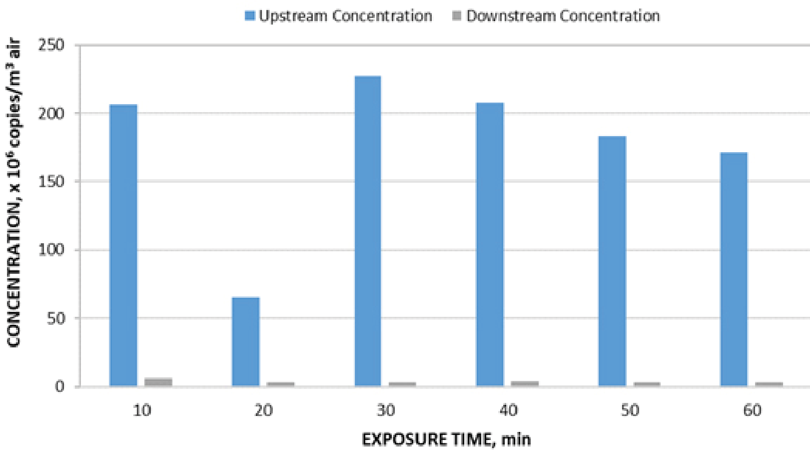

Figure 3. *Total bacteriophage Phi X174 (in genome copies/m3 of air) detected by qPCR. Each bar represents average concentration of the surrogate virus in the air sampled at different time points using 37-mm cassettes located outside (upstream) and inside (downstream) the trailer animal compartment from four replicate trials.*

Results and Discussion

Among the issues raised on the existing commercial livestock trailers were potential for disease infection via air due to the open configuration of the trailer, difficulty in loading and cleaning, and variable thermal conditions, among others. To address these concerns, the initial plan for the prototype trailer included design features such as incorporating mechanical ventilation and air filtration systems, reduced internal ramps and partitions, and having hinged floor panels to allow ease of loading/ unloading pigs, and to facilitate cleaning.

Five of the six design options showed comparable range and mean values for heat removal effectiveness (HRE), temperature, moisture and air velocity at designated monitoring points in summer conditions. Taking into account both summer and winter simulation results, the trailer design which included one inlet opening on each side at the front area of the trailer and two air outlets on each side near the back of the trailer was selected as the best design option for subsequent sensitivity analysis (Figure 1).

The front compartment holds components of the trailer air filtration and ventilation systems where a 10-kW, single-phase generator set and air filter wall was installed. Two 18-inch diameter fans were installed at the downstream side of the filters to pull fresh air through the bank of air filters and into the animal compartment. The flow rates for each fan were controlled using a commercially-available centralized ventilation control system.

The animal compartment included solid walls, two straight decks (divided by a gate into two compartments) both being 3’5” in height. The middle portion of the floor of the upper deck and trailer roof are hinged and can be lifted up to allow easier loading, unloading or other activities (i.e., trailer cleaning, washing, inspection, etc.) (Figures 2A and 2B). To address animal handling and welfare issues arising from loading and unloading in the conventional livestock trailer, a 1000-kg capacity hydraulic loading platform was added in the prototype trailer

Overall, the air filtration system installed in the trailer yielded an approximately 96.9% reduction in the concentration of bacterial virus Phi X174 measured in the animal compartment of the trailer relative to upstream concentration (Figure 3). Monitoring of the trailer thermal condition during actual trips with the prototype trailer loaded with pigs under winter condition showed the need for supplemental heating to avoid temperatures in the animal compartment lower than 10°C. In addition, moisture (RH) level and air quality (CO2) inside the trailer during the monitored trips were maintained at levels comparable to conditions found inside swine barns.

Implications

Cost analysis of the air-filtered trailer prototype which considered total equipment and installation cost as well as annual operational and filter maintenance costs, yielded a payback period of 2.10 years if a modest premium of $5 per pig is realized for transporting pigs using an air-filtered trailer. From this first effort on design and development of major equipment, various points for optimization of the prototype have been identified to facilitate continuing work to further improve the efficiency of the trailer and to bring the overall trailer design closer to commercialization.

Acknowledgements

We would like to acknowledge the financial support for this research project from the Saskatchewan Ministry of Agriculture and the Canada-Saskatchewan Growing Forward 2 Bi-lateral Agreement and the Canadian Agrisafety Applied Research Program funded by Agriculture and Agri-Food Canada. 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.

Long-Term Feeding of Graded Levels of Deoxynivalenol in Finisher Pigs

D.A. Columbus

Summary

With a lack of effective strategies (i.e., feed additives) available for mitigation of DON-contamination, it will be important to evaluate alternative strategies, including reevaluation of the recommended level of DON in feed. With the potential for adaptation to mycotoxins, use of mycotoxin-contaminated grain in the grower-finisher period presents a possible strategy to minimize the impact of mycotoxins on growth performance and profitability of pork production. However, in order for this strategy to be successful, economic and physiological analysis of long-term DON exposure will need to be conducted. Performance and feed intake (75 kg – market) was compared among four diets (control and 1, 3, & 5 ppm DON) in finishing pigs. Results indicate there was an immediate reduction in feed intake, growth performance, and feed efficiency, however these parameters had recovered by week four, for DON3-fed pigs, and week five, for DON5-fed pigs. Overall, it may be possible to feed diets containing higher levels of DON than currently recommended, however, adjustments may be needed to account for reduced performance.

It may be possible to feed diets containing higher levels of DON than currently recommended

Introduction

Mycotoxin-contaminated grains are commonly downgraded for use in livestock feed and while the best strategy for livestock producers is to avoid feeding mycotoxin-contaminated grain altogether with the increased incidence and level of contamination this is no longer a viable option. Therefore, many strategies have been proposed to eliminate or reduce the negative effects of mycotoxins in animal feeds. Most of these strategies are based on deactivation of the mycotoxin through binding of the mycotoxin using adsorbents, such as silicate clays and activated carbon, which can be included in feed as non-nutrient additives. In general, however, current feed additives are relatively ineffective in mitigating the negative effects of DON.

Experimental Procedures

A total of 200 finisher pigs (initial body weight of 75 kg) were housed in groups of five pigs/pen and randomly assigned to one of four dietary treatments over two blocks (n=10/trt). Dietary treatments (Table 1) consisted of a control diet with no DON contamination (CON), or one of three DON-contaminated diets containing 1, 3, or 5 ppm DON (DON1, DON3, DON5). DON diets were achieved by replacing clean wheat with naturally-contaminated wheat and wheat screenings. Diets were formulated to be isonitrogenous and isocaloric and to meet or exceed nutrient requirements according to NRC (2012). Pigs were fed ad libitum for a total of six weeks. Growth performance (body weight) and feed intake were monitored on a weekly basis for the duration of the study.

Results and Discussion

Compared to CON fed pigs, body weight was reduced in pigs fed the DON3 and DON5 diet from week one to the end of the study. Average daily gain was reduced on the DON3 and DON5 diets for the first three weeks of the study but recovered by week four for DON3 and week five for DON5. Average daily feed intake was reduced only in week one for pigs fed DON3 and up to week 4 for DON5 fed pigs, whereas afterwards ADFI was the same across diets. Feed efficiency was only reduced for DON5 fed pigs in week one. There was no difference between CON and DON1 fed pigs for any measures.

Implications

Initial results indicate margin over feed costs may not differ between Control, 1, 3, and 5 ppm DON contaminated diets. While feeding diets containing 3 and 5 ppm DON resulted in a lighter hog at market resulting in lost revenue up to $20/hog, feed consumption was also reduced by approximately $20/hog resulting in little change when comparing margin over feed cost. Overall, it may be possible to feed diets containing higher levels of DON than currently recommended, however, adjustments may be needed to account for reduced performance.

Acknowledgements

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Table 1. *Experimental diets used to determine effects of long-term mycotoxin exposure in finisher pigs*

	CON	DON[1]	DON[3]	DON[5]
Ingredient (%, as-fed)				
Wheat (clean)	39.6	32.9	19.6	6.3
Wheat (8 ppm DON)[1]	-	4.9	14.8	24.7
Wheat screenings (35 ppm DON)[1]	-	1.7	5.2	8.6
Barley	44.0	44.1	44.1	44.1
Canola oil	3.5	3.5	3.5	3.5
Soybean meal	10.0	10.0	10.0	10.0
Calculated nutrient content[3]				
DM (%)	86.5	86.5	86.5	86.6
ME (kcal/kg)	3282	3282	3282	3282
CP (%)	15.9	15.9	15.9	16.0
Lysine (%, SID)	0.76	0.76	0.76	0.76
DON (ppm)	0	1	3	5
Analyzed nutrient content[4]				
DM (%)	88.1	88.3	88.4	88.1
CP (%)	15.5	16.1	16.2	15.7
DON (ppm)	<0.2	1.0	3.5	5.1

Table 2: *Growth performance of finisher pigs fed diets containing graded levels of DON for 6 weeks*

	CON	DON[1]	DON[3]	DON[5]	SEM	P-value
Body weight (kg)						
Day 0	76.9	77.0	76.3	76.0	1.18	0.917
Day 7	85.4a	84.8a	83.0b	80.8c	0.34	<.0001
Day 14	95.3a	95.3a	92.4b	88.7c	0.42	<.0001
Day 21	103.4a	103.8a	99.8b	95.7c	0.50	<.0001
Day 28	112.1a	111.9a	107.8b	103.0c	0.53	<.0001
Day 35	119.7a	119.8a	114.9b	110.4c	0.63	<.0001
Day 42	126.7a	126.9a	123.6b	118.5c	0.80	<.0001
Average daily gain (kg/d)						
Week 1	1.27a	1.18a	0.93b	0.60c	0.05	<.0001
Week 2	1.40ab	1.49a	1.33b	1.13c	0.04	<.0001
Week 3	1.17ab	1.21a	1.06b	1.01c	0.04	0.004
Week 4	1.24a	1.17ab	1.15ab	1.04b	0.04	0.033
Week 5	1.08	1.12	1.01	1.06	0.04	0.392
Week 6	1.06	1.00	1.20	1.14	0.06	0.116
Overall	1.19a	1.20a	1.12b	1.00c	0.02	<.0001
Average daily feed intake (kg/d)						
Week 1	2.59a	2.59a	2.22b	1.70c	0.06	<.0001
Week 2	2.98a	3.07a	2.89a	2.55b	0.07	<.0001
Week 3	3.03a	3.03a	2.88a	2.56b	0.05	<.0001
Week 4	3.25a	3.19a	3.13a	2.85b	0.05	<.0001
Week 5	3.22	3.20	3.19	3.04	0.06	0.222
Week 6	3.19	3.11	3.36	3.05	0.08	0.079
Overall	2.99a	3.06a	2.94a	2.60b	0.05	<.0001
Gain:Feed (kg/kg)						
Week 1	0.49a	0.46a	0.41a	0.34b	0.02	<.0001
Week 2	0.47	0.49	0.47	0.44	0.01	0.136
Week 3	0.38	0.40	0.37	0.40	0.01	0.518
Week 4	0.38	0.36	0.37	0.36	0.02	0.738
Week 5	0.33	0.35	0.32	0.35	0.01	0.211
Week 6	0.33	0.32	0.36	0.37	0.01	0.083
Overall	0.40	0.39	0.38	0.38	0.01	0.073

a,b,c,d Means within a row without a common superscript differ significantly ($P < 0.05$)

Interaction of Dietary Fibre and Immune Challenge on Threonine Requirements and Pig Robustness

D.A. Columbus[1,2], Wellington M.O.[1,2], A.G. Van Kessel[2], J.K. Htoo[3]

Summary

Sub-clinical disease results in reduced growth and less efficient use of nutrients. With the elimination of in-feed antibiotics for growth promotion it is increasingly important to understand the interaction between nutrition and health and nutrient requirements during disease challenge events. This project set out to more fully understand the interaction between dietary feedstuffs and immune status on nutrient requirements and utilization for body protein deposition, aiding in the development of effective techniques and protocols to reduce the negative effects of disease/stress on pig performance, as well as nutrition alternatives to antibiotics. Results suggest that supplemental threonine was able to mitigate the effects of Salmonella challenge and dietary fibre alone, but was only partially able to improve growth performance when both are present. Additional threonine is required in pigs fed high fibre diets and subjected to an enteric pathogen challenge.

Introduction

Feeding high-fibre feedstuffs reduces the efficiency of utilization of dietary threonine for growth in pigs due to an increase in endogenous threonine loss as a result of increased mucin production. The mucus layer serves to protect the intestinal mucosal surface against threats, such as enteric pathogens, with mucin production shown to also increase with immune challenge. In addition to mucin production, threonine is an important precursor for the synthesis of many acute phase proteins involved in the immune response. While an increased threonine requirement has been shown with increased fibre (i.e, mucin production) and with immune challenge (e.g., immunoglobulin production), the interaction of these factors on threonine requirements is unknown. Greater dietary threonine may therefore be required to improve pig robustness and ability to resist immune challenge. With the increased use of high-fibre co-products, such as DDGS, and other feedstuffs resulting in an increase in total dietary fibre content in swine rations, studies into the interaction between high-fibre diets and immune challenge are warranted.

Experimental Procedures

Phase 1 – Nitrogen-balance study

A total of 90 growing barrows were used in a nitrogen (N) balance study. Dietary treatments represented two main factors 1) threonine level (0.49,0.57,0.65,0.73 and 0.81% SID) and 2) fibre level (high fibre or low fibre). A basal diet was formulated, based on wheat and barley, to be first limiting in threonine but to meet or exceed nutrient requirements and all other amino acids according to NRC (2012). Whole body N-balance was measured during a pre-ISS (immune system stimulation) and ISS period of 4-days each. At the start of the ISS period, pigs were injected intramuscularly (I.M) Escherichia coli lipopolysaccharide (LPS) to stimulate the immune system.

Phase 2a - Dietary Fibre Study

A total of 160 growing pigs were randomly assigned to wheat and barley-based diets formulated to contain 10% sugar beet pulp and 5% wheat bran as sources of soluble and insoluble fibre respectively, and one of five levels of SID Thr (0.66, 0.71, 0.76, 0.81 and 0.86%). All other AA were balanced at 110% of NRC (2012) requirement, diets were fed ad-libitum.

Phase 2b – Enteric Pathogen Challenge Study

A total of 128 growing pigs were randomly assigned one of four dietary treatments based on wheat-barley-soybean diets containing high or low dietary fibre and a standard (STD; 0.68% SID based on NRC(2012)) or supplemented (SUP; 0.78% SID based on Phase 1 and 2a results) level of dietary threonine. At day 0 of the challenge period, all pigs were orally inoculated with a culture containing Salmonella typhimurium. Growth performance was monitored for 21-days post challenge during which body weight gain and feed intake were measured.

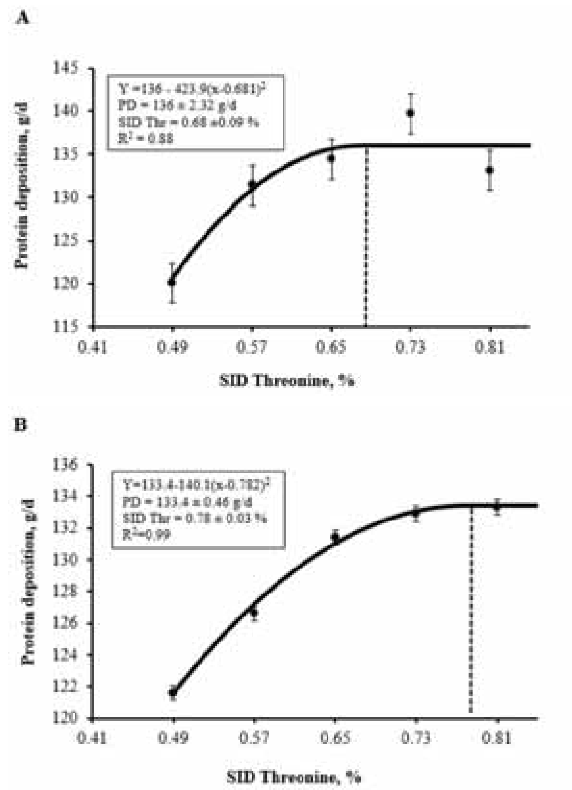

Figure 1. *The quadratic break-point model analysis estimate during the pre-immune system stimulation period for low fiber (A) and high fiber (B). Low fiber diets show a breakpoint at 0.68 % SID Thr for maximum protein deposition (PD) at 136g/d. High fiber diets show a breakpoint at 0.78% SID Thr for maximum PD at 133 g/d.*

Results and Discussion

Phase 1 – Nitrogen-balance study

During the pre-ISS period, protein deposition (N-balance) increased linearly ($P < 0.01$) as threonine concentration in the diet increased, with a significant interaction between fibre and threonine ($P < 0.05$). During ISS, protein deposition increased linearly ($P < 0.05$) as threonine concentration in the diet increased. Quadratic break-point model estimated SID threonine required to maximize protein deposition of pigs fed low and high fiber diets without ISS at 0.68% and 0.78%, respectively (Figure 1). During ISS, the SID threonine requirement was estimated at 0.76% and 0.72% for low and high fibre diets, respectively (Figure 2). Overall, both dietary fibre and ISS increased the estimated threonine requirement, although these effects were not additive.

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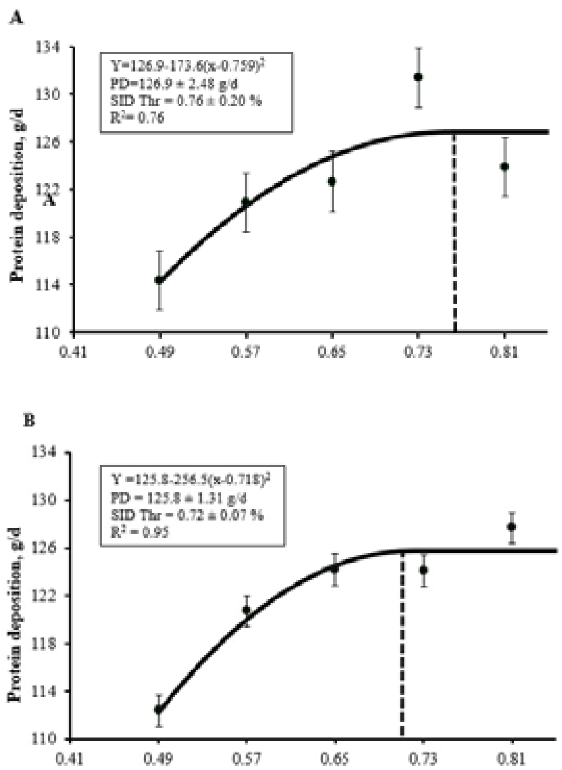

Figure 2. *Quadratic break-point analysis estimates during the immune system stimulation period for low fiber (A) and high fiber (B). Low fiber diets show a breakpoint at 0.76 % SID Thr for maximum protein deposition (PD) at 127g/d. High fiber diets show a breakpoint at 0.72% SID Thr for maximum PD at 126g/d.*

Phase 2a - Dietary Fibre Study

Increasing the dietary SID threonine concentration did not affect the overall ADFI however, between d21-28 there was a linear increase in ADFI. The overall ADG reported in this study showed both linear and quadratic responses as dietary Thr level increased. There were no significant differences in the initial BW among dietary treatments, however, as dietary SID threonine concentration increased, the final BW increased. Increasing dietary SID threonine increased the overall G:F. Dietary SID threonine required to maximize ADG was estimated at 0.76% and 0.80% based on linear and quadratic break-point models, respectively, confirming results from Phase 1.

Phase 2b – Enteric Pathogen Challenge Study

The initial BW was not different between treatments ($P > 0.05$), however final BW was higher in low fiber treatment group compared to the high fiber group ($P < 0.0001$). The effect of threonine on final BW was significant ($P < 0.01$), with greater final BW with high dietary threonine (Table 1). Regardless of dietary fibre content, average daily gain was improved with threonine supplementation compared to unsupplemented ($P < 0.05$), although this increase was less in pigs fed high fibre diets.

Implications

This series of studies indicate an increased threonine requirement may be necessary when pigs face immune disease challenge and/or fed high dietary fibre diets.

Acknowledgements

We would like to acknowledge the financial support for this project provided by Alberta Agriculture and Forestry, Evonik Nutrition & Care 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.

Table 1. *Growth performance of pigs after Salmonella thyphimurium challenge*

	Low Fiber		High Fiber			P value		
Parameters	Low STD Thr	High SUP Thr	Low STD Thr	High SUP Thr	SEM	Fib	Thr	Fib × Thr
Initial BW, kg	22.76	22.32	22.69	22.45	0.167	0.8646	0.0521	0.564
Final BW, kg	49.51	51.45	46.34	48.57	1.055	0.0001	0.0041	0.832
Post Challenge (d0-7)								
ADG, kg	0.965	1.082	0.843	0.911	0.025	<.0001	0.0011	0.3397
ADFI, kg	1.788	1.635	1.653	1.551	0.047	0.0081	0.0025	0.5200
GF, kg/kg	0.543	0.665	0.511	0.588	0.022	0.0164	<.0001	0.2915
Post Challenge (d8-21)								
ADG, kg	0.940	1.093	0.783	0.938	0.031	<.0001	<.0001	0.9840
ADFI, kg	1.983	1.944	1.934	1.831	0.075	0.2922	0.3566	0.6758
GF, kg/kg	0.483	0.566	0.409	0.514	0.022	0.0072	0.0002	0.6291
Overall (d0-d21)								
ADG, kg	0.953	1.088	0.813	0.9243	0.020	<.0001	<.0001	0.5356
ADFI, kg	1.885	1.789	1.793	1.691	0.042	0.0299	0.0243	0.9382
GF, kg/kg	0.514	0.615	0.459	0.553	0.017	0.0016	<.0001	0.8255

Pretreatment of Feed Ingredients to Enhance Value

A.D. Beaulieu[1,2], A.G. Van Kessel[2], D. Sotto[1,2,3], E. Darambazar[2] and J. Wang[2]

Summary

Grains are typically harvested at <15% moisture to maintain quality during storage. When harvested at >15%, artificial drying may be employed but this increases cost. Low-quality high-moisture grains may also be preserved by acidification. These experiments were conducted with the overall objective of determining whether the benefits of acidification on performance and gut health of weanling pigs are maintained when the acid is presented as acid-preserved high-moisture grain. Results indicate that feeding acidified high-moisture wheat or barley to weanling pigs gave similar performance to feeding acidified diets providing an additional strategy for producers to utilize low quality grains.

Introduction

Harvesting grain at high moisture is an attractive option for grain producers, particularly during years with challenging growing conditions. However, drying the grain is expensive and may cause nutrient damage. A potential alternative to artificial drying is preserving the grain by acidification.

Acidification of diets for the weanling pig has demonstrated potential to improve the feeding value of the diets and various acids have been suggested as potential alternatives for antibiotic growth promotants. The overall objective of this series of experiments was to determine if the benefits of diet acidification are maintained when the acid-preserved grains are used in the diets for weanling pigs.

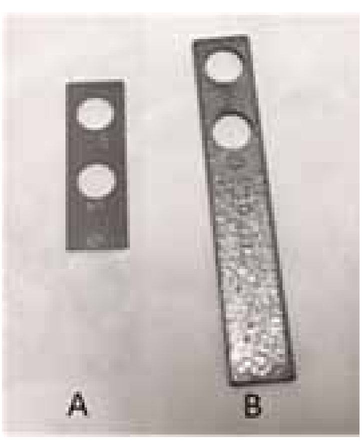

Figure 1. *Carbon steel (A) and galvanized steel (B) coupons used to estimate corrosion*

Experimental Procedures

Two experiments were conducted to determine the effect of grain acidification as an alternative to in-feed acidification on weaned pig performance, nutrient digestibility and gastro-intestinal health. Whole wheat and barley were reconstituted with water to achieve 20% moisture. Either a commercial phosphoric acid-based acidifier (30 to 50% phosphoric. 0.1 to 1% lactic, 5 to 10% citric and 1 to 5% malic acid) or propionic acid (99%) was then added to the grain with mixing, followed by storage in polyethylene barrels for about 35 days. –Weight loss of galvanized or carbon steel coupons, embedded in the acidified grain, were used to estimate corrosion rate (Figure 1).

The preserved grains were then used in piglet feeding trials. Trial 1 (wheat) and trial 2 (barley) used 160 and 90 pigs respectively (weaned at 21 ± 2 days of age, 6.50 to 6.60 kgs BW, housed 4 pigs/pen). Pigs were fed stage 1 and stage 2 treatments diets from day 0 to 7 and 8 to 21, followed by a common commercial diet from day 22 to 35.

The 5 Treatments in trial 1, arranged as a 2 x 2 factorial with a control, were type of acid (phosphoric acid mixture, or propionic) and type of application method (acid added as the preserved wheat or added directly to the diet) compared to a negative control. In trial 2 there were just 3 treatments, the phosphoric acid mixture added as a preservative or directly to the diet compared to a negative control.

Table 1. *pH and mould counts of high moisture (20% moisture) wheat and barley stored for about 35 days.*

		Acidified high moisture grain		
		pH		Mould, CFU/gm
		Initial	Final	Final
Study 1. Wheat	Phosphoric acid	4.27	5.72	7,000
	Propionic acid	4.56	4.85	20
Study 2. Barley	Phosphoric acid	4.60	5.47	821,000

Untreated wheat and barley had a pH of 6.24 and 6.19, respectively.

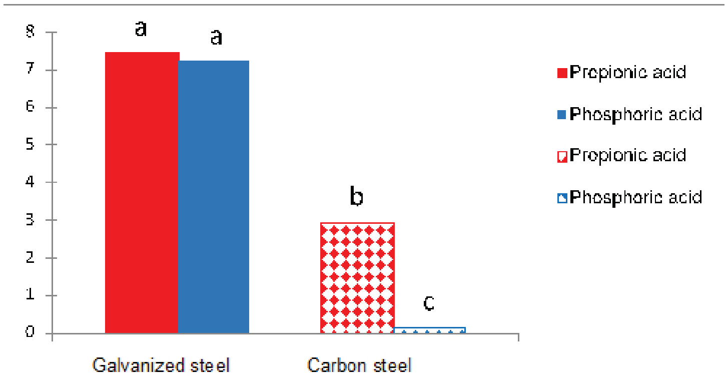

Figure 2. *The interaction of acid and metal on loss of coupon (mls per year) during storage for 35 days.*

Results and Discussion

Grain pH and mould count

pH of the grain fell by almost 2 points following the addition of the acid (Table 1), and while it had increased following storage it was remained below the initial values. Mould was observed on the phosphoric acid preserved wheat and barley, especially around the top of the barrel. However, when the grains were tested for a series of mycotoxins, all were below limits of detection, or below acceptable levels, thus the feeding trial proceeded.

Effect of acids on corrosion

Propionic acid and the phosphoric acid mixture were equivalent in their corrosiveness of galvanized steel while propionic acid was more corrosive to carbon steel (measured in mls per year, coupon x acid, $P = 0.002$). Produces will need to consider bin and feed equipment materials if considering using acid-preserved grains in their diets.

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Feeding acid preserved grains to weanling pigs.

Study 1.

Treatment had no effect on growth, feed intake or feed efficiency during the first 7 days post-weaning ($P > 0.05$; Figure 2). During phase 2, the pigs fed the propionic acid treatment grew faster and had improved feed efficiency than those fed the phosphoric acid mixture, regardless of application method (acid, $P = 0.05$). Feed efficiency was also improved in the acid treatments when the acid was applied directly to the diet, rather than acidified wheat. An improvement in feed intake and reduced gain:feed with the propionic acid treatments observed in phase 3, is difficult to explain as all pigs were receiving the same commercial production diet during this time.

Study 2.

Treatment had no effect on growth rate, feed intake or feed efficiency throughout the trial (data not shown).

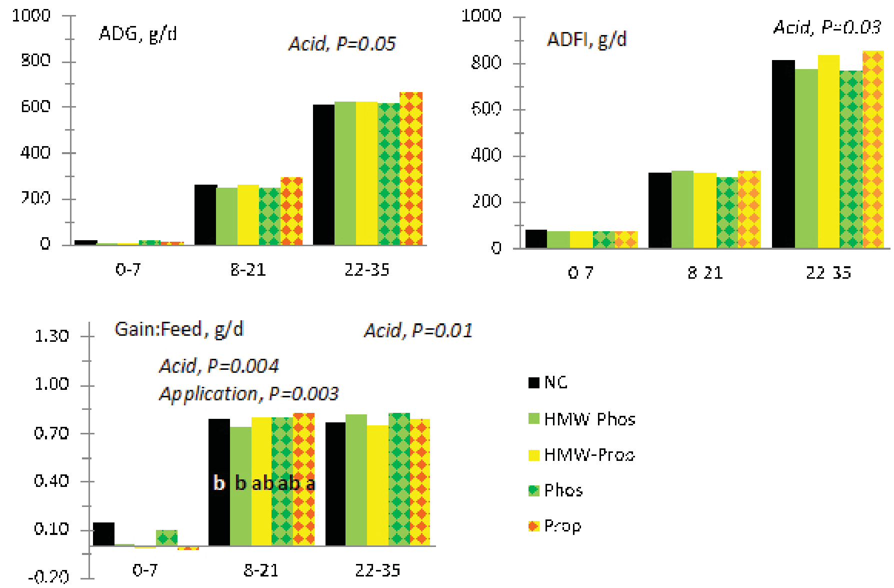

Figure 3. *Average daily gain, feed intake and feed efficiency of pigs fed a control diet (NC), or the control diet with wheat preserved with a phosphoric acid mixture (HMW-Phos) or propionic acid (HMW-Prop) compared to equivalent amounts of the phosphoric acid mixture (Phos) or propionic acid (Prop) added to the diet immediately prior to feeding in 2 phases. Days 22 to 35 the pigs were fed a common diet.*

Conclusions

Results indicate that feeding acidified high-moisture wheat or barley to weanling pigs gave similar performance to feeding acidified diets. Therefore, feeding acid-preserved high-moisture grains can be an alternative to direct diet acidification for weanling pigs. This provides producers an alternative tool to utilize and improve the feeding value of low quality, high-moisture wheat or barley with a potential to reduce cost.

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High Fibre Diets - Satiety in Sows and Offspring Growth Performance

A. K. Agyekum[1], A.D. Beaulieu[1,2], and T. Gebreyohannes[2]

Summary

Feeding high fiber diets to sows during gestation is reported to play a positive role in the swine industry both in terms of animal welfare (improved satiety in feed-restricted pregnant sows) and production (increased weaning weight) during the gestation-lactation period. This study was designed to determine the effect of hydrothermal processing of straw on metabolic indicators of satiety, behavioral measures in group-housed gestating sows, and growth indicators of litter performance. Results indicated that adding 10% oat or wheat straw to the diet of sows in late gestation had no effect on feeding motivation, piglet characteristics at birth, estimated milk production, market weight or carcass quality of the offspring, regardless of processing. In addition, However, oat straw supplementatione did influenced sow endocrine and metabolic statusin late gestating sows and improved lactation feed intake and litter body weight up to nursery exit. y. Overall, oat straw had the greatest impact on sow physiology, lactation feed intake, and litter weight gain

Introduction

Feed restriction in gestating sows is required to prevent excessive body weight gain and the associated negative consequences on, locomotion, farrowing and feed intake during lactation. Aggression and stereotypies associated with restricted feed intake are a welfare and production concern, especially when sows are housed in groups. Feeding high fibre diets to sows during gestation is reported to play a positive role both in terms of animal welfare (improved satiety and production e (increased litter size and weaning weight) during the gestation-lactation period. Wheat and oat straws can be cheap sources of fibre; however, the fibrein these straws is primarily insoluble. Feed processing techniques can be used to change the physical property of fibrous ingredients, potentially improving solubility and nutritive value for pigs.

Experimental Procedures

One hundred and fifty gestating sows were randomly assigned to one of five dietary treatments (30 sows per diet) until farrowing. Sows were fed a standard gestation diet or this diet supplemented with processed or unprocessed oat or wheat straw at 10% of the daily feed allowance. Processed straws were produced by hydraulically compressing straw at a temperature of about 80□C. Nutrient digestibility, plasma insulin, IGF-1, prolactin, glucose , urea and feeding motivation (time required to consume 200 g feed) were determined in late gestation.. After farrowing, sows were fed a standard lactation diet and litter characteristics and sow feed intake 7 days post-parturition were also recorded. Upon weaning, three piglets per litter with BW close to the average litter weight were selected, placed on standard nursery, grower and finisher diets, and followed from weaning to market. Body weight of the selected pigs was recorded at nursery exit (four weeks post weaning). Pigs were identified at market, allowing estimation of treatment effect on offspring market weight, backfat thickness, loin thickness, percent lean yield, carcass weight, and dressing percentage

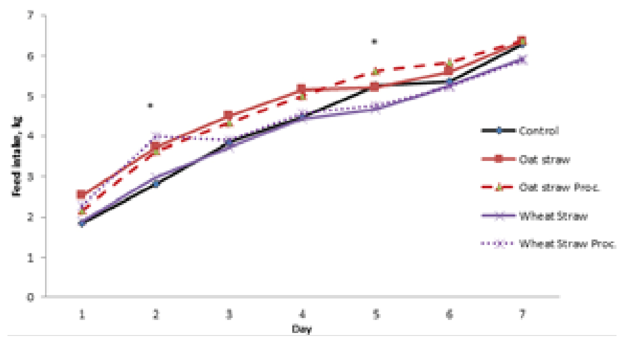

Figure 1. *Daily feed intake in lactating sows supplemented with processed or unprocessed oat and wheat straws during late gestation. Values are means. Overall treatment effect: * P < 0.05.*

Results and Discussion

Treatment had no effect on feeding motivation, piglet characteristics at birth, estimated milk production, and offspring BW at market or carcass quality. Processed straw improved DM digestibility and energy content and the effect was greater with oat straw. Pre- and postprandial glucose concentrations tended to decrease with processing of wheat, but not oat straw, and this effect was more apparent in the preprandial samples. Sow lactation feed intake improved with oat straw supplementation compared to the wheat straw (figure 1). Piglet weaning weight increased with oat straw supplementation and processing improved nursery exit BW. Straw supplementation, however, had no effect on offspring BW at market or carcass quality, regardless of processing, (Overall, oat straw supplementation had a greater impact on sow physiology and provided benefits for sows in late gestation, than wheat straw, and there was some indication that further benefits could be obtained through mild processing.

Conclusions

Processing improved dry mater digestibility and energy content, and these effects were greater with oat than wheat straw. Furthermore, processing the oat straw increased plasma glucose in sows, whereas the opposite effect was observed with the wheat straw, indicating a potential for improved satiety with the oat straw. Moreover, pregnant sows fed oat straw from day 86 of gestation to farrowing had increased feed intake in early lactation and greater average piglet weaning weights. Overall, results suggest that oat, but not wheat, straw impacted sow physiology and provided benefits for gestating sows

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