PRAIRIE SWINE CENTRE 30 YEARS

MISSION STATEMENT

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

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2021 Report Highlights

Chairman's Report

Creative Opportunities

Don Down, Chairman of the Board

The Pork Industry has navigated through some unique challenges this past year and the Prairie Swine entre has worked to try and provide support to the future of Swine Production in Canada.

The Covid 19 pandemic combined with a severe drought in the prairies has put pressure on feed costs and overall costs or production. The threat of foreign animal disease has required the industry to be vigilant on biosecurity in all areas of the supply chain.

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.

The pandemic has highlighted the need for increased communication via a virtual and digital platform. The Knowledge Transfer and Translation Program have adjusted the delivery of information and have remained very connected to the needs of the Canadian industry.

PRAIRIE SWINE CENTRE 30 YEARS

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 2022 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 2022.

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

President's Report

Thirty Years of Practical Swine Research

Murray Pettitt, Ph.D. - CEO

Thirty years ago Prairie Swine Centre was created from the University of Saskatchewan swine research facility through the leadership of the Saskatchewan Pork Industry. We began as a Saskatchewan initiative and our influence has grown throughout western Canada and now into the rest of Canada. We have become a provider of practical information to the pork industry throughout Canada, providing producers and the pork value chain with solutions as we compete with other regions of the world.

Our mission 30 years ago and still today is to provide novel information to the Canadian pork value chain through knowledge, innovation and communication. We have focused on near market and applied research in the areas of Nutrition, Ethology and Engineering. Our Knowledge Translation and Transfer (KTT) Program is a key tool for us to serve the swine industry by delivering relevant science-based information to the pork value chain using multiple platforms including publications, events and electronic methods. This past year we enhanced our KTT program, better serving the needs of the industry, by adding additional human resources.

Many agencies, organizations and companies have contributed to base and project funding over the last 30 years. I wish to acknowledge the integral base funding provided by the Saskatchewan pork producers through the Saskatchewan Pork Development Board and the Saskatchewan Government - Agriculture Development Fund. We also thank the pork producers of Alberta, Manitoba and Ontario for their base funding contributions through Alberta Pork, the Manitoba Pork Council and Ontario Pork, in addition to the support from the University of Saskatchewan. The key support of these organizations has been critical for the Centre to leverage into additional project funding from other granting agencies and industry collaborators.

The financial support of the industry and government has enabled Prairie Swine Centre to contribute to the economic and environmental sustainability and social licence of the Canadian pork industry. Over the last 15 years, our return on investment to industry was $4.10/pig/year and during the last five years this increased to $5.60/pig/year. The value of Prairie Swine Centre's research would conservatively exceed $31 million annually across western Canada, based on the number of animals marketed and assuming an adoption rate of 40% of our research. This reflects our real-world impact as our "Auditing Best Management Practices" study measured the adoption rates of research. The results described in this report are the most recent studies to generate impactful information that contributes to the sustainability of the industry.

Looking towards to the next 30 years we will continue to do what we do best: novel Engineering, Nutrition and Ethology research results, delivered through an effective Knowledge Transfer Program, to support the success and sustainability of the pork industry. We are also looking forward to meeting with you again in person at industry events and conferences, as we put the COVID-19 pandemic behind us.

I wish to thank all PSC staff and students for all of their contributions towards the work in this report. They proudly serve the Canadian pork industry and their dedication to excellence is reflected in this report.

Take care, be safe.

Murray Pettitt, PhD

Operation's Report

Fine Tuning Operations to Achieve Optimal Production

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. Staff embraced new challenges that 2021 has brought upon us and adapted to the new situations and changes quickly.

We continue to use a caliper as a guideline for sow body condition and currently 80 % of our herd falls under the ideal category. Number of pigs born alive maintains consistent and above average.

In the past several months, we have slightly improved pre wean mortality, but have not been able to make a significant impact to get below 10%. We continue to use practical tools, such as split nursing 14+ litters, to manage PWM. When there are no trials in the farrowing rooms, we work on improving performance of the slowest growing/disadvantaged pigs by cross fostering to litters of small birth weights and creep feeding in the last week of lactation. The purpose of this is to produce high quality weaned pigs and maintain consistent throughput. In the last year, we have seen continuous improvement in the post wean mortality.

Table 1. Production targets for fiscal year 2021

Category	Target/week	Rolling Average
# Bred	14.0	14.1
# Sows farrowed	12.7	12.6
# Pigs born alive	178	182.3
Average born alive	14.0	14.4
# Piglets weaned	161	157.7
Pre-wean mortality	9.6%	12.1%
Post-wean mortality	3.0%	1.3%
Finish mortality	2.0%	1.4%
# Sold/week	156.0	154.7

**last 16 weeks, ending June 30, 2021*

With nursery trials finished, we were able to continue with regular production management practices in the nurseries. Along with resuming creep feeding prior to weaning and sorting pigs by size at weaning, we also manage fewer pigs per pen in the nursery. The feeding program of newly weaned pigs has changed to multiple small meals throughout the day, for the first five days in the nursery. When possible, we hold back a nurse sow for smaller weaners. The number of treated pigs in the nursery has decreased in the past year and post wean mortality has gone down by 50% compared to the last fiscal report from June 2020. This resulted in producing a high quality wean pig and maintaining consistent throughput wean to finish.

One of the biggest production drivers is the number of pigs wean to finish and survivability of pigs placed to market. Our grow finish mortality continues to stay low. We have seen decreases in tail bites over the past several months. The grow finish staff continuously work on addressing pen densities in a timely manner as well as providing different enrichment toys through all stages of production.

Table 2. Production parameters

	2018	2019	2020	Jan-Sept 2021
Number of sows farrowed:	744	696	661	268
Conception rate %:	90.6	90.7	91.4	94.0
Farrowing rate %:	80.8	89.8	91.5	90.3
Average born alive/litter:	14.0	14.2	14.4	14.3
Farrowing index:	2.48	2.47	2.46	2.47
Number weaned/sow:	12.4	12.6	12.6	12.4
Pre-wean mortality %:	12.0	11.2	12.1	12.5
Pigs weaned/sow/year:	29.5	29.6	29.2	29.3

Despite the challenges and obstacles we are still facing this year, we managed to stay competitive and in benchmarking with other farms across Canada (38 farms) and USA (305 farms) we are in the 10th percentile in Pig Champ data for 2020 as well as making the 25+ League List with PIC. We placed 13th out of 75 PIC farms, for 29.7 pigs weaned per sow in 2020.

The production team also won several MLF Signature Awards in December 2020: 1st place for Highest Average Carcass Weight 106 kg; 2nd place for Demerit Free %; 4th place for Highest Average $ per Hog and 4th place for Highest Average Yield %.

Over the past fiscal year, we had 18 research projects started in grow finish, breeding, gestation, farrowing and nursery rooms. Research projects involved the use of over 3,661 animals over the past year. We continue the balancing act between managing high productivity and meeting research needs.

Working closely with everyone, keeping communication lines open and having great staff that is willing to go the extra mile when needed makes all of this possible. Staff embraced new challenges and were open to changes that helped us continue business and maintain efficiency. We have faced many challenges in the last year. Through all of it we have learned valuable lessons and were reminded, once again, what a great team of people we have. People that are able to rise up to the occasion and take on the hard work, long hours and make sure our core values and beliefs stay intact at the end of the day is what makes the PSC so great. I am very grateful and commend them for their efforts and enthusiasm.

Knowledge Transfer Report

Engaging the Pork Industry Across Canada

Ken Engele, BSA. - Manager, Knowledge Transfer

Over the course of the upcoming year, Prairie Swine Centre will be celebrating its 30th anniversary. Through hard work of staff and students and supported by the pork industry PSC has adapted to an ever changing pork industry over this time. Thirty years ago, the advisory committee recognized the importance of delivering research results to producers; this resulted in the creation and development of the Knowledge Transfer (KT) Program.

A great deal of credit goes to the original advisory committee in realizing the importance of Knowledge Transfer in delivering a successful research program to the pork industry. One that continues to deliver practical, relevant, and timely information. As with any organization, change is a constant and required to ensure longevity and relevance in the industry that you serve.

Delivering timely, accurate and practical information has always been the goal of the KT program at the Centre. The year and a half has been challenging in connecting with the pork industry in traditional ways. Meetings, conferences, trade shows and other in-person events 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 producer and the Scientists. We learn just as much from producers as they do from us, regarding those challenges and opportunities producers face on a daily basis in their operations. We have the opportunity to take these industry challenges, incorporate them into research programs, and find answers that will help producers achieve their goals.

Finding new ways to deliver research results to the pork industry is not something new for the Centre. Over our history, the KT has evolved meeting the needs of an ever-changing pork industry. While the pillars of personal, print and electronic communication remain the same over the years, the level of influence for each pillar and the balance of push versus pull communication has changed. Thirty years ago, we developed communication plans focused on a push strategy: printing newsletters, fact sheets, handbooks, annual reports and producer meetings ensuring every producer had information at their fingertips. This largely meant publications on their staff room table. In today's digital age, we focus largely on pull communications (website, social media) ensuring producers can access the information they are looking for when it is convenient to them.

Over the past year, we added additional resources to the KT program at the Centre including the hiring of a new position (Assistant Manager, Knowledge Transfer). These additional resources not only fit with the strategic plan, but ensures information is delivered on a timely basis and results required to help make producers succeed. While we continue to adapt to challenges placed in front of us, we will all be stronger in the end as we make our way through these uncharted times.

Program Objective

To effectively communicate the knowledge generated at Prairie Swine Centre to pork producers and other key players that help support the pork industry throughout Canada.

To support Prairie Swine Centre's objective "To be viewed as a leader in the area of knowledge transfer within the hog industry".


2019


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Alternative sanitization measures to control pathogen growth in antibiotic-free production

M. Baguindoc[1,2], B. Predicala[1], , and D. Korber[3]

Bernardo Predicala

SUMMARY

This project set out to develop and evaluate alternative sanitization and disinfection measures that may be effective for control of potentially antibiotic-resistant pathogens, as well as measures that might prevent or further reduce development of antimicrobial resistance in pig production.

Various sanitation technologies identified and screened, included the use of alternative chemical-based disinfectants, selected nanoparticles, thermal and irradiation technologies, among others, which were also evaluated for their potential application in pork production. A follow up survey designed to gather additional information from various stakeholders reinforced the screening criteria in order to identify the top four potential sanitation alternatives. The top four alternatives will further receive an in-depth assessment in laboratory-scale and in-barn tests.

Initial results from the laboratory trials showed the efficacy of the silver nanoparticle treatment in reducing the microbial load on test surfaces. Subsequent tests are on going to compare the performance of the other treatments, followed by actual in-barn testing of the top measures.

INTRODUCTION

Due to the increasing public concern with the development and prevalence of antimicrobial resistance (AMR) to medically-important antibiotics, restrictions on the use of antibiotics in livestock production have been recently implemented. As a result, pig producers have adapted practices that eliminate or minimize antibiotic use in their production system, such as feeding prebiotics and enhanced vaccination programs. Maintaining high herd health status is difficult to sustain, and some pig operations inevitably still experience disease outbreaks, thus necessitating treatment of the affected pigs with antibiotics.

Currently, the most commonly used sanitization and disinfection strategies involve the application of chemical disinfectants such as peroxygen (i.e., Virkon) and glutaraldehyde/quaternary ammonium compound (i.e., Synergize). However, some studies showed these chemical disinfectants now have lower biocidal capabilities as pathogens develop resistance to them. Therefore, an assessment of the efficacy of currently used disinfectants as well as potential alternative disinfection and sanitization methods will help pork producers manage herd health.

Alternative measures identified include the application of ozone, slightly acidic electrolyzed water, non-thermal plasma, and ultraviolet germicidal irradiation. In addition, their potential applicability, feasibility, and efficacy in swine barns were evaluated against a set of criteria, which included cost, properties, and safety. From the initial screening, six treatment measures will be subjected to evaluation in laboratory-scale testing, with the best performing treatment to be subsequently tested in a room-scale experiment.

The overall approach for this project is to determine various potential sanitization methods available in other applications and then evaluate the effectiveness of the most promising ones for controlling the growth of disease-causing microorganisms under swine production conditions.

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EXPERIMENTAL PROCEDURES

***Phase 1**: Evaluation of applicability of potential sanitization and disinfection techniques to swine production*

A comprehensive literature review assessed various potential sanitization procedures and technologies developed and applied in other industries and applications (water treatment facilities, hospitals, food processing and manufacturing facilities) to determine their possible adaption and application in pork production. Identified sanitation measures include technologies such as ultraviolet germicidal irradiation, non-thermal plasma, ozonation, thermo-assisted drying and decontamination, use of slightly acidic electrolyzed water, among others. Nanoparticles (zinc oxide, silver nanoparticle, and titanium dioxide) combined with various chemical-based disinfectants with different active ingredients (peracetic acid, hydrogen peroxide, chlorine dioxide, sodium hypochlorite) were also included in the screening and evaluation in laboratory-scale experiments.

The next phase includes stakeholder survey, which gathered more practical information related to cleaning and disinfection that may not be available from published literature. A short online survey was developed and distributed to target stakeholders including pig producers, barn workers, truck wash operators, disinfectant suppliers, veterinarians, and other researchers.

***Phase 2**: In-barn testing of the selected most promising sanitization techniques*

The top two sanitation methods identified in phase 1 will be further evaluated on-farm for their efficacy of controlling the growth of disease-causing microorganisms. After each room cycle with pigs, the selected room will be pressure-washed following standard cleaning practices in commercial barns, except the sanitizing/disinfecting step; this last step will be carried out as part of this experiment by applying the selected alternative sanitization measures.

***Phase 3**: Feasibility analysis and development of recommendations and application guidelines*

The final phase is a feasibility analysis assessing the costs and requirements for the proper implementation of the top treatments in a commercial pig production unit. The analysis will focus on all the costs associated with the sanitization technologies, materials and required equipment, as well as labour and operating costs. Also included will be recommendations and guidelines for the proper application of the most effective sanitization techniques in commercial barns.

RESULTS AND DISCUSSION

Based on the literature search we identified and evaluated 18 potential sanitation and disinfection measures. Results from the literature search showed that the most commonly employed method for controlling pathogens in livestock facilities is the use of chemical disinfectants. The potential alternative and experimental measures identified from the literature search included ultraviolet (UV) germicidal irradiation, ozonation, thermo- assisted drying, non-thermal plasma, the use of slightly acidified water spray, with varying degrees of efficacy in inactivating pathogens. The result of the preliminary assessment and ranking of various potential measures allowed the initial identification of the most promising ones for the next phase of the study (i.e., testing under pig barn conditions).

To reinforce the screening process, an industry survey will supplement and verify the information gathered on each potential measure. Each sanitation and disinfection measure will receive a final rating based on its level of effective in controlling various pathogens.

IMPLICATIONS

Based on initial results (laboratory-scale trials), it appears that silver nanoparticle treatment can be applied at 10 ppm and contact time of 30 minutes.

ACKNOWLEDGEMENTS

We would like to acknowledge the financial support for this research project from the Saskatchewan Agriculture Development Fund. 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 also wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

Evaluation of a modified prototype livestock trailer through road and disease-challenge tests

B. Predicala[1] , M. Sapaden[1,2], A. Alvarado[1,2], and S. Kirychuk[3]

Bernardo Predicala

Alvin Alvarado

SUMMARY

This project set to develop an improved (prototype) trailer that addresses emerging biosecurity risks and enhance animal welfare during transport. The trailer incorporates an environmental control system that is versatile in nature and equipped with a data logging system capable of displaying data in real-time, providing data access during transit. The truck driver can bypass or modify the system if the need arises. In addition, reliable and robust types of sensors for temperature, relative humidity (RH), CO2 and airflow were installed that will withstand the wide range of environmental conditions inside the trailer. The new design modifications also include emergency hatch, feeders, drinkers, misters, portable heaters, video cameras, and LED lights.

INTRODUCTION

Hog operations can suffer devastating losses due to pathogens that spread via aerosols. A previous project "Reducing Pathogen Distribution from Animal Transportation" developed a prototype trailer aimed to protect the animals from airborne transmissible diseases during transport. This project aimed to mitigate the consequences of infection by airborne transmissible diseases during transportation through pig-dense areas where serious swine diseases can be present.

In addition, public demand for enhanced animal welfare in food production animal has increased in recent years. Transport-related animal welfare concerns may include animals experiencing stress, fatigue, injury, morbidity, and mortality, which can be due to feed and water deprivation. Other factors include potential extreme thermal conditions inside the trailer due to trailer design, exposure to noise, vibrations and toxins, and poor animal handling (Nielsen et al., 2011; Pilcher et al., 2011; Torrey et al., 2008; Xiong et al., 2015).

While the design of the prototype trailer assembled in the previous project tried to integrate as many features as possible – to mitigate the risk of airborne infection and to improve the welfare of animals transported – the initial prototype is still a first attempt at developing an entirely new platform. It is not yet perfect, thus, this project aims to optimize and further enhance the previously developed prototype by integrating new design characteristics.

EXPERIMENTAL PROCEDURES

***Activity 1** - Enhancement and optimization of the design of the prototype trailer*

This activity focuses on implementing modifications to the existing prototype trailer optimizing the biosecurity and welfare properties during transportation. We identified two areas of modifications: 1) the instrumentation systems, and 2) the physical and structural modifications of the trailer. The first steps included modifications to the environmental control and data logging systems, followed by retrofitting additional physical and structural features on the trailer.

***Activity 2** – Testing and Evaluation*

This portion of the project evaluates the modified prototype trailer on road tests as well as in disease challenge tests to determine its performance in maintaining a pathogen-free and welfare-friendly environment for pigs during transport. Planning and preparation for the road and disease challenge tests, including protocol development are in development.

RESULTS AND DISCUSSION

***Activity 1** – Enhancement and optimization of the design of the prototype trailer*

Modifications to the environmental control and data logging system, including ventilation and heating controls and the misting and drinking systems are completed. The system has an independent and separate control for the top and bottom deck fans governed by temperature, RH and CO2 levels inside the trailer. In addition, the new system has more reliable data logging features capable of displaying data in real-time, and it allows access to the data while in transit. The driver can also access and make setting adjustments if the need arises. In addition, we upgraded the existing temperature, RH, CO2 and airflow sensors in the trailer to more reliable and robust models that can withstand the varying environmental conditions inside the trailer.

Figure 1 shows the locations of the sensors, data acquisition system, components of the misting and drinking system, and lighting.

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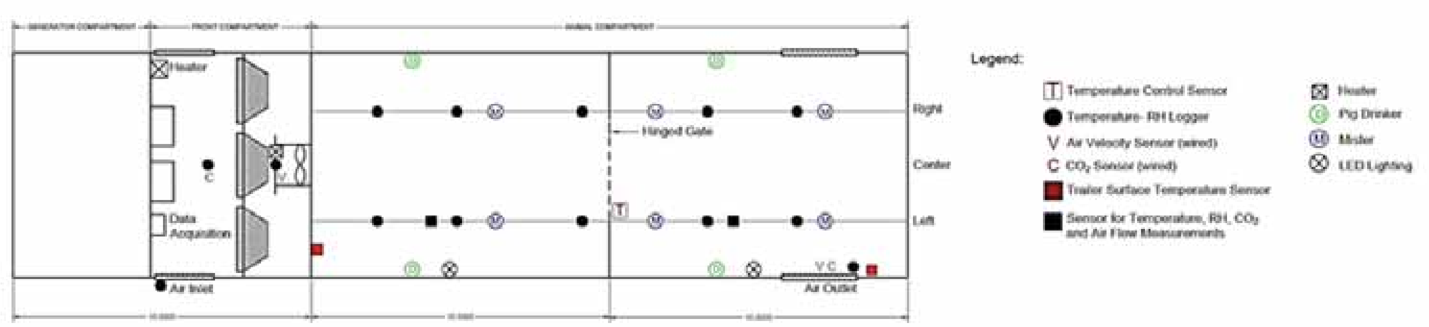

Figure 1. Updated trailer schematic diagram.

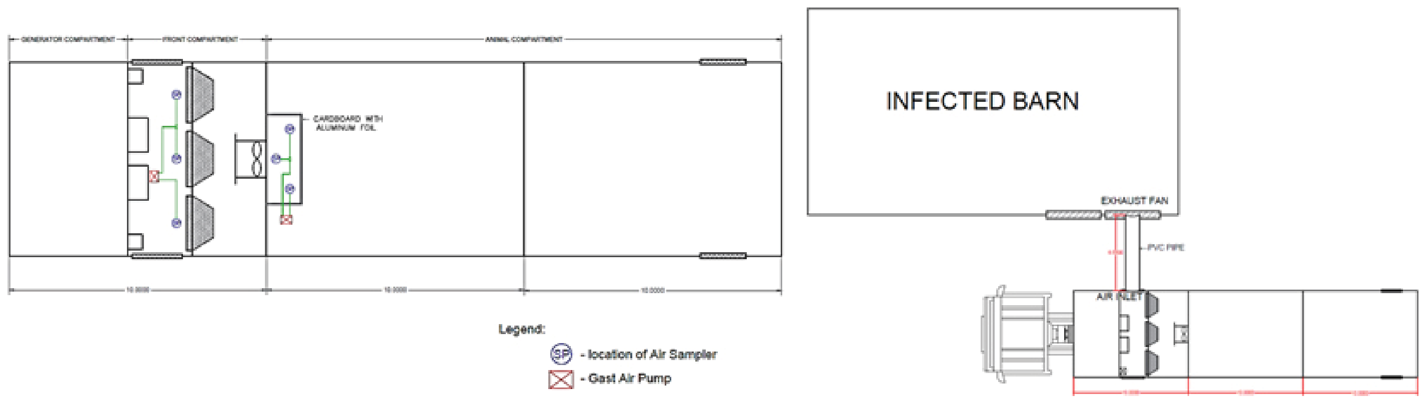

Figure 2. Experimental set-up during disease-challenge test.

To date, changes to the physical components of the trailer include the installation of LED lights, drinkers, misters in addition to portable heaters installed on the fans. Modifications of the other physical and structural areas are expected to be completed soon. All of the necessary preparations for the remaining physical and structural modifications such as preparing work drawings, discussion with contractors/fabricators, sourcing out of materials and equipment, among others, have already been carried out.

***Activity 2** – Testing and Evaluation*

Over the past year, we have identified and developed several critical parameters required for the road and disease-challenge tests. These include:

- Development of the overall framework of the disease-challenge tests to determine the critical test parameters and procedures such as number of pigs, viral load of contaminated barn air, flow rate of infected air passing through the trailer, blood testing procedures, among others.
- Based on the suggested stocking density of pigs set by the Code of Practice for the Care and Handling of Farm Animals during transport we will use 40 weaned pigs per group, reducing it by 25% during hot humid weather conditions.
- Weaned pigs will come from a barn known to be IAV-negative.
- Prior to the disease-challenge test, a preliminary sampling of the exhaust air of a IAV-positive barn will ensure the viral load in the exhaust air is sufficient to cause infection.
- A polyvinyl chloride pipe will connect the exhaust of the infected barn and the inlet of the trailer to ensure maximum exposure to contaminated air from the barn.
- We will use two groups of pigs for the disease challenge tests. One group will be exposed to contaminated air with no air filtration system installed in the trailer (Control) while the other group will be exposed to contaminated air but with air filtration system installed (Treatment).
- Following the exposure to IAV-contaminated air, we will move the trailer to a designated site for a 14-day observation period.
- Blood samples will be taken on days 7 and 14 for serological testing to confirm their IAV status.

IMPLICATIONS

Incorporating new design and monitoring components into trailers will assist producers in reducing losses associated with transporting pigs due to airborne transmissible disease infection.

ACKNOWLEDGEMENTS

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

Assessing the impact of intervention measures for reducing antibiotic use

B. Predicala[1], S. Chekabab[1,2], A. Alvarado[1], D. Korber[2], and J. Lawrence[2]

Bernardo Predicala

Alvin Alvarado

SUMMARY

Previous activity in this study aimed to evaluate the impact of the Raised without Antibiotics (RWA) program on pig production focused on quantifying the overall antibiotics use both in participating RWA and non-RWA barns. Next steps involved the assessment of prevalence of antimicrobial resistance (AMR) and pathogen abundance, by conducting long-term surveillance of AMR and pathogens using whole genome sequencing (WGS), quantifying the resistome, virulome and bacterial diversity in the RWA and non-RWA barns.

Preliminary results from comparative analysis of the ARGs frequency readouts showed significant differentiation between RWA and non-RWA program effects. Specifically, a significant reduced frequency of ARGs for beta-lactams, multi-drug resistance (MDR), phenicol and tetracycline, was observed in manure samples of RWA barns and for phenicol and tetracycline ARG in RWA-piglet feces. On the other hand, data showed a greater frequency of tetracycline-ARG class in the nasopharynx of sows in RWA barns.

In terms pathogen prevalence, we found a similar pattern between the non-RWA and RWA barns in the piglet feces and the barn manure samples. Overall, our longitudinal study suggests that raising RWA pigs may have an impact on the prevalence of pathogens and AMR. Results also suggest the possibility to correlate RWA practices with variations in specific sets of AMR classes and pathogens – leading to potentially adjusting RWA measures and practices to target the reduction of certain AMR classes and the persistence of specific pathogens.

INTRODUCTION

In response to general concerns about the spread of antimicrobial resistance (AMR) along with increasing public concern regarding the use of antibiotics in livestock production, various measures such as changes to livestock feed regulations have been implemented in Canada. Another strategy available to producers is raising animals without antibiotics (RWA). The question is how effective are these strategies in reducing total on-farm use of antibiotics, the occurrence of pathogens, and the prevalence of antimicrobial resistance?

To answer these questions, we conducted longitudinal surveillance monitoring of conventional farms still using antibiotics (except in feed) and RWA farms. The monitoring strategy focused on three key areas: antibiotics usage, antibiotic resistance, and prevalence of pathogens. Based on the findings, a list of recommendations for best management practices can be developed to help ensure the success of intervention measures, such as the RWA program and regulations for the responsible use of antibiotics.

EXPERIMENTAL PROCEDURES

Activity 1 *– Determining on-farm antibiotic usage patterns and total use*

Each farm participating in the project documented antibiotics in one of two categories:

- Inventory of antibiotics in the farm
- Record of any use of antibiotics for animal treatment, including type of drug, dosage, type and number of animal(s) treated and approximate age, treatment cause, location in the barn, and date and time.

Information related to on-farm antibiotics was collected using treatment sheets that are a part of the CQA requirements or Canadian Pork Excellence Program. Analysis of the data then determined patterns of antibiotic use and total usage of different antibiotics on farm.

Activity 2 *– Surveillance monitoring of prevalence of antimicrobial resistance and pathogens*

The second phase of the project monitored the prevalence of antimicrobial resistance and pathogens in each of the participating farms. Representative fecal and manure samples from 6-week, 12-week and 20-week old pigs, earthen manure storage, and soil samples from the barn's immediate environment were collected from each farm at defined intervals and analyzed. In addition, fecal samples and nasal swabs from sows were included in the monitoring because these animals reside the longest in the barns.

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RESULTS AND DISCUSSION

Activity 1 *- Determining on-farm antibiotic usage patterns and total use*

Treatment records collected included the type of drug, dosage, approximate age of animals, cause of treatment, location in the barn as well as the date of drug administration. Based on the data collected, antibiotics mostly given belonged to four classes: Antifolates (Trimidox), B-lactams (Penicillin G, Ampicillin, Ceftiofur), Tetracycline (Biomycin), and Chloramphenicol (Nuflor).

As expected, most of the antibiotic drugs recorded were from the non-RWA barns, with very little total amount used in RWA barns during the monitoring period (i.e., none in the RWA #1 and #3 barns, and small amount in RWA #2).

- In Non-RWA #1, 79% of antibiotics used are Antifolates, 20% are B-lactams, 1% are Tetracyclines, and 0% Amphenicol.
- In Non-RWA #2, 40% of antibiotics are Antifolates, 11% are B-lactams, 43% are Tetracyclines, and 0% are Amphenicol.
- In Non-RWA #1, 25% of antibiotics are Antifolates, 60% are B-lactams, 0% are Tetracyclines, and 6% are Amphenicol.

Activity 2 *- Surveillance monitoring of prevalence of antimicrobial resistance (AMR) and pathogens*

Samples were sequenced and analyzed using Whole Genome Sequencing (WGS) technique (involving processing and analysis of raw samples, quality control protocols, and outputs that include frequency of bacterial species, resistome (antimicrobial resistance genes), and pathome (abundance of pathogens)), which is a widely available tool with demonstrated potential for AMR surveillance. The overall methodology is illustrated in Figure 1 (Chekabab et al., 2020).

Activity 3 *- Identification and quantification of drug residues related to AMR*

To determine the presence of residual drug components that might related to AMR, aliquots of manure and soil samples collected from the participating barns at the start and the end of the study were sent for analysis using Liquid Chromatography coupled with tandem Mass Spectrometry (LC/MS/MS).

All samples were tested for a total of 29 drugs which are routinely tested and quantified at the lab, including: Acetaminophen, Benzoylecgonine, Chloramphenicol, Ciprofloxacin, Clindamycin, Cocaïne, Codeine, Cotinine, Enrofloxacin, Erythromycin, Fluoxetine, Lincomycin, Methamphetamine, Norfloxacin, Norfluoxetine, Ofloxacin, Oxolinic Acid, Pentoxifylline, Pipemidic Acid, Sulfabenzamide, Sulfadimethoxine, Sulfadoxine, Sulfamerazine, Sulfamethazine, Sulfamethoxazole, Sulfapyridine, Sulfaquinoxaline, Sulfathiazole and Trimethoprim.

Additionally, our samples were tested and quantified for tetracycline and tested for the presence/absence of additional antibiotic drugs including: Apramycin, Streptomycin, Dihydrostreptomycin, Bacitracin, Tilmicosin, Erythromycin, Tiamulin, Lincomycin, Tylosin, Tylvalosin, Neomycin, Virginiamycin M1, Virginiamycin S1, Penicillin G, Spectinomycin, Tetracycline and Chlortetracycline.

Results of the analysis summarized in Table 1 show only the specific drugs detected in samples. Overall, the LC/MS-MS data showed the presence of Acetaminophen in both RWA and non-RWA manure samples. Tilmicosin, Tiamulin, Spectinomycin, Tylosin were also detected in both manure and soil samples in both RWA and non-RWA barns.

IMPLICATIONS

Analysis of the resistome and pathome over time (statistical analysis between group of samples) for all samples sequenced and analyzed clearly show different separate clusters of types of samples – fecal, manure, and nasopharynx – with respect to the presence of ARGs and pathogen prevalence.

We observed a significant decrease in ARGs-frequency in RWA manure samples for beta-lactams, MDR, phenicol and tetracycline. Furthermore, RWA piglet feces had reduced phenicol and tetracycline AMR levels. On the other hand, sampling of the nasopharynx of RWA sows showed a greater frequency of tetracycline-ARG.

In the analysis of total prevalence of pathogens, we found a similar pattern between the non- RWA and RWA barns in the piglet feces and the barn manure samples. The frequency of pathogens in the fecal-piglets and manure was not significantly different between RWA and non-RWA farms. However, the RWA-Sows tended to have fewer pathogens in feces and more in nasopharynx compared to non-RWA.

Based on these findings, our longitudinal study suggests that raising pigs using RWA practice may have impact over time on the prevalence of pathogens and AMR, which may differ depending on the animal development stage and on the type of sample.

ACKNOWLEDGEMENTS

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Long-term feeding of graded levels of deoxynivalenol in grower-finisher pigs

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Dan Columbus

SUMMARY

Mycotoxin-contaminated grains are commonly downgraded for use in livestock feed and, while the best strategy for producers is to avoid feeding mycotoxin contaminated grain altogether, this may no longer be possible. Therefore, strategies that allow the use of these grains in livestock feed are necessary. With a lack of effective strategies (i.e., feed additives) available for mitigation of DON, it is important to evaluate alternative strategies, including re-evaluating the recommended level of DON in feed. There is the potential for pigs to adapt to mycotoxins therefore the use of mycotoxin-contaminated grain in the grower-finisher period presents a possible strategy to minimize the impact on growth performance and profitability. Results from this project indicate while there was an initial reduction in performance, pigs seem to be able to adapt to DON intake of > 1 ppm, and < 5 ppm).

INTRODUCTION

The mycotoxin DON (vomitoxin) is of significant importance since it commonly contaminates corn, wheat, oats, and barley, and is one of the most prevalent mycotoxins. In the 2016 World Mycotoxin Survey conducted by BIOMIN, DON reported to be the most prevalent mycotoxin in many ingredients of importance in swine, occurring in 77, 70, 46, and 48% of corn, barley, wheat, and soybean samples tested, respectively. In North America, 58% of all grain samples analyzed contained DON, representing a 'severe risk' (Biomin, 2016). Data for wheat in Saskatchewan shows an increase in the incidence of fusarium, with 80-90% of wheat downgraded due to DON .

Typical negative effects of mycotoxin consumption include reduced feed intake, digestive dysfunction, immune suppression, and reduced growth, with the primary physiological effect dependent on the mycotoxin present.

There have been many strategies proposed to eliminate or reduce the negative effect of mycotoxins in feed. Most of these strategies try to deactivate 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, current feed additives are relatively ineffective in mitigating the negative effects of mycotoxins and may not be effective for all mycotoxins.

Given the increasing incidence of DON-contamination there is an obvious economic impact of mycotoxin contamination for both the grain and pork industries. In addition, with the lack of effective mitigation strategies further information is required on long-term DON exposure in grower-finisher pigs. This information can be used to develop feeding programs which maximize inclusion of DON-contaminated grains while minimizing the impact on growth performance and profitability of both pork and grain producers.

EXPERIMENTAL PROCEDURES

Study 1. *Effect of long-term feeding of graded levels of deoxynivalenol on finisher pig performance, nutrient utilization, and health status.*

Two-hundred mixed-sex finishing pigs with an initial body weight (BW) of 76.6 +/- 3.9 kg were grouped of five pigs/pen, and assigned to one of four dietary treatments (n=10 pens/treatment; Table 1). Dietary treatments consisted of a control diet (CONT) containing no deoxynivalenol (DON) or a diet containing 1, 3, or 5 ppm DON (DON1, DON3, or DON5). The basal diet was wheat- barley-soybean meal-based and formulated to be isonitrogenous and isoenergetic with

Table 1. Analyzed mycotoxin content (ppm) of diets used in Study 1 (as-fed basis)1

	Finisher Diet							
	Growth Performance Diets				Nitrogen-Balance Diets			
Mycotoxin, ppm	**CONT[2]**	**DON1[3]**	**DON3[4]**	**DON5[5]**	**CONT**	**DON1**	**DON3**	**DON5**
Deoxynivalenol	0.11	1.34	3.59	5.72	1.56	1.32	3.09	4.94
3-acetyldeoxynivalenol	ND6	ND	ND	ND	ND	ND	ND	ND
15-acetyldeoxynivalenol	ND	ND	ND	ND	ND	ND	ND	ND
HT-2 toxin	ND	ND	ND	0.050	ND	ND	ND	0.03
Nivalenol	0.15	0.18	0.53	0.64	0.12	0.11	0.12	0.08
Ochratoxin A	0.01	0.03	0.01	0.01	0.01	0.03	0.07	0.09
Zearalenone	ND	0.002	0.009	0.014	0.003	0.002	0.009	0.013
Total Ergot alkaloids	0.99	0.57	1.03	1.26	0.24	0.16	0.39	0.67

[1]Mycotoxin contents analyzed in diet samples by BIOMIN., [2]CONT, 0 ppm DON Control diet, [3]DON1, 1 ppm DON diet, [4]DON3, 3 ppm DON diet, [5]DON5, 5 ppm DON diet, and [6]ND, Not detected or below the limit of detection.

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nutrients meeting or exceeding the recommended requirement for finisher pigs (NRC, 2012). Dietary DON levels were achieved by replacing DON-free wheat with DON- contaminated wheat and wheat screenings proportionally according to the target DON levels. Pigs had ad libitum access to feed and water.

***Study 2**. Effect of long-term feeding of graded levels of deoxynivalenol on grower-finisher pig performance, nutrient utilization, health status, and carcass quality.*

A total of 240 grower pigs (initial body weight of 35.9 +/- 1.1 kg) were housed in groups of six pigs/pen and randomly assigned to one of four dietary treatments over two blocks (n=10/trt). Dietary treatments (Table 2) 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 consisted of replacing clean wheat with naturally contaminated wheat and wheat screenings. Diets were isonitrogenous and isocaloric in order to meet or exceed nutrient requirements according to NRC (2012). Pigs were fed ad libitum for a total of 11 weeks (six weeks grower, five weeks finisher). Blood samples were obtained at 0, 2, 6, 8, and 11 weeks for liver and kidney blood chemistry panel as indicators liver and kidney function.

RESULTS AND DISCUSSION

***Study 1**. Effect of long-term feeding of graded levels of deoxynivalenol on finisher pig performance, nutrient utilization, and health status.*

Body weight was reduced in DON3 and DON5 fed pigs by day seven of the study, with the greatest reduction observed with DON5 ($P > 0.05$) and was maintained throughout the study. Throughout the study, ADG in DON1 fed pigs was not different compared to pigs receiving the CONT diet ($P > 0.05$). From d 0-7, DON3 fed pigs had reduced growth compared to both CONT and DON1 fed pigs ($P < 0.05$) but was not different from CONT fed pigs from d 8-42 ($P > 0.05$). Pigs fed DON5 had reduced ADG from d 0-21 compared to all other dietary treatments ($P < 0.05$).

Overall (d 0-42), ADG was reduced in DON3 and DON5 fed pigs compared to both CONT and DON1 (Table 3), with the greatest reduction observed with DON5 ($P < 0.05$) with no impact of DON1 on ADFI compared to CONT ($P > 0.05$).

Overall (d 0-42), ADFI was only reduced in DON5 fed pigs (Table 3) ($P < 0.05$). Feed efficiency, measured as GF, was reduced in DON5 fed pigs from d 0-7 compared to all other dietary treatments ($P < 0.05$), which were not different from each other ($P > 0.05$). There was no effect of dietary treatment on GF from 8-42 or overall (d 0-42) ($P > 0.05$).

***Study 2**. Effect of long-term feeding of graded levels of deoxynivalenol on grower-finisher pig performance, nutrient utilization, health status, and carcass quality.*

There was a significant decrease in body weight of DON3 and DON5 compared to CON-fed pigs by day 35, with no effect of DON1 (Table 5) to the end of the study. DON3 and DON5 reduced average daily gain in the grower phase and overall compared to CON-fed pigs. There was no DON effect on average daily gain in the finisher phase. There was a reduction in average daily feed intake during the first week of the study in DON3 and DON5-fed pigs compared to CON, with no effect of treatment in grower phase overall. Compared to CON,

DON fed pigs experienced a reduction in feed intake throughout the finisher phase and over the entire study, with no effects on feed efficiency. Feed intake of DON-fed pigs was reduced compared to control fed pigs, while feed efficiency was only reduced in week one, suggesting that the capacity for growth is not affected in these pigs but feed intake is insufficient to support maximum growth. Based on these preliminary results, while feeding 3 or 5 ppm DON resulted in reduced body weight and growth performance, there is evidence that pigs can adapt to DON-contaminated diets. There was no impact of dietary treatment on any measures of kidney and liver health (data not shown).

IMPLICATIONS

Two growth performance studies were conducted to examine the impact of long-term feeding of graded levels of DON in finisher (75 – 120 kg) and grower-finisher (35 – 120 kg) pigs. In finisher pigs we found that there was a rapid negative response to > 1 ppm DON intake, resulting in a decrease in average daily gain and feed intake as well as reduced body weight within the first week. The reduction in body weight was maintained throughout the study, however, after a period of approximately four weeks, the feed intake and average daily gain of all pigs had recovered. In grower-finisher pigs, the response to DON intake was less pronounced and not as rapid, resulting in variability in the response over time and across treatments. Overall there was reduction in average daily gain, feed intake, and body weight in pigs fed > 1 ppm DON, however, this negative effect was less than observed in finisher pigs. Overall, this study provides further evidence for an upper limit of 1 ppm DON in finished feed to avoid reduced performance. While there was an initial reduction in performance, pigs seem to be able to adapt to DON intake of > 1 ppm, and < 5 ppm).

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Table 2. Analyzed mycotoxin content of finishing diets used in Study 2 (as-fed basis)[1]

	Growth Performance Diets				Nitrogen-Balance Diets			
Mycotoxin, ppm	**CONT2**	**DON13**	**DON34**	**DON55**	**CONT**	**DON1**	**DON3**	**DON5**
Deoxynivalenol	0.20	1.02	3.28	4.13	1.04	1.35	3.22	5.43
3-acetyl-deoxynivalenol	ND[2]	ND	0.03	0.04	ND	ND	ND	0.02
15-acetyl-deoxynivalenol	ND	ND	ND	ND	ND	ND	ND	ND
HT-2 toxin	ND	ND	ND	ND	ND	ND	ND	0.04
Nivalenol	0.53	0.63	0.55	0.16	0.10	0.09	0.12	0.09
Ochratoxin A	ND	0.02	0.02	0.07	0.01	0.03	0.09	0.12
Zearalenone	0.001	0.004	0.004	0.007	0.006	0.004	0.008	0.014
Total Ergot alkaloids	0.32	0.63	0.61	0.36	0.18	0.20	0.28	0.77

[1]Mycotoxin content analyzed in diet samples by BIOMIN, [2]CONT, 0 ppm DON Control diet, [3]DON1, 1 ppm DON diet, [4]DON3, 3 ppm DON diet, DON5, 5 ppm DON diet, [6] ND, Not detected or below the limit of detection

Table 3. Growth performance of grower-finisher pigs fed diets with graded levels of deoxynivalenol (DON)1

	CONT[2]	**DON[3]**	**DON[4]**	**DON[5]**	**SEM[6]**	**P-value**
Body weight, kg						
Day 0	36.0	35.6	35.7	36.4	0.34	NS7
Day 7	42.5	41.6	40.7	41.7	0.44	NS
Day 14	50.1a	49.8a	47.8b	49.2ab	0.49	0.01
Day 21	58.0a	57.7a	55.7ab	56.7b	0.60	0.04
Day 28	68.1	67.6	65.4	65.7	0.84	NS
Day 35	75.9a	74.5ab	72.7b	72.7b	0.86	0.03
Day 42	85.2a	83.7ab	81.9b	81.6b	0.91	0.03
Day 49	94.7a	93.1ab	90.9bc	89.8c	0.96	0.005
Day 56	102.7a	100.9ab	98.3bc	97.7c	1.00	0.004
Day 63	110.6a	108.6ab	106.3bc	105.0c	0.91	<0.001
Day 70	118.4a	116.2ab	114.6bc	112.9c	0.91	0.001
Day 77	124.9a	123.0ab	121.0bc	120.0c	0.91	0.002
Average daily gain, kg/d						
Day 0-42	1.17a	1.15ab	1.10bc	1.08c	0.02	<0.01
Day 42-77	1.14	1.13	1.11	1.10	0.01	NS
Overall (d 0-77)	1.15a	1.14a	1.11b	1.09b	0.01	<0.001
Average daily feed intake, kg/d						
Day 0-42	2.29	2.27	2.20	2.18	0.03	NS
Day 42-77	3.12a	2.97b	2.96b	2.88b	0.05	<0.001
Overall (d 0-77)	2.62a	2.55ab	2.47b	2.47b	0.03	0.003

1Values are least squares means with n=10 pens/treatment, 2CONT, 0 ppm DON Control diet, 3DON1, 1 ppm DON diet, 4DON3, 3 ppm DON diet, 5DON5, 5 ppm DON diet, 6 SEM, Standard error of the mean, 7NS, Not significant, a, b, c Means without a common superscript are significantly different (P < 0.05)

Creep feed source: What is effective and what do piglets prefer?

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Dan Columbus

SUMMARY

While creep feeding continues to be widely used in swine operations, the effectiveness of creep feeding to improve pre- and post-weaning performance up for debate. We conducted a study to determine whether provision of creep feed is beneficial and whether this is dependent on the type of creep feed provided. We also determined preference for type of creep feed in piglets. Overall, there was little impact of creep feeding on post-weaning performance and piglets or preference for type of diet (creep diet, lactation diet). While there does not seem to be a benefit to creep feeding, producers who choose to provide creep feed can use a less expensive diet.

INTRODUCTION

Creep feeding is a common practice in swine production, with approximately 90% of farms indicating that they provide creep feed. There are a number of perceived benefits including provision of nutrients, higher weaning weight, and improved transition at weaning, however the benefits of creep feed exist when pigs eat the feed. Intake of creep feed is usually low and highly variable among pigs with approximately 30-50% eating creep feed. It is generally higher in smaller piglets with little to no intake observed in larger piglets. The achieved benefit of creep feeding on growth performance in the suckling and/or nursery period remains inconsistent.

Other work has demonstrated the benefits of providing creep feed is related to enhancing exploratory behaviour in piglets (i.e., allowing natural rooting behaviours) and exposure to feed in a dry form than provision of nutrients. Therefore, it is possible that providing expensive creep diets is not necessary to achieve the benefits of creep feed on weaning weight and overall performance, and that simple diets such as a typical lactation diet, would be sufficient. Creep feed is the most expensive diet used in pig production, costing between $600-1800/tonne. Identification of less expensive alternatives would help to reduce production costs.

EXPERIMENTAL PROCEDURES

A total of 50 sows and litters (n=12-14 per treatment) were randomly assigned to one of four creep feeding treatments. Creep feeding protocols were: 1) no creep feed provided (CON), 2) complex creep feed provided (CC), 3) simple creep feed provided (SC), and 4) both complex and simple creep feed provided (SCC). The CC consisted of a standard nursery starter diet and the SC consisted of a standard lactation diet. Two feeders contained creep feed and were located in the front and back of the farrowing crate. For the SCC treatment, one feeder contained the simple creep and one contained the complex creep. The location of the creep type remained constant for each litter throughout the entire creep feeding period but varied across litters to reduce the effects of feeder location on intake of the two creep diets.

Litter weight was recorded weekly on day 7, 14, 21, and at weaning; mortalities were recorded and litter size was adjusted. At d 14 post-farrowing, litters were placed on their respective creep treatment. Piglets received fresh creep feed each day, with total feed provided and intake recorded on a daily basis and adjusted for wastage. At weaning, piglets were housed in pens of 10-13 pigs/pen (n=14-16 pens/treatment) within pre-weaning treatment groups. Individual pig body weight and per pen feed intake were recorded on a weekly basis for four weeks.

RESULTS AND DISCUSSION

Pre-weaning performance

The initial body weight of piglets on the Control and SC treatments was higher ($P < 0.05$) than other treatments but this difference was not evident at the onset of provision of creep feed ($P > 0.05$). There was no difference in litter performance prior to provision of creep feed ($P > 0.05$). There was no difference in ADG in the first week of creep provision; however, in the second week we saw an increase in ADG in piglets receiving the SC treatment (P < 0.05) compared to Control and CC, with SCC being intermediate. There was a trend for improved overall ADG in litters receiving the SC and SCC creep treatments (P = 0.062). There was no difference in creep feed intake across treatments (P > 0.05).

Post-weaning performance

Pigs that received no creep feed pre-weaning had slightly reduced ADG (P < 0.05) in the first week post-weaning, with no differences among those pigs that received creep feed (P > 0.05). There was no difference (P > 0.05) in performance after the first week and no effect on ADG throughout the entire nursery period or on final body weight. Overall, there appears to be little benefit of provision of creep feed under the conditions of the current study.

While we did not observe a benefit in the current study, it is important to note that this is specific to the conditions of the study. Data presented are averages for litter or pen and does not account for potential positive effects of creep feed on individual piglets. Previous work has indicated there may be a benefit of providing creep feed, but only in those piglets that actually consume the creep feed.

Another factor to consider is while there may be no benefit on overall pig growth; we should consider other benefits not determined in this study. For example, more rapid onset of feeding and adjustment to intake of plant-based diets vs. milk may help to improve gut development and health, improving long-term robustness of the pig. Future work should attempt to determine the non-growth impact of provision of creep feed.

There also appears to be no preference for either simple or complex creep diets, with no difference in intake between the creep types in those litters receiving both diets (Figure 1). It is important to note that this is based on a small number of litters (N=12). However, based on overall creep intake in all litters, we did not see an impact of feeding creep feed.

Table 1. Pre-weaning performance 1,2

	Treatment					
Item	Control	SC	CC	SCC	SEM	P-value
n	14	14	12	12	12	
Birth weight, kg	1.52a	1.53a	1.45ab	1.43b	0.030	0.041
d 14 weight, kg	4.69	4.74	4.57	4.60	0.138	NS
Wean weight, kg	8.17	8.59	8.19	8.25	0.209	0.081
Average daily gain, kg/d						
d 0-7	0.180	0.187	0.181	0.187	0.010	NS
d 7-14	0.273	0.273	0.262	0.265	0.007	NS
d 0-14	0.219	0.223	0.216	0.220	0.008	NS
d 14-21	0.278	0.291	0.294	0.283	0.112	NS
d 21-28	0.221b	0.259a	0.223b	0.239ab	0.015	0.002
d 14-28	0.274	0.290	0.276	0.284	0.008	0.062
Creep consumed, g/pig/d						
d 14-21	-	6.02	4.14	6.68	1.41	NS
d 21-28	-	13.85	13.83	20.62	4.37	NS
d 14-28	-	9.88	9.04	13.62	2.55	NS

BW, body weight; CC, complex creep provided; Control, no creep feed provided; NS, not significant; SC, simple creep provided; SCC, both simple and complex creep provided; SEM, standard error of the mean, 1Values are least square means. Creep feed was offered to piglets from d 14 after birth until weaning

IMPLICATIONS

Overall, there appears to be little benefit of providing creep feed in general or of providing complex, expensive creep feed. Specifically:

- Piglets showed no preference for simple or complex creep feed.
- There was little impact of provision of creep feed on pre-weaning performance, with increased ADG only in the final week pre-weaning.
- While there was a slight benefit to providing creep feed on growth performance in the first week post-weaning, there was no benefit at the end of the nursery.

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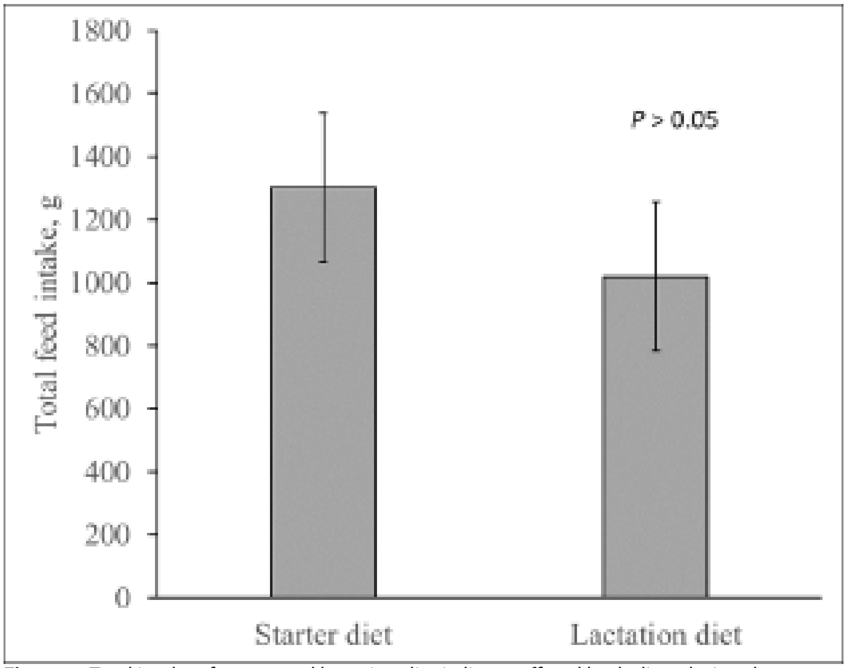

Figure 1. Total intake of starter and lactation diet in litters offered both diets during the pre-weaning period. Values are least square means +/- SEM.

Table 3. Nursery Performance

	Treatment					
Item	**Control**	**SC**	**CC**	**SCC**	**SEM**	**P-value**
n	14	16	15	14		
Initial BW, kg	8.14	8.19	8.13	8.08	0.283	NS
Final BW, kg	21.60	21.91	21.99	22.15	0.445	NS
Average daily gain, kg/d						
d 0-7	0.163b	0.181ab	0.209a	0.192a	0.015	< 0.05
d 7-14	0.446	0.454	0.452	0.453	0.047	NS
d 14-21	0.584	0.588	0.604	0.621	0.040	NS
d 21-28	0.723	0.731	0.721	0.742	0.020	NS
d 0-28	0.480	0.496	0.489	0.502	0.124	NS
Average daily feed intake, kg/d						
d 0-7	0.163	0.172	0.185	0.176	0.010	NS
d 7-14	0.468	0.466	0.488	0.490	0.022	NS
d 14-21	0.732	0.725	0.744	0.772	0.034	NS
d 21-28	0.970	0.971	0.978	1.002	0.034	NS
d 0-28	0.584	0.583	0.599	0.610	0.017	NS
Gain:Feed, kg/kg						
d 0-7	0.985	1.048	1.099	1.087	0.046	NS
d 7-14	0.935	0.971	0.919	0.931	0.078	NS
d 14-21	0.803	0.802	0.817	0.797	0.035	NS
d 21-28	0.754	0.751	0.742	0.731	0.018	NS
d 0-28	0.867	0.823	0.852	0.825	0.031	NS

BW, body weight; CC, complex creep provided; Control, no creep feed provided; NS, not significant; SC, simple creep provided; SCC, both simple and complex creep provided; SEM, standard error of the mean, 1Values are least square means.

Examining the effectiveness of providing functional amino acids to enhance pig robustness

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Dan Columbus

SUMMARY

Pigs are continuously exposed to microbial pathogens and immune-stimulatory antigens that have a negative impact on productivity. Pigs exposed to immune challenge, without exhibiting any clinical signs of disease, show reduced appetite and growth and less efficient use of nutrients compared to healthy pigs. While current dietary strategies include use of in-feed antibiotics, increasing consumer pressure and regulatory restrictions have led to the complete elimination of antibiotic use for growth promotion and pressure to reduce overall antibiotic usage in animal agriculture. Therefore, novel nutritional strategies designed to minimize costs must maintain or promote animal health and resistance to infectious challenge. Results from this project show diet supplemented with key functional amino acids (FAA), specifically threonine (Thr), methionine (Met), and tryptophan (Trp), above estimated requirements for growth improves growth performance and immune status of pigs, regardless of dietary protein content.

INTRODUCTION

Stress experienced in the post-weaning period contributes to increased susceptibility of newly weaned pigs to a number of enteric pathogens, including enterotoxigenic E. coli (ETEC) and Salmonella. ETEC is the cause of approximately 25% of post-weaning diarrhea in pigs and a major contributor to the post-weaning growth lag through further damage to the intestinal epithelium and activation of inflammatory responses.

Stimulation of the immune system alters protein and amino acid (AA) metabolism and utilization, with AA redirected from growth towards supporting the immune response. The increase in AA requirement to support the immune response is met through a reduction in protein synthesis and increase in protein catabolism in the muscle, which represents the largest pool of AA. However, the AA profile of muscle protein differs significantly from that of protein involved in the immune response, resulting in an AA imbalance and a disproportionate use of some AA during immune challenges leading to an obligatory increase in whole-body AA catabolism and reduction in body protein growth.

Alterations to the gut epithelium induced by dietary protein and/or fibre content may lead to increased susceptibility to pathogens and immune stimulation. In the post weaning pig, feeding diets high in crude protein content has been associated with increased incidence of diarrhea following ETEC challenge; however, the performance responses of piglets fed such diets have been variable.

An increased understanding of the interaction of nutrition and the pig's immune response will be a key component in efforts to reduce feed costs and antibiotic use while improving animal robustness and profitability of the swine industry.

EXPERIMENTAL PROCEDURES

Effect of functional amino acids and dietary protein content on performance and health of Salmonella-challenged weaned pigs

A total of 64 mixed-sex weanling pigs 13.9 □ 0.82 kg initial body weight (BW) were randomly assigned to one of eight treatments in a 2 × 2 × 2 factorial arrangement in a randomized complete block design (n=8 pigs/treatment) for 14 d, including a 7 d adaptation period (no inoculation) and 7 d post-inoculation period. Dietary treatments consisted of a low [LP; 16% crude protein (CP)] or high (HP; 20% CP) protein diet with either a basal (AA-) or functional (AA+) AA profile. Diets were corn- wheat- barley- soybean meal-based and were formulated using the reported nutrient content and analyzed AA content of ingredients to meet or exceed nutrient requirements based on NRC (2012) and AMINODat 5.0 (Evonik, 2016).

High protein (HP) diets were formulated by partly replacing corn in the low protein (LP) diet with soybean meal. The AA- profile met the standardized ileal digestible (SID) AA requirements according to NRC (2012) and the AA+ profile contained Thr, Met, and Trp at 120% of requirements. Pigs were fed ad libitum and had unrestricted access to water. Individual pig BW and feed intake was obtained on d -7, 0, and 7 of the study for calculation of pre- and post-inoculation average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F).

Effect of functional amino acids adaptation time on performance of Salmonella-challenged weaned pigs

A total of 32 mixed-sex weanling pigs 11.6 +/- 0.34 kg initial BW were randomly assigned to one of four treatments in a randomized complete block design (n=8 pigs/treatment) for 21 d, which consisted of a 14-d adaptation period (no inoculation) and 7 d post-inoculation period.

Dietary treatments consisted of a basal (AA-) AA profile fed throughout the experimental period, or a functional (AA+) AA profile fed either post-inoculation (AA+0), for 1 wk pre-inoculation and post-inoculation (AA+1), or throughout the experimental period (AA+2). AA+0 and AA+1 pigs were fed AA- diets for 2 and 1 wk pre-inoculation, respectively. Diets were corn- wheat- barley- soybean meal-based and were formulated using the reported nutrient content and analyzed AA content of ingredients to meet or exceed nutrient requirements according to NRC (2012).

The AA- profile met the standardized ileal digestible (SID) AA requirements according to NRC (2012) and the AA+ profile contained Thr, Met, and Trp at 120% of requirements. Pigs were fed ad libitum and had unrestricted access to water.

RESULTS AND DISCUSSION

Effect of functional amino acids and dietary protein content on performance and health of Salmonella-challenged weaned pigs. Growth performance data for pre- and post-inoculation (Table 1) indicates there was no effect of dietary treatment (P> 0.10). There was no effect of FAA supplementation or CP content on post-inoculation performance of CT pigs (P > 0.10). Both ADG and ADFI were reduced post- inoculation in ST compared to CT pigs (P < 0.05). Salmonella-inoculated pigs fed AA+ diets had greater ADG (P < 0.05) and tended to have increased G:F compared to ST pigs fed AA- diets (P < 0.10). There was no effect of CP content and no significant interactive effect among dietary treatments on post-inoculation growth performance of ST pigs (P > 0.10).

IMPLICATIONS

Results clearly show that diet supplementation with key FAA, specifically Thr, Met, and Trp, above estimated requirements for growth improves growth performance and immune status of pigs, regardless of dietary protein content. Data further suggests the positive effects of these FAA are due to beneficial effects on intestinal health and antioxidant defense systems. Further to this an increased adaptation period will further enhance the effectiveness of functional amino acid supplementation to improve growth performance and attenuate the immune response in Salmonella-challenged weaned pigs. It may, therefore, be beneficial for producers to adjust diets in advance of known times of stress of disease challenge to get the maximum benefit from these amino acids, however, provision of supplemental amino acids at the time of disease challenge is still beneficial.

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Table 1. Pre- and post-inoculation growth performance of control (CT) and Salmonella-inoculated (ST) pigs fed diets differing in functional amino acid and protein content[1]

	CT				ST				
	Low protein		High protein		Low protein		High protein		
	AA-	AA+	AA-	AA+	AA-	AA+	AA-	AA+	SEM
Initial BW (d -7), kg	13.96	13.93	13.93	13.94	13.98	13.96	13.95	13.90	0.31
Inoculation BW (d 0), kg	16.92	17.33	17.08	17.18	17.14	17.15	17.18	17.22	0.97
Final BW (d 7), kg	20.92av	21.36ax	21.18av	21.24ax	19.22bv	20.36bx	19.27bv	20.40bx	1.31
Pre-inoculation period (day -7-0)									
Average daily gain, kg	0.423	0.486	0.450	0.463	0.451	0.456	0.461	0.474	0.05
Average daily feed intake, kg	0.580	0.602	0.563	0.636	0.614	0.646	0.632	0.648	0.05
Gain:Feed, kg/kg	0.72	0.80	0.79	0.72	0.73	0.70	0.73	0.73	0.10
Post-inoculation period (day 0-7)									
Average daily gain, kg	0.571a	0.576a	0.586a	0.580a	0.297bv	0.459bx	0.300bv	0.456bx	0.06
Average daily feed intake, kg	0.880a	0.906a	0.916a	0.936a	0.738b	0.673b	0.744b	0.686b	0.08
Gain:Feed, kg/kg	0.64	0.63	0.63	0.62	0.40y	0.68z	0.40y	0.66z	0.13

AA-, Basal amino acid profile; AA+, Functional amino acid profile (Thr, Met, and Trp at 120% of requirements for growth); BW, body weight; SEM, Standard error of the mean.
1 Values are least squares means; n=8 pigs/treatment. Main or interactive effects not presented were not statistically significant for any of the parameters measured.
a,b Means within a row with different superscripts differ (CT vs ST) (P < 0.05).
v,x Means within a row with different superscripts differ (AA- vs AA+) (P < 0.05).
y,z Means within a row with different superscripts tend to differ (AA- vs AA+) (P < 0.10).

Table 2. Pre- and post-inoculation growth performance of Salmonella-inoculated pigs fed diets with a basal amino acid profile (AA-) fed throughout the experimental period or a supplemented amino acid profile for 0 (AA+0), 1 (AA+1) or 2 (AA+2) weeks pre -inoculation, and post-inoculation1

Item	AA-	AA+0	AA+1	AA+2	SEM	P-value
Pre-inoculation wk 1 BW (d -14), kg	11.74	11.63	11.63	11.73	0.346	0.98
Pre-inoculation wk 2 BW (d -7), kg	13.77	13.37	13.65	13.70	0.465	0.87
Inoculation BW (d 0), kg	16.85	16.34	16.74	17.40	0.701	0.71
Final BW (d 7), kg	18.33	18.62	19.55	20.59	1.093	0.26
Pre-inoculation wk 1 period (day -14 to -7)						
Average daily gain, kg	0.290	0.248	0.289	0.281	0.032	0.79
Average daily feed intake, kg	0.446	0.381	0.405	0.407	0.049	0.75
Gain:Feed, kg/kg	0.65	0.65	0.71	0.69	0.089	0.73
Pre-inoculation wk 2 period (day -7 to 0)						
Average daily gain, kg	0.440	0.424	0.441	0.529	0.061	0.59
Average daily feed intake, kg	0.778	0.750	0.740	0.801	0.042	0.92
Gain:Feed, kg/kg	0.57	0.57	0.60	0.66	0.088	0.49
Post-inoculation period (day 0 to 7)						
Average daily gain, kg	0.211b	0.326ab	0.401ab	0.456a	0.059	0.01
Average daily feed intake, kg	0.720	0.705	0.763	0.727	0.052	0.87
Gain:Feed, kg/kg	0.29b	0.46ab	0.53ab	0.63a	0.099	0.02

AA-, Basal AA profile fed throughout the experimental period. AA+0, Basal AA profile fed pre-inoculation and supplemented AA profile (Thr, Met, and Trp at 20% above basal) fed post-inoculation. AA+1, Basal AA profile fed for 1 wk pre-inoculation and supplemented AA profile fed post-inoculation. AA+2, Supplemented AA profile fed throughout the experimental period. SEM, Standard error of the mean. 1Values are least squares means; n=8 pigs/treatment

Effects of long-distance transport in the health and welfare of early-weaned pigs

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SUMMARY

The Canadian swine industry relies heavily on the transport of weaned pigs. Recently, the maximum acceptable transport time for pigs in Canada has been decreased from 36 to 28 hours. Weaning is a stressful period for pigs and pigs are often transported at the same time that they are weaned. This project examined the effects of long and short transport durations under Canadian commercial conditions on the health and welfare of piglets.

Data from four loads of each duration were collected in summer 2019. The physiological responses of weaned piglets undergoing short duration (<2 h; SD), and long duration (<36 h; LD) transport were compared at three time points: before loading (T0), immediately after transport (T1) and 3 days after arrival at nursery sites (T2).

For each time point, 60 LD and 50 SD piglets were weighed, and lesion and gait scores were recorded. Results indicate that LD piglets lost weight during transport, while SD piglets did not. The SD piglets showed a large increase in cortisol levels, indicating stress, during transport whereas levels in LD piglets were higher at loading and decreased during long transport. Differences in weaning timeline between LD and SD piglets also influenced measures of stress and lesion scores making interpretation difficult. While both the LD and SD piglets showed signs of transport stress, mortality levels were low (0.06%) and did not differ significantly between treatments.

Further analysis of behaviour during transport and in nursery pens is underway and will provide additional insights on the effect of transport on weaner pig health and welfare.

INTRODUCTION

Approximately 120,000 iso-wean pigs are placed in US swine barns each week with weaned pigs being transported across Canada or into the US with travel durations ranging from one to over 36 hours. The maximum acceptable transport time allowable for pigs without feed, water or rest in Canada was recently reduced to 28 hours (Canadian Health of Animals Regulation, C.R.C. 296), brining it inline with U.S. regulations.

During transport, piglets experience numerous stressors, including feed and water deprivation, handling at loading and unloading, extreme temperatures (depending on season), vibrations and noise. In light of concerns over feed and water deprivation, long transport times are often under the most scrutiny. In a country of large geographical area such as Canada, a full understanding of the effects of long transports and ways to mitigate any negative effects is required. Additionally, weaning is a very stressful period for pigs resulting from separation from the sow, diet change, mixing with unfamiliar pigs, and a novel environment. Weaning stress typically results in low feed intake for > 24hrs following weaning.
More information is needed on the effects of long transport, including food and water deprivation, on piglet welfare during and after transport. This information is important to help identify best practices for transport, to provide a basis for transport policy and to set directions for future study and improvement.

EXPERIMENTAL PROCEDURES

Two commercial farms were selected based on transport distance between the sow and nursery barns; long duration transports (LD) were a maximum transport time of 36 hours, whereas short duration transports (SD) were between one and two hours. Each treatment had four replicates.

The LD piglets were transported in a 4-deck potbelly trailer in one of three compartments: the upper-back (C-UB), bottom-front (C-BF), or bottom-middle (belly) (C-B), which represent a range of different environmental conditions. The SD piglets were transported in a flat deck trailer and were loaded onto the main deck, which was comparable in size and stocking density to the C-BF of the LD potbelly trailer.

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Monitoring equipment on the interior and exterior of the LD and SD trailers recorded temperature (T, °C) and relative humidity (RH, %) in five-minute intervals throughout transport. In addition, we collected piglet data at three time points: the morning before loading for transport (T0), immediately after transport (T1) and 78 – 93 h (3 days) after arrival to the nursery barns (T2).

To assess piglet behaviour during transport, time-lapse photography was used to identify pigs postures (standing, lying, sitting). When piglets arrived at their destinations, video recorded observations at arrival and three days later focused on: feeding, drinking, postures, aggression and damaging behaviours.

RESULTS AND DISCUSSION

Effects of long transport durations on weaner pigs

Transport temperature

Average values for interior environmental conditions (T, RH, and THI) were different between transport lengths. Interior compartment conditions for SD groups were on average, warmer and more humid than for LD groups.

LD compartment loggers, measured temperatures under 24°C for 46.5% of total transport time, falling below the recognized thermoneutral zone for this age group (National Farm Animal Care Council, 2014). This proportion was smaller for the SD group, with temperatures below 24°C for 36.0% of the time (Table 1).

Hot compartment temperatures were less frequent, with LD and SD loads recording 6.8% and 0% of time, respectively, at temperatures greater than 30°C. The most extreme interior temperatures (both cold and hot) were recorded during the LD transports (6.08°C and 42.59°C, both in the C-UB compartment).

The temperature results suggest that pigs undergoing LD transport experienced a greater thermoregulatory challenge than those in SD transports.

Piglet weights

After adjusting for sex and pre-transport weight, piglets from the LD group weighed significantly less than piglets from the SD group at T1 (immediately after transport) but no difference was found at T2, 72 h following arrival ((Table 2). Relative to their average weights at T0, SD piglets gained 0.1% of their body weight between T0 and T1, while LD piglets lost 6.2%. There were no significant differences in body weights among the LD compartments after transport.

Mortality and injury assessments

Of the total number of pigs loaded, no piglets died in SD transports (0/2,034) and 7 piglets died during LD transports (7/11,434 = 0.06%); however, due to the low frequency of these events no association was found between transport duration and odds of death during transport.

IMPLICATIONS

Effects of long transport durations on weaner pigs

SD piglets appear to have had a greater stress response compared to LD, possibly related to SD piglets' exposure to multiple stressors (weaning, loading and transport) with limited time to recover. The LD piglets were weaned up to 6 days prior to transport and may have habituated to conditions during transport. Significant differences existed between treatments regarding weight change, hydration, stress, physical strain, and injury after transport. Average trailer temperatures where within pigs' thermal comfort zone throughout the course of this project (summer months). Additional research, across seasons, where thermal conditions are much colder and more likely to pose a greater thermoregulatory challenge is needed.

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Table 1. **Results of average exterior and compartment temperature (T; °C), relative humidity (RH; %) and temperature-humidity index (THI)a value comparisons between duration groups**

		SD				LD				
Location	Variable	N	Mean	Min	Max	N	Mean	Min	Max	P-Value b
Exterior	T	164	22.28	19.09	25.63	4028	18.77	6.60	36.09	<0.0001
	RH	164	70.73	49.69	97.42	4028	68.30	24.45	100.61	0.0265
	THI	163	69.85	64.95	75.68	4028	63.71	44.58	80.84	<0.0001
Interior	T	164	24.29	29.61	27.12	12093	22.84	6.08	41.59	<0.0001
	RH	164	62.72	47.22	82.67	12093	55.49	18.64	92.16	<0.0001
	THI	164	72.06	66.92	76.44	12093	68.79	44.71	88.09	<0.0001

[a] Calculated using the equation: THI = (1.8 * T + 32) - [(0.55 - 0.0055 * RH) * (1.8 * T - 26)]. bMean values were compared using a two-sample t-test with Satterthwaite P-values reported due to unequal variances between duration groups.

Table 2. Least squares means and standard errors (SE)1 of piglet weights (kg) at each study timepoint.[2]

Fixed Effects	**F Value**	**Pr > F**
Sex	4.95	0.027
Pre-transport weight	3456.63	<0.0001
Time	334.77	<0.0001
Duration	16.58	0.007
Duration*Time	23.62	<0.0001
Least Squares Means[1]	**Estimate**	**SE**
	Sex	
Male	6.14	0.034
Female	6.21	0.034
	Duration	
Long	6.05	0.042
Short	6.30	0.043
	Time	
Arrival	5.90	0.034
72hrs post-arrival	6.45	0.034
	Duration*Time	
Long: arrival	5.70	0.047
Short: arrival	6.10	0.049
Long: 72hrs	6.40	0.047
Short: 72hrs	6.50	0.049

1 Results of the mixed multivariable linear regression model with random and fixed effects. 2N=440, 435 weights analyzed at the arrival timepoint due to sampling error in the 4th short duration replicate.

Infrared technologies for identification of market pigs at risk during transport

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SUMMARY

Digital infrared thermography (DT) is a non-invasive imaging technique that could be a valuable instrument for producers and packaging plants to identify compromised and diseased animals for isolation and treatment, as well as to implement management practices to reduce the prevalence of pale, soft and exudative (PSE) pork. The decreasing cost of infrared technology makes it a potential for automated real-time data collection. This study evaluated a simple 'consumer grade' digital thermography (DT) camera for measuring stress in market weight pigs; comparing DT values collected on-farm with those collected at an abattoir after transport; and determining if DT values collected at the abattoir are predictive of physiological measures of stress and meat quality characteristics. The results indicate that infrared technology is able to measure temperature changes due to stress in pigs. Temperature measures collected on the farm following weighing and tagging were predictive of pig's response to transport, and measures collected in the abattoir after transport were predictive of physiological measures of stress and meat quality.

INTRODUCTION

According to the Code of Practice for the Care and Handling of Pigs, producers cannot transport unfit pigs. Compromised animals with obvious injury or disease are easy to detect with visual examination. However, sick (febrile) pigs or those affected by stress are more difficult to identify during visual assessment at loading. Digital infrared thermography (DT) is a non- invasive imaging technique that involves recording superficial thermal emission patterns from the pig. Temperature measurements using DT is a promising tool to identify stressed or sick animals in real time with potential benefits for producers and packers.

This project had multiple research objectives. First, two models of DT cameras (research and consumer grade) were used to evaluate whether an inexpensive DT camera (with limited pixel resolution) was as effective for identifying of sick or stressed animals as a more expensive model with higher resolution capabilities.

A second research objective was to identify which area of the pig is more reliable for surface temperature measurement for identifying stressed or morbid pigs. Two body regions were compared, with DT images obtained of the pigs' eyes (ocular region) and body (dorsal region), to determine changes in pigs' temperature over time.

Pork quality can also be affected by stress, with pale soft and exudative (PSE) meat being a significant problem. Because of its association with acute stress, PSE meat is also an indicator of poor welfare, however, there is still no simple, non-invasive, and reliable way to assess acute stress before slaughter. DT may be a useful tool to identify pigs experiencing stress and thus manage and improve pig welfare and pork quality.

EXPERIMENTAL PROCEDURES

Evaluation of research grade and consumer grade digital infrared cameras for assessment of temperature changes in market pigs following handling

A research grade (RG) camera (FLIR A325sc, resolution: 320x240 pixels, FLIR Systems) was compared to a consumer grade (CG) camera (FLIR C3, resolution: 80x60 pixels, FLIR Systems) on 168 finisher pigs near market weight. Eighteen pens of 4-5 pigs were randomly assigned to two treatments, where half of the pens (84 pigs) acted as the Control group (no handling treatment) while the remaining pens received a mild handling stressor consisting of moving groups of two or three pigs down the hallway and back to the home pen (a distance of approx. 100m). Baseline DT images were obtained on the pig's whole body and eye area using both the RG and CG cameras. Three images taken in rapid succession using each camera of both the body and eye region to ensured precise measurement.

Treatment pigs were moved 50 m down a hallway (total distance of 100 meters) in groups of two or three (two groups per pen), then returning to their home pen where ocular and dorsal surface temperature measurements were taken (using both cameras within five minutes of completing the handling stressor). Control pigs remained in their home pen throughout the trial.

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Relationship between thermographic images collected on-farm and following transport

Infrared data collection

DT images of two body areas (ocular and body regions: three images for each per pig) were obtained on all selected pigs in their home pen after selection, weighing and tagging (T1: three days prior to transport) and again on the day before transport (T2) with minimal handling using a CG. The purpose of collecting DT images at two time points was to compare data collected on calm pigs with data collected after a handling stressor, and determine which is better for predicting stress at later time points.

Table 1. Descriptive statistics for infrared ocular and body temperature measures recorded on market pigs at three time points*

Variable	N	Mean Temperature (°C)	Std Dev	Min.	Max.
Ocular T1	120	37.95	2.96	34.10	49.97
Body T1	120	37.29	3.12	33.87	50.13
Ocular T2	120	35.36	1.00	32.43	37.13
Body T2	120	34.69	1.21	30.30	36.83
Ocular T3	120	36.51	1.03	33.93	38.77
Body T3	120	35.90	1.32	32.00	38.70

*Time 1 (T1): After tagging and weighing, three days before transport. Time 2 (T2): In group pens, one day before transport. Time 3 (T3): In lairage pens 10 to 45 min after transport.

Transport

Weekly batches of selected pigs (20 to 25 pigs/week) were shipped approximately 225km to a commercial packing plant using a commercial livestock trailer. On arrival at the packing plant, the fitness of test animals was assessed visually during unloading and in lairage pens, in addition the time taken to unload the trailer (start and end) as well as any handling problems were recorded. Once pigs entered the lairage pen, DT measurements were repeated on all pigs (T3), as previously described.

Can infrared body temperatures pre-mortem predict meat quality in pigs?

Carcass and meat quality measurements

Carcasses of test animals were identified using individual tattoo numbers and placed on a separate rail in the cooler. Carcasses were split, eviscerated and chilled according to standard commercial practices.

Measurements:

- Muscle pH was evaluated on carcasses in the cooler at 1 and 3 h post mortem at the 10th rib of the longissimus dorsi (LD) muscle using a probe pH meter.
- The pH24 was measured in the loin (LD) muscle at 24 hours post-mortem.
- Meat colour was determined in LD muscle at 24 h post-mortem using a chromameter (Minolta Chromameter, CR 300) according to the reflectance coordinates (CIE L*, a*, b*) after exposing the muscle surface to 15 minutes blooming time at 4°C.
- Three cylindrical muscle cores were taken by a cork borer (25 mm diameter) in each slice and weighed. After weighing, the cores were placed into plastic drip loss containers in sample racks and stored at 4°C. Forty-eight hours after sampling, the samples were removed from their containers, carefully dabbed and weighed.

RESULTS AND DISCUSSION

Evaluation of research grade and consumer grade digital infrared cameras for the assessment of body and ocular temperature changes in market pigs following handling

Effect of camera model and region of interest

Both the research grade (RG) and consumer grade (CG) cameras recorded significantly higher temperatures in the ocular region of pigs after a handling stressor; indicating that both cameras were sensitive enough to identify changes in body temperature due to a mild handling stressor. Temperature of the body region was also significantly higher in treatment pigs following handling, compared to baseline temperatures. However, a significant change in temperature was also found in control animals using the research grade camera, indicating that other factors such as ambient temperature may have affected pigs' body temperature.

Relationship between thermographic images on-farm and after transport

The objective of Experiment 2 was to determine if body temperatures measured on-farm using DT are predictive of body temperatures recorded after transport. Body and ocular DT measures were recorded at two time points on the farm, once (T1) shortly after pigs were stressed by weighing (movement out of the pen and through a weigh scale), ear tagging and slap tattooing, and again two days later (T2) where pigs were disturbed as little as possible. Interestingly, there were significant correlations between T1 measures and DT measures collected after transport, but no significant correlations were found between T2 temperatures and those collected after transport.

Average ocular temperatures were higher than body temperatures at all time points, and overall, the temperature results were highest at T1 and lowest at T2. The T1 measures were recorded immediately after weighing, ear tagging and tattooing the pigs, indicating these handling procedures resulted in higher average temperatures. Temperature measures at T1 also showed a wider range and SD (Table 1). The T2 infrared recordings were collected on pigs in their home pen (with minimal disturbance) on the day before transport, and resulted in lower average temperatures and SD values. Temperatures recorded at T3 fell between T1 and T2 results, suggesting that the stress levels following transport were lower than after on-farm handling (T1).

Can infrared temperatures pre-mortem predict meat quality in pigs?

Numerous significant relationships were identified between DT measures after transport, physiological measures of stress and meat quality characteristics. Of particular note were the relationships between DT temperatures and blood cortisol, b* (meat yellowness), pH and WB shear force (tenderness). Increasing ocular and body temperatures corresponded with higher cortisol levels in blood, lower meat pH at 3 h post-mortem, increased yellow colour and tougher meat. In general, these factors are all associated with PSE pork, although meat lightness (L*) was not affected by pig temperatures in this study.

IMPLICATIONS

Results from this project indicate that an inexpensive 'consumer grade' DT camera is suitable for recording temperature measures in pigs. The consumer grade camera gave similar results to a more expensive research grade camera when used to compare body temperatures between non-stressed pigs and pigs that received a mild handling stressor.

On farms, infrared technology could be used to determine if pigs are stressed during handling or following procedures such as mixing, so that management can be improved, and compromised animals identified. It could also be used to identify sick (febrile) animals in a disease outbreak allowing rapid diagnosis and treatment.

Associations between meat quality and pig temperatures were statistically significant but not strong enough to accurately predict meat quality problems. However, the small sample size and favorable conditions (lack of high ambient temperatures) in this study limited the results, and further investigation is warranted.

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