PRAIRIE SWINE CENTRE

# 2007

# Annual Research Report

PRAIRIE SWINE CENTRE

## MISSION STATEMENT

*"To provide a Centre of Excellence in Research, Technology Transfer, and Graduate Education, all directed at efficient sustainable pork production in Canada."*

# Table of Contents

# 2007 Report Highlights

*Survival Strategies, Making Every Penny Count*

A biological treatment approach developed for the containment of hydrogen sulphide has shown to effectively reduce hydrogen sulphide emissions from swine manure...***page 13***

Substantial energy savings are possible, as energy cost varied from $3.00 to $12.00 per hog marketed on farrow-to-finish operations...***page 15***

Nanoparticle technology is successful in reducing ammonia concentrations up to 86%...***page 17***

Aggression levels are reduced in group sow systems where sows are maintained in similar groups from gestation to gestation when compared to other re-grouping strategies ...***page 18***

While difficult groups of pigs were encountered when loading pigs housed in small groups and large groups of pigs, smaller groups tended to take 50% longer to load when compared to large groups...***page 20***

Flaxseed meal can be effectively fed up to 15% without adversely impacting performance...***page 22***

Inclusion of phytase into flaxseed meal diets can increase phosphorus digestibility up to 40%...***page 24***

While high-oil oat groats present one more feed opportunity in nursery diets, they do not present any advantage over wheat diets...***page 30***

Digestible energy content of peas is higher in finishing pigs than in weaned pigs...***page 32***

The inclusion of Micro-Aid® in the diet of gestating sows for 30 days pre-farrowing resulted in an additional 1 pig per litter...***page 34***

Nursery diets containing 2ppm DON will decrease feed intake close to 10% when fed for a three week period...***page 36***

Reducing crude protein by 4% in finishing diets does not adversely impact performance when diets are formulated to be equivalent in true ideal amino acid digestibility and Net Energy...***page 38***

Birth weight had no impact on the cracass quality or physical properties of overall eating quality...***page 42***

# Chairman's Report

## *Finding Solutions in Challenging Times*

**ERIC PETERS**, Chairman of the Board

As I enter my 5th and final year as a member of the Board of Prairie Swine Centre I am astounded by the progress that has been made at the Centre under some very difficult market circumstances. The Centre has suffered from losses as has every other Canadian pork producer during the past year and prospects for the immediate future show only marginal improvement for most of the coming year. The long-term prospects for pork consumption remain unchanged with growth in most parts of the world as pork enjoys the position of the world's most popular meat protein, and so we know that Canada will play a part in that future.

Investment in research continues because research is not a short-term investment. Today we are benefiting from research conducted over the past 15 years at the Centre. This work is demonstrating the places where we can find savings in feeding, ingredient selection, housing & handling recommendations, energy management, manure nutrients and even water conservation. Savings of over $25 per pig marketed were presented by Prairie Swine Centre personnel at the fall and winter meetings held across western Canada.

*"As pork producers that it is our contribution through our various research check-off programs that are the real fuel behind the research."*

On a brighter note the Centre was successful in attracting new federal and provincial funding to an initiative to modernize the infrastructure at the original Floral site. The $2 million dollar grant allows the Centre to replace the original 1980 gestation and farrowing barns, combining four small barns into one modern unit. The barn will contribute significantly to the research capability of the Centre and thus its ability to serve our industry, and other authors will be reporting on the research capabilities elsewhere in this report. As a board member and producer what I like most about the idea is that the new structure lowers the operating costs of the Centre significantly. From updated structure to high efficiency heaters and lighting the utility bill will be reduced significantly, staffing will be much more economical with automated feed delivery replacing hand-feeding, and bringing the entire breeding herd under one roof will make animal management much more efficient.

This efficiency will continue to be important in future years as hog margins are expected to remain tight. Traditionally the pork production component of the Centre has been breakeven, covering all costs of operating and some years turning a profit. In combination with producer funding, government funding and private corporate research contracts the Centre built a low-cost research facility at a time when universities were not inclined to invest in modernizing animal facilities. This model, although right for the past 16 years is under stress and new creative ways will be sought for funding the original and practical work done at the Centre. As I stated last year in this report, "we should never lose site as pork producers that it is our contribution through our various research check-off programs that are the real fuel behind the research."

My last remarks I save for Dr. John Patience. As the founder and leader of the Centre from its inception to its present position of prominence in both the fields of academia and the pork industry world-wide, John has provided the type of vision that has been both bold and practical. John has captured a unique opportunity, attracted all the right talent to make it happen and then kept on searching for excellence with additions to the building infrastructure, the base of funding and the breadth of the research work. Through all this he has never lost sight of why Prairie Swine Centre exists, to bring value to its stakeholders! John we all salute you and your accomplishments and wish you all the best in your future endeavours.

# President's Report

## *Innovative Research Addressing Industry Challenges*

**JOHN PATIENCE**, Ph.D. • CEO / President

This will be my last report to the stakeholders of the Prairie Swine Centre. Following 20 years at the Centre, and 27 associated with the province's pork industry, it is time for me to take on new challenges, and hand the reigns over to a new President. As an organization based on change and innovation, new ideas and new perspectives are the fuel to the future. I am sure that given the outstanding staff and students at the Centre, the new President will find it an exciting and invigorating place to work.

*"The Centre's focus on "the bottom line" has allowed us to provide pork producers with a host of ideas for controlling losses during this most difficult of market conditions.."*

The Centre has always, and must always, strive to maintain relevance in a rapidly changing pork industry. One particular challenge is in the operation of the pig research herds. On the one hand, the herd must maintain a high level of productivity, in order to maximize revenues and thus contribute to the financial success of the Centre. Concurrently, it must achieve levels of productivity that reflect those of the commercial pig industry; an irrelevant pig herd leads inevitably to irrelevant research. At the same time, the productivity of the herd is under constant pressure to accommodate the unique needs of research; afterall, a research piggery cannot reject research projects due to the potential for impairment of performance, as it would then be abdicating its basic responsibilities to the pork industry. It is a continuous balancing act demanded of both our research and our production staff, who together ensure the herd "gets the job done." This year, I would like to recognize the barn staff for the outstanding job they do on our behalf.

Advisory Board established 1989. L-R Front: Dr. David Fraser, Dr. John Patience, Dave Price, and Dr. Al Theede. L-R Back: Vic Pouteaux, Dennis Hodgkinson, Garth Larson, Don Lidster, and Dr. Harold Fast

Twenty years ago, the Prairie Swine Centre in its current form was only a dream. Because of the support we have received from pork producers from across western Canada and from the Saskatchewan Ministry of Agriculture and the University of Saskatchewan, the dream has become a reality. This unique partnership has demonstrated what can be done when resources are pooled, common visions are developed and hard work and dedication to success are mobilized. The current upheaval in the pork industry has not swayed the commitment by our stakeholders, and for this we are truly thankful.

However, because a quarter of the revenues of the Centre are derived from the sale of stock, and because the Centre is not eligible for any of the provincial or federal programs currently in place to assist pork producers, the past 6 months have been particularly troubling, and the prospect for next year are not good. Strong action will be required to ensure the financial viability of the Centre during these difficult times. In a sense, we share a common bond with our pork producer stakeholders, because when the industry is struggling with depressed hog prices, so too does the Prairie Swine Centre. In my last two months at the Centre, I will be redoubling my efforts to ensure as strong a financial platform for the future as possible.

The Centre's focus on "the bottom line" through research that addresses ways to increase gross revenues or minimize expenses, has allowed us to provide pork producers with a host of ideas for controlling losses during this most difficult of market conditions. For certain, applying the results of our research cannot allow a pig operation to achieve profitability at this time, but it can ensure losses are minimized. We recently calculated that a hog operation achieving

Executive Management Team 1995: L-R Front: Dr. John Patience, Lee Whittington L-R Back: Dr. Harold Gonyou, Brian Andries, Dr. Yuanhui Zhang

"average" production levels has a cost of production of almost $170 (using 5 year average feed prices), while a leading edge operation has a cost of production of only $120. This illustrates the magnitude of the financial advantage gained by producers achieving a high level of technical success. Clearly, surviving in the current marketplace, which many have called a "perfect storm," requires more than a high level of productivity; however, it certainly is one of the pillars of long-term success in our industry. In fact, true financial success may be achieved at the present time not by seeking maximum performance,

but rather by seeking maximum financial returns. It is not uncommon to see expenditures aimed at maximizing pig performance that actually exceed the potential for increased revenues, such that net financial return is lowered, not increased. In this way, we can see that technical success must be achieved hand-in-hand with a strong focus on finances.

I would like offer a particular and heartfelt thank you directed to the Directors and staff of Sask Pork, who over the years, have provided unerring support, both financial and moral. Both were absolutely critical to the success of the Centre.

Finally as I reflect on the past 21 years I consider myself incredibly to have worked with pork producers, others serving the pork industry and especially the staff and students at the Prairie Swine Centre and PSC Elstow Research Farm. I feel honoured to have served as Director and first President of a truly outstanding organization. The support, encouragement and dedication of everyone involved or associated with the Centre have made us what we are today.

I have made many friends in the pork industry and I hope our paths will cross many times in the future. Friendships can ensure all things, and it's friendships that have helped me to be what I am today.

THANK YOU ALL!

# Technology Transfer Report

*Providing Producers Answers at Their Fingertips*

**LEE WHITTINGTON**, MBA • Manager, Information Services

PorkInsight - the new name for the website-based information source is well into its second year and growing rapidly. New knowledge is added regularly to a database of practical research information now surpassing 4,000 articles. These articles cut straight to providing production and cost reducing solutions. For example there are 9 articles under the Survival Strategies banner, each with checklists and numerous suggestions how to reduce losses during this time of unprecedented market conditions.

With over 4,500 unique visitors each month to the website, plus hundreds of CD versions of the website distributed to barn managers, the opportunity to look for practical solutions inexpensively has never been better.

Of course it's that personal interaction which many people prefer when they are looking for solutions that fit their operation. This personal communication continues to be an active area, with our staff handling over 800 phone enquiries, and making over 40 presentations during the past year.

We had more than 50 farms, companies and institutions visit us in the past year collecting knowledge, and viewing our facilities. These interactions are an essential part of the technology transfer process and also serve to provide that critical feedback to PSC from pork producers, the supplier industry (example, feed manufacturers, genetics suppliers, etc), and other researchers.

## HIGHLIGHTS OF 2007 INCLUDE:

PorkInsight
The Knowledge Network

### Electronic Medium

- Redevelopment of search mechanism of Prairie Swine Centre website, to become searchable by using the popular Google search engine
- Introduction of PorkInsight now with over 4,000 entries on production research information
- biweekly Ezine to 390 subscribers
- Funding secured from Ontario Pork, and coalition of Farm Animal Councils to each contribute to the on-line database project.
- Hire summer student to summarize articles for on-line database. In the past year we added 265 new entries to database we look to repeat this level of activity in 2008.

- Contribution to 'Swine Disease Net", a VIDO Swine Technical Group project which parallels the purpose of PorkInsight but specializes in disease information.
- Enterprise Modeling allows all research to be evaluated on a cost benefit basis for various sizes and types of pork production farms.

### Printed Materials

- Submissions to Better Pork magazine – 6 submissions (Ontario), Western Hog Journal – 7 submissions (Alberta), National Hog Farmer – 6 submissions (US)
- Developed 9 new Strong Concluding Statements of Research Results as per Strategic Plan
- Centred on Swine (4 issues) mailed to 3,400 people
- Annual Report highlighting all the year's research

*"PorkInsight is our on-line information resource with over 4,000 research summaries and reports"*

We hope you find this publication helpful in managing your operation and making better use of the new technology developed at Prairie Swine Centre.

# Operations Manager Report

*New Facilities Provide New Answers*

**BRIAN ANDRIES**, BSA. • Manager, Operations

Construction of a new 300-sow barn to include a gilt development room, breeding and gestation rooms and 5 farrowing rooms for 4-week weaning, started in the fall of 2007 at Prairie Swine Centre Inc. The original facility built in 1979 consisted of 4 separate barns including 2-110 sows units, 1-80 sow unit and a small finisher barn converted to a gilt development facility in 1989. The 2-110 sow barns were connected to the new grow-finish facility in 1992.

In August the farrowing crates from Barn 4, one of the 110-sow barns that was demolished to make room for the new construction, were moved into one grow-finish room and 2 smaller experimental rooms in the grow-finish facility to act as continual flow farrowing during construction. Two other partially slatted grow-finish rooms were set up to house gestating sows at 5 sows per pen. More grower animals were shipped to our contract-finishing site at Osler to accommodate this loss of finisher space at the Floral site.

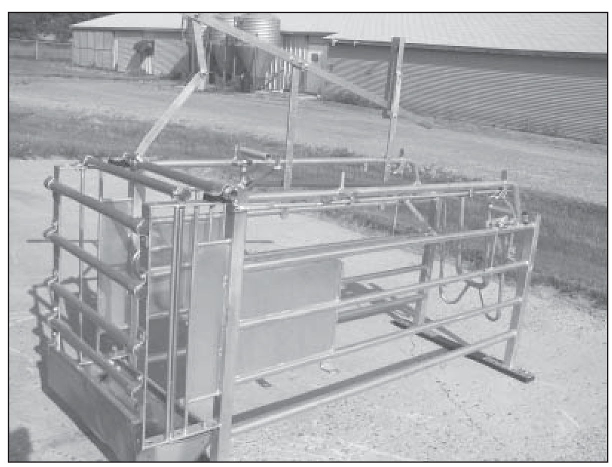
Construction of the new facilities at Prairie Swine Centre (Floral) will provide an opportunity to update aging facilities

*"Farrowing rate is up to 85.8%, numbers born alive above 11.4 and pigs weaned/ female inventory at 25.8."*

It was immediately obvious that housing sows in group pens that had always been housed in gestation stalls would have a detrimental effect on production for this parity, due to mixing. Sow mortality and cull rates increased quite dramatically for the months of September through November. Older parity animals previously housed in stalls were mixed in small groups. These same sows that have now been housed in groups over this last parity are performing very well with few losses and increasing farrowing rates.

See Table 1 indicating production parameters over the last 3 years. Production for the first 6 months of this fiscal year, 2007-2008 has improved only in average farrowing rate with 10.8 pigs born alive per litter and 22.8 weaned sows per year. We are back up to 11.2% per-wean mortality which may be the result of our continual flow farrowing rooms. The last 3 months has seen a substantial improvement in production. Farrowing rate is up to 85.8%, numbers born alive above 11.4 and pigs weaned/female inventory at 25.8.

Research over the last year has decreased slightly as seen in Table 2 as part of a report to the Canadian Council of Animal Care. All research projects are required to be reported and experimental protocols are approved for every trial started at the Centre. All mortalities on every trial, even though most are normal production mortalities, are required to be reported to the Animal Care unit to ensure that all incidence of death for research animals are logged.



Walk-in lock-in stalls will be installed throughout the gestation barn, used in combination of the group-sow housing system

**Table 1.** Production parameters for the fiscal years 2004-2007

| Category | 2004-2005 | 2005-2006 | 2006-2007 |
|---|---|---|---|
| Sows Farrowed, # | 826 | 773 | 770 |
| Farrowing Rate, % | 81.5 | 87.5 | 83.2 |
| Pigs Born Alive/Litter | 10.8 | 11.4 | 11.2 |
| Pre-Weaning Mortality, % | 11.6 | 10.1 | 9.6 |
| Litters Weaned | 835 | 766 | 757 |
| Pigs Weaned | 8,025 | 7,922 | 7,602 |
| Weaned/Female Inventory | 23.8 | 25.1 | 23.4 |

The objective of maintaining good production even during renovation and construction was a challenge, along with a change in 2/3's of my production staff September 2007, made this fall interesting. Good training and self motivated staff have improved production over the last few months and will carry us through to the opening of the new facility in the spring of 2008.

We lost a very valued employee,and a dear friend, Karen Wurtz to cancer in January of 2008 after a 4 year battle with the disease. She had worked at Prairie Swine Centre Inc since 1981 and will be missed by all of us at the Centre. Karen trained all new production staff and was involved with a number of research projects at Prairie Swine Centre over the years. She enjoyed her work and ensured all aspects of production were carried out with the highest care. She always put her heart and sole into her job and was a great example to all who worked with her. She pulled no punches and always said what was on her mind. She will be sadly missed.

**Table 2.** Research Usage between 2000-2007

| Category | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| # Experiments Started | 42 | 36 | 28 | 50 | 41 | 24 | 31 | 27 |
| # Sows on Trial | 0 | 605 | 674 | 1,344 | 1,351 | 1,223 | 870 | 749 |
| # Nursery Pigs on Trial | 2,432 | 7,360 | 2,868 | 7,184 | 3,504 | 1,908 | 2,398 | 1,976 |
| # Grow-Finish Pigs on Trial | 2,001 | 4,780 | 4,648 | 4,660 | 3,588 | 4,757 | 4,716 | 4,233 |
| Total Pigs on Trial | 4,433 | 12,745 | 8,190 | 13,188 | 8,443 | 7,888 | 7,984 | 6,958 |

# Pork Interpretive Gallery Report

*Discovering the "Real Dirt on Farming"*

Jessica Podhordeski[1] and Lee Whittington[2]

### Playing Host to International Visitors

2007 was a transitional year at the Pork Interpretive Gallery (P.I.G.). International and local visitors continued to tour the P.I.G. keeping our tour guides busy. In January we hosted first year students from the College of Agriculture and Bioresources. Their tour has now become an annual field trip and is considered by staff and students to be very beneficial! Other groups welcomed to the gallery include the Rotary Club "Adventure and Technology" program, visiting students from across the province, and international visitors from China, Mongolia, Japan and Australia. The P.I.G. was also one of the destinations for Sask Pork's "Real Dirt on Farming" tour program and the Agriculture in the Classroom Teachers Roadshow.

### Providing Training to Pork Producers

In addition to these tours, numerous pork production groups from across Canada visit the facility for training and exposure to alternative management systems, as well as to discuss the latest research developed at Prairie Swine Centre. This year a one-day training session was held at PSC Elstow Research Farm for colony pig bosses and assistants through a joint project of the University of Saskatchewan, Meyers Norris Penny and Prairie Swine Centre. In total the course included 9 days of training, one of which was held at the farm which included a review of heat detection, breeding supervision, ultrasound use, and animal handling techniques.

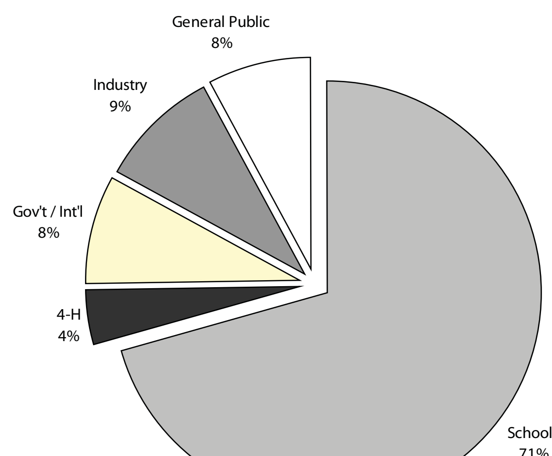
*"Two new displays were installed - Air Quality and Careers in Animal Agriculture"*

### Answering Industry Questions with New Information

This year two new displays were installed at the gallery. The "Air Quality" display focuses on the importance of protecting yourself from small dust particles and hydrogen sulphide gas. Visitors learn that the health and safety of our barn workers is important to our industry, as is the care of our animals.


The second display is titled "Careers in Animal Agriculture" which spans 55 feet and features 17 careers in the pork industry with an interactive puzzle. A focal point of the display is a large hand-painted mural depicting several careers within the industry. Development of the display would not have been possible without financial and in-kind assistance of several industry members and sponsors. Thank you to Canadian Adaptation and Rural Development Saskatchewan (CARDS), Sask Tel, Big Sky Farms Inc., DNL Farms and Cudworth Pork Investors Group for your contributions in developing this educational display.

**Table 1.** PIG visitor profile for 2007




[1] Sask Pork Development Board
[2] Prairie Swine Centre

# Construction of New Sow Facilities

## *Expanded Research to Answer Timely Questions*

Lee Whittington and Brian Andries


Barn 7 in early demolition, previously used for gilt development

On January 25, 2007 Smithfield Foods, and shortly thereafter (January 31, 2007) Maple Leaf Foods announced that the farms they own would be changing their sow management systems from conventional stalls to loose housing over the next 10 years (by 2017). As was indicated in the Smithfield announcement "Our decision acknowledges that extensive research into sow housing has concluded both gestation stalls and group pens provide for well-being of pregnant sows and work equally well from a production standpoint. There is no scientific consensus on which system is superior, and we do not endorse one management system over another."

Some of this research referred to above took place at Prairie Swine Centre, and involved developing management strategies for the electronic sow feeding option. Construction of the PSC Elstow Research Farm in 2000 enabled both stall and ESF systems to be operated within the same herd. The work conducted in this facility demonstrated conclusively that equal performance can be obtained from these very different systems provided: 1) sows are not mixed sooner than 30 days post-breeding (post-implantation of embryos), and 2) that animals re-grouped in subsequent gestations exhibit less aggression than mixing animals from different groups. Additionally conclusions could be made that pre-implant sows when mixed were more aggressive than post-implant sows, entered the feeder earlier in the day, and avoided sleeping on the slats. Young sows experienced more scratching, entered the feeder later, and slept on slats more than older sows.


Students and staff from Prairie Swine Centre tour the construction site to learn how barns are built.

*"There are at least 72 different combinations of gestation management systems and most of these can be researched in the new barn design"*

Although the ESF system is preferred by many pork producers considering loose housing options, it is not the only alternative system available, we would estimate that considering the key variables of feeding system, flooring type, with/without bedding and time of mixing (pre-implant/post-implant/weaning) there are in fact at least 72 different combinations of management systems available for gestating sows. Considering the variety of systems, and the relative young age of many Canadian swine buildings it is widely anticipated that there is no one system that will emerge. Thus the new facility will incorporate a flexible design allowing research on a variety of gestation systems including: traditional stalls, free access stalls, cafeteria and simple floor feeding. The new barn is designed to improve efficiency and reduce costs of labour, heating and maintenance.


Construction crews are busy installing walk-in, lock-in stalls in the gestation room

# Research Objectives

*Information is the 'Value' We Provide*

**Objective #1**
To increase net income through the development of feeding programs which emphasize economic efficiency and final product quality.

**Objective #2**
To maximize the economic value gained from feeding locally available ingredients and ingredient fractions by characterizing and modifying their nutritional and functional characteristics.

**Objective #3**
To increase net income by developing housing systems that optimize pig performance considering both construction and operating costs.

**Objective #4**
To ensure that the animal care and welfare interests of pigs, producers and the marketplace are met in a productive and profitable manner through the development of acceptable housing and management systems and practices.

**Objective #5**
To improve indoor air quality through the development of economical and practical techniques ensuring the health and safety of barn workers and animals.

**Objective #6**
To reduce odour and gas emissions or improve nutrient and water management by developing in-barn operating systems and management procedures that ensure the long-term environmental sustainability and acceptability of pork production.

# Application of a Biological Treatment Approach to Control Gaseous Emissions from Swine Operations

B.Z. Predicala, M. Nemati and C. Laguë


## SUMMARY

This study demonstrated that adaptation of measures developed in another industry with similar environmental concerns (i.e., oil industry) could lead to successful control of gas emissions generated from swine operations. Use of metabolic inhibitors such as nitrite and molybdate when added to swine manure slurry significantly decreased the level of hydrogen sulphide ($H_2S$). Room-scale tests will be conducted to evaluate the impact of the treatment process on overall gaseous and odour emissions from swine production rooms.


## INTRODUCTION

Swine barn workers may be exposed to potentially hazardous levels of gases, especially $H_2S$, generated during in-barn manure handling tasks. A biological treatment method developed in the oilfields was evaluated for possible adoption to address similar concerns in the swine industry. This treatment process relied on two different mechanisms which are utilized simultaneously. First, the activity of microbial species which are responsible for generation of undesirable gases and odour precursor compounds in the manure are diminished using a balanced mixture of specific inhibitors, namely nitrite ($NO_2$) and molybdate (Mo). The second mechanism involved stimulation of the catalytic activity of sulphide-oxidizing bacteria that are either indigenous in the raw swine manure or those which are isolated and enriched from the manure in the laboratory and subsequently added to raw swine manure as a treatment.

## RESULTS AND DISCUSSION

Laboratory test results showed that addition of $NO_2$ at gradually increasing concentrations led to corresponding incremental reduction in $H_2S$ levels over the first few days after application of the treatment, then the residual effect of the treatment was diminished over time (Figure 1). Addition of molybdate (Mo) even at the lowest concentration tested (0.25 millimole Mo) led to a sharp decrease in concentration of $H_2S$ from an initial value of about 1450 ppm (Figure 2). Similar to the trends observed for $NO_2$, the residual effect on $H_2S$ levels was dependent on the quantity of Mo added. However, at high Mo concentrations, the resulting levels of $H_2S$ remained low over the duration of the tests (>40 days). Simultaneous addition of $NO_2$ and Mo initially led to a sharp decrease in concentration of $H_2S$ in the headspace gas (Figure 3). With combined application of nitrite and molybdate at higher amounts, a low $H_2S$ concentration in the range of 200 to 300 ppm was maintained over a period of 45 days. It must be noted that the test conditions were designed intentionally to create high levels of $H_2S$, thus, the treatment can be deemed effective if it was able to reduce these extremely high values and maintain low $H_2S$ levels.

*"Lab-scale studies have been successful in significantly reducing Hydrogen Sulphide levels, with technologies adopted from other industries."*

The combination of treatments using metabolic inhibitors that reduced the concentration of $H_2S$ in the headspace gas of the small serum bottles to less than 20 ppm $H_2S$ were assessed in 4-L bottles. All combinations tested were effective and decreased the concentration of $H_2S$ to a range between 0 to 25 ppm $H_2S$, which was maintained throughout the tests.

In initial laboratory-scale tests, a microbial culture of sulphide-oxidizing bacteria was isolated from swine manure and enriched. The use of the isolated culture to treat 30 mL of swine manure slurry in serum bottle tests did not result in a

**Figure 1.** Profiles of $H_2S$ concentration in the headspace gas of the serum bottles containing fresh manure, treated with varying levels of nitrite.

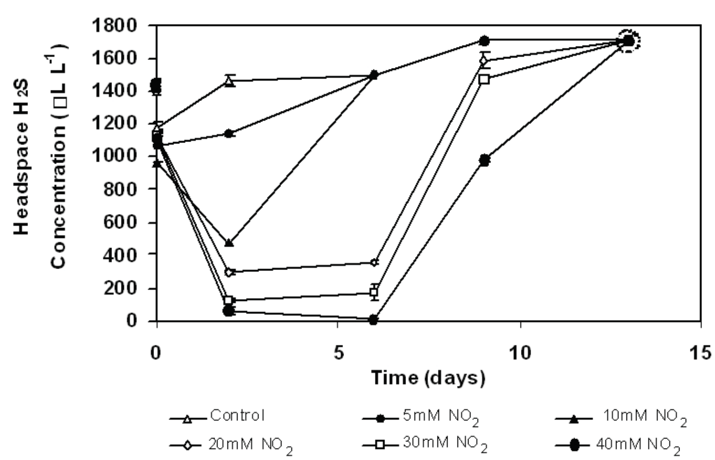


**Figure 2.** Profiles of $H_2S$ concentration in the headspace gas of the serum bottles containing fresh manure, treated with varying levels of molybdate.

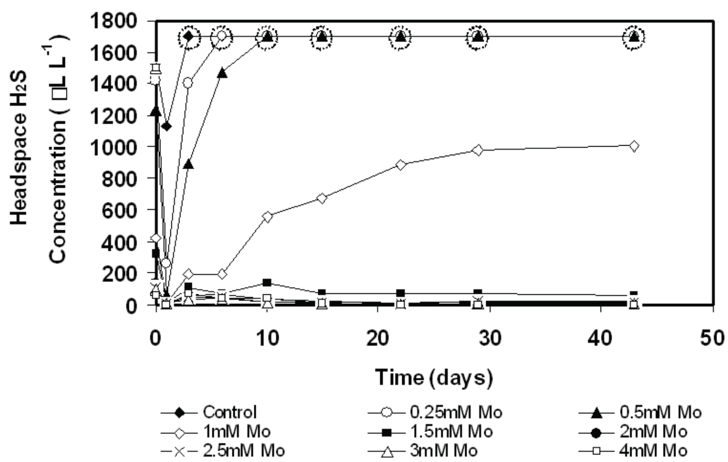
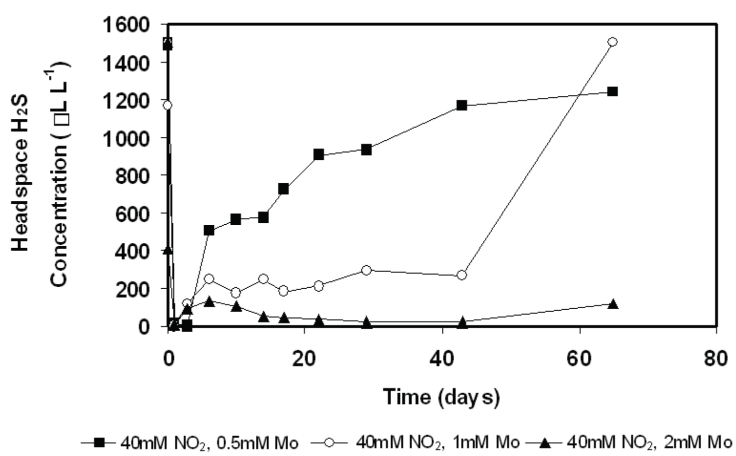



**Figure 3.** Profiles of $H_2S$ concentration in the headspace gas of the serum bottles containing fresh manure, treated with various combinations of nitrite and molybdate added simultaneously.




significant decrease in sulphide concentration, possibly due to a small inoculation size, or the low concentration of biomass in the inoculant liquids. However, these preliminary results indicate the potential for isolation and enrichment of indigenous sulphide-oxidising bacteria present in the manure. A more detailed study is being conducted to verify the possibility of enriching a sulphide-oxidizing culture from the manure and to assess the activity of the enriched culture in reducing the emission of sulphide from manure slurries.

## CONCLUSION

A biological treatment approach developed for the containment of hydrogen sulphide ($H_2S$) in oil reservoirs has been shown to reduce the emission of $H_2S$ from swine manure. Isolation and enrichment of sulphide-oxidizing bacteria from manure is currently underway to examine various factors affecting the microbial culture aspects of this treatment approach. In this on-going study, the treatment method will be evaluated in room-scale tests to fully assess its impact on the overall odour and gaseous emissions. The effect of this treatment on manure nutrient properties will also be examined to determine the possible environmental impact of subsequent land application of the treated manure. This information will form the basis of practical guidelines for pork producers seeking new cost-effective ways to reduce $H_2S$ in the barn.

## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food. Project funding provided by the Alberta Livestock Industry Development Fund (ALIDF), Saskatchewan Agriculture Development Fund (ADF), and the Alberta Agriculture and Food Council.

# Benchmarking Energy Costs in Swine Barns

E.C. Navia, B.Z. Predicala, D.L. Whittington and J.F. Patience


## SUMMARY

To assess current energy consumption patterns in swine operations, a survey followed by energy audits were conducted in different types of swine barns in Saskatchewan. Benchmark information showed high variability in the use of energy even among the same type of barns, indicating wide opportunities to improve energy use practices. The next step would be to use computer simulation to evaluate different energy saving measures and to quantify the reduction in energy costs that can be achieved from implementation of these strategies.


## INTRODUCTION

Swine production involves energy intensive tasks. With increasing energy prices and concern with greenhouse gas emissions from energy generation, reducing energy use is imperative to reduce overall cost of production in swine operations while contributing to mitigation of greenhouse gas emissions in the process. The goals of the current phases of this study are to gather benchmark information on current energy usage in swine barns, to conduct energy audits to document energy use practices in various types of swine barns, and to evaluate different applicable energy-saving measures using computer simulation.

*"Substantial energy savings are possible, as energy cost varied from $3.00 to $12.00 per hog marketed in farrow-to-finish operations studied."*

## RESULTS AND DISCUSSION

Twenty-eight (28) different swine facilities participated in the energy survey conducted in February 2007. From each barn, information on barn energy use and pig production numbers over the past 3 years were obtained. As shown in Table 1, the average utility cost (electricity and gas) per animal marketed ranged from $6.80 for farrow-to-finish barns to $0.60 for nursery barns. Interestingly, some barns were using twice as much energy as the average for all barns; energy usage between the barns which used the least amount of energy per animal and the most intensive energy users differed by as much as four times.

Over-ventilating a room by just 10% in the winter at current energy prices can cost producers an additional $3.00/hog marketed.

Based on the results of the survey, four barns were selected on which an energy audit and detailed energy use monitoring were conducted. Two of the barns were among the highest energy users (per animal) and the other two were among those which used the least energy per animal. Results of energy audits conducted during summer months showed that the farrowing rooms had the highest level of electrical power consumed per pig (kWh/head) as shown in Table 2. The choice of strategies adopted for creep heating contributed to the wide range of energy used between farrowing rooms in different barns. Barn C used heat lamps only, thus resulting to high electrical energy consumption. Other barns used a combination of heat lamps and heat pads that resulted to a relatively lower electrical energy consumption compared to Barn C. Gestation rooms had the second highest energy usage. Heat generated by the sows combined with high outdoor temperature required almost continuous operation of all fan stages to maintain the required room set-point temperature and keep the sows comfortable.

**Table 1.** Energy costs per animal for different types of barns

| | | $/100 kg sold | | $/animal marketed | |
|---|---|---|---|---|---|
| **Type of Barn** | **Size Range** | **Range** | **Average** | **Range** | **Average** |
| Farrow-to-Finish | 300 to 1,500 sow | 3.50-12.0 | 6.30 | 3.00-12.00 | 6.80 |
| Farrow-to-Finish (excluding feedmill) | 300 to 2,000 sow | 6.00-11.50 | 6.30 | 3.80-13.00 | 6.50 |
| Grower-Finisher | 10,000 to 40,000 feeders | 1.20-2.60 | 1.70 | 1.30-2.10 | 1.70 |
| Nursery | 130,000 to 140,000 feeders | 1.70-2.20 | 2.00 | 0.50-0.70 | 0.60 |
| Farrow-to-Wean | 150 to 1,200 sow | 8.20-17.80 | 12.20 | 0.80-4.30 | 1.90 |

**Table 2.** Daily average of electrical consumption per pig in kWh/head (July-September 2007)

| Type of Barn | Barn A (Farrow-to-Finish) | Barn B (Farrow-to-Finish) | Barn C (Farrow-to-Wean) | Barn D (Grower-Finisher) | Average (kWh/head) |
|---|---|---|---|---|---|
| Farrowing | 3.74 | 2.70 | 4.93 | | 3.79 |
| Nursery | 0.08 | 0.16 | | | 0.12 |
| Grower-Finisher | 0.17 | 0.14 | | 0.096 | 0.14 |
| Gestation | 0.39 | 0.53 | 0.36 | | 0.43 |

## CONCLUSION

Results of the survey and energy audits showed that within each barn type, some barns used significantly higher energy than the overall mean for all barns of the same type while others used substantially less than the mean, indicating that there are significant opportunities for improving energy use practices in some barns to reduce overall energy costs. Production stage, equipment, and practices in different types of rooms in the barn can significantly impact the overall energy consumption. Among the different production stages, farrowing rooms using heat lamps solely for creep heating had the highest electrical energy usage per pig.

Data collected from winter energy monitoring will complete the benchmarking phase of the study. Information from the benchmarking phase will be used to run computer simulations to evaluate various energy conservation strategies and quantify energy savings associated with implementation. Understanding the patterns of how energy is utilized in each barn is valuable in determining energy conservation strategies that would work best for each particular operation. The outcome of this project is expected to help guide pork producers in managing the use of energy in their operations more efficiently, thereby reducing overall energy costs.

## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food. Project funding provided by Advancing Canadian Agriculture and Agri-Food Saskatchewan (ACAAFS). Assistance provided by Zhifang Chen, Emmanuel Canillas and Daisy Asis is acknowledged.

# Use of Nanoparticles to Control Gaseous Emissions from Swine Manure Slurry

B.Z. Predicala and D.A. Asis


## SUMMARY

A series of tests using commercially-available nanoparticles was conducted to evaluate their impact on ammonia ($NH_3$), hydrogen sulphide ($H_2S$), carbon dioxide ($CO_2$), and gas mixture emitted from swine manure slurry. A number of nanoparticles tested reduced $NH_3$ at initial concentration of 50 ppm by 78 to 86%, while a few were able to reduce 25-ppm $H_2S$ to below detection level (<1 ppm).


## INTRODUCTION

Nanoparticles are highly reactive powder materials with unique properties due to its nanoscale dimensions. The goal of this work is to take advantage of advances in nanotechnology to control odour and gaseous emissions from swine operations. Specifically, various types of nanoparticles and deployment techniques for reducing swine barn gaseous contaminants were assessed in laboratory-scale tests.

## RESULTS AND DISCUSSION

Nanoparticles were selected using a set of criteria based on physical and chemical properties, previous use in remediation applications, availability, and cost. Six types of nanoparticles were chosen and obtained from a commercial supplier; these include: magnesium oxide (MgO), magnesium oxide plus (MgO+, a proprietary name for the same material derived using a different process), aluminum oxide ($Al_2O_3$), aluminum oxide plus ($Al_2O_3$+), zinc oxide (ZnO), and titanium dioxide ($TiO_2$).

Figure 1 shows the normalized concentrations of each target gas after being passed through a filter cassette assembly filled with different types of nanoparticles and powder materials. Normalized concentration values equal to 1.0 indicate no effect of the treatment; values close to zero indicate effective removal of target gases. For $NH_3$, the top three materials were $Al_2O_3$, $TiO_2$ and ZnO, which correspond to a reduction of 85.6%, 85.2%, and 78%, respectively, from an initial 50-ppm $NH_3$ concentration. However, the gas filtered with MgO+ showed a possible reaction between the material and the gas analyzer sensor, thus showing a substantial increase in $NH_3$ concentration.

Using MgO, MgO+ and ZnO nanoparticles, $H_2S$ gas at initial concentration of 25 ppm was reduced to levels below detection limit of the $H_2S$ monitor used (<1.0 ppm). On the other hand, $Al_2O_3$ and $TiO_2$, which were effective for $NH_3$, reduced the concentration of $H_2S$ by 57% and 13%, respectively. A decrease in $CO_2$ concentration by 73% and 78% was achieved using MgO and MgO+, respectively.

Commonly available powders (talcum powder and sodium bicarbonate) were also tested and showed results comparable to the least effective nanoparticles. However, when compared with the blank filter assembly, the observed results from talcum powder and sodium bicarbonate (and the least effective nanoparticles) indicate that the reduction in the target gas concentration could be mainly attributed to the filtration effect.

*"Nanoparticle technology has the potential to significantly reduce Ammonia and Hydrogen Sulphide levels."*

## CONCLUSIONS

Nanoparticles were found effective in reducing levels of specific gaseous contaminants emitted from swine manure slurry. Additional tests are being conducted to investigate potential techniques for practical implementation of this technology in commercial swine barns.


## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food. Project funding provided by National Science and Engineering Research Council (NSERC) of Canada and the Saskatchewan Agriculture Development Fund (ADF).

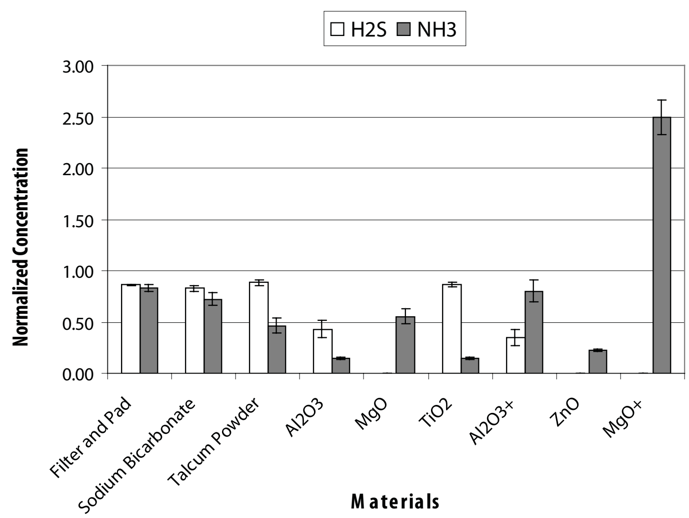




**Figure 1**. Average normalized concentrations of target gases passed through various powder materials. Each value is the average of three replicates and the error bars represent standard error of the mean.

# Comparison of Management Factors Affecting Aggression in Group Housed Sows

H. W. Gonyou and S.M.Hayne


## SUMMARY

This study investigated the aggression and injuries resulting from group formation after breeding. Five social management treatments were imposed with four of them designed to reduce aggression compared to the Control treatment. The results indicate that the Familiar treatment had the most potential to reduce aggression and injuries, where the same social group was maintained as in the previous gestation.


## INTRODUCTION

Group housing of sows during gestation involves some degree of aggression when the groups are formed. Although short-lived, this aggression results in scratches to the animals and, more seriously, may affect farrowing rate. The objectives of this study were to reduce the level of aggression among sows re-grouped within a few days of breeding, using five experimental social treatments.

## EXPERIMENTAL PROCEDURES

Groups of 16 bred sows were used. All animals had previous experience in group housing with an electronic sow feeder. Re-grouping occurred at 11 days post-partum, and subsequent observations occurred in a mixing pen providing approximately 80 $m^2$ (860 $ft^2$)of partially slatted floor.

Unless otherwise noted in treatment specifications, each group consisted of approximately equal numbers of parity 1-2 (Young) and 3-6 (Old) animals, and less than 50% of all social pairs within the group were familiar with each other based on sharing a pen during the previous gestation. The largest group of sows originating from the same previous gestation group were designated as Acquainted, while those from smaller groups were referred to as Unacquainted.

### The treatments included:

1. Control: group formed as above
2. Familiar: sows from the same previous gestation group
3. Dominant: standard group of sows and three socially dominant animals that were large (5th parity or higher), had been housed together for at least 6 weeks, and well acquainted with the mixing pen
4. Protected: standard group of sows but provided with 7 free-access half-stalls to provide protection to their head and shoulders
5. Exposed: standard group of sows except that they had been weaned directly into the mixing pen and kept there for 48 hours before being moved to the breeding stall

Following regrouping, saliva samples and data on aggression and injuries were collected.

## RESULTS AND DISCUSSION

The incidence of aggression and injuries among the five social management treatments are presented in Table 1. The Familiar treatment appears to have the most potential for reducing aggression. The relatively short fights among familiar sows probably represents reinforcement of social position rather than the establishment of a new hierarchy.

*"Having dominant sows within the group had a tendency to reduce aggression and injuries on the first day following regrouping."*

The Dominant treatment, which involved the presence of three older animals from a well-established social order, tended to have fewer aggressive events, particularly on the 1st day of group formation. The concept behind this treatment is that sows would avoid initiating aggression when in the presence of a clearly dominant individual.

The Exposed treatment, in which the sows had spent 48 hrs together after weaning, but before being stalled for breeding, did not reduce the incidence of aggression compared to the Control group except on the first day. However, the level of injuries was reduced. The short period of pre-exposure used in this study may have only accomplished a weak social order that required additional establishment after the subsequent re-grouping.

This study confirmed other reports of the ineffectiveness of protective stalling on the aggression among re-grouped sows.

There were no differences in overall salivary cortisol concentration among the five treatments (Table 1). However, there were differences in cortisol levels on different days, with the lowest concentration prior to re-grouping and the highest concentrations on all the days following regrouping (Table 2).

**Table 1**. Incidence of aggression and injuries among regrouped sows on five social management treatments.

| | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Control | Dominant | Exposed | Protected | Familiar | SEM | P-Value |
| **Fighting (#/6 hrs)** | | | | | | | |
| Overall | 6.4 | 4.3 | 6.9 | 13.9 | 5.7 | 3.16 | 0.33 |
| 1st day | 11.4 | 5.8 | 8.6 | 17.5 | 10.8 | 3.49 | 0.07 |
| 2nd day | 3.9 | 3.7 | 6.3 | 6.5 | 2.9 | 3.41 | 0.07 |
| 3rd day | 3.7 | 3.9 | 5.8 | 17.7 | 3.5 | 3.53 | 0.07 |
| **Fighting (sec/6 hrs)** | | | | | | | |
| Overall | 79 | 48 | 71 | 105 | 21 | 33.38 | 0.55 |
| 1st day | 203 | 88 | 116 | 207 | 45 | 40.30 | 0.17 |
| 2nd day | 17 | 37 | 63 | 55 | 11 | 39.06 | 0.17 |
| 3rd day | 18 | 28 | 32 | 54 | 8 | 41.19 | 0.17 |
| **Injuries (score)** | | | | | | | |
| Day 1-3 | 7.7 | 6.2 | 4.7 | 6.2 | 4.2 | 0.99 | 0.03 |
| 10 days | 4.1 | 5.6 | 3.3 | 3.3 | 2.5 | 3.37 | 0.03 |
| **Cortisol (nmol/L)** | | | | | | | |
| Overall | 5.9 | 7.2 | 5.6 | 4 | 5.8 | 1.02 | 0.26 |

**Table 2**. Incidence of aggression and injuries among regrouped sows on five social management treatments.

| | Day | | | | | | |
|---|---|---|---|---|---|---|---|
| | Pre | 24 hr | 48 hr | 72 hr | 10 days | SEM | P-Value |
| Cortisol (nmol/L) | 3.9 | 5.9 | 6.6 | 5.6 | 6.5 | 0.70 | 0.01 |

## CONCLUSIONS

If sows are maintained in similar groups from gestation to gestation, it is more likely that aggression will be reduced compared to the other re-grouping strategies tested. However, this method would not always be practical. Having dominant sows within the group had a tendency to reduce aggression and injuries on the first day following regrouping. A similar trend was found when sows were exposed to each other before breeding. Providing protection during re-grouping did not have an effect on aggression or injuries.

## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council, Saskatchewan Agriculture and Food and the National Pork Board.

# Handling Stress During Marketing of Pigs from Large Groups

S.M. Hayne, D.L. Whittington and H.W. Gonyou


## SUMMARY

When handled through the same facilities, pigs from large and small groups required similar levels of force during handling. However, pigs from large groups tended to load more quickly. Pigs from the two treatments had similar physiological responses to handling. When given adequate lairage time to recover from handling and transportation, meat quality was similar between group size treatments.


## INTRODUCTION

We have previously shown that pigs from large groups are more socially tolerant than pigs from conventional small groups and will fight less when re-grouped, as happens during marketing. Anecdotal evidence from producers and truckers indicates that pigs from large groups are easier to handle and load. These two factors could combine to result in less marketing stress for pigs from large groups, with a potential to improve meat quality. Indeed, farms using large group auto-sort housing have been reported to have fewer death losses during marketing than conventional farms (Brumsted et al., 2004).

This study was conducted to compare handling attributes, stress responses, and meat quality of pigs from conventional and large group auto sort pens marketed through the same facilities.

## RESULTS AND DISCUSSION

Two hundred forty pigs raised in either conventional small groups (16-18 pigs/pen) or in large groups with auto-sort facilities (approx. 250 pigs/pen) were marketed on 10 days to assess differences in response to handling and meat quality. Pigs were loaded in groups of 4 pigs up a ramp onto a trailer. Transportation to the packing plant was 45 min in length and lairage was approximately 4 hours. Behavioral and physiological measures were taken prior to, during and after the handling and transport process. Standard meat quality assessment was conducted on loins from the animals 24 h after slaughter.

*"Pigs from small groups tended to take approximately 25 seconds longer to load up the ramp than did pigs from large groups."*

Although the time taken to load a group of 4 pigs varied considerably, it took approximately 50% longer to run pigs from small groups up the loading ramp (Table 2, $P < 0.10$). The need for electric prods, as defined in this study, was similar for both treatments. However, the number of shocks applied to a group, although similar statistically, reflected the amount of time needed to load pigs from each treatment.

The only differences observed in heat balance variables (temperatures, skin colour and breathing) were early in the handling of the pigs, with an increase in rectal temperature after removal from the pen, and an increase in ear temperature once on the transport trailer for the pigs from small groups (Table 1, $P < .05$). Cortisol levels, reflective of acute stress, increased approximately 3-fold from in the barn prior to loading, to after unloading at the plant. However, these values did not differ between large and small group treatments.

**Table 1**. Physiological data of pigs from large and small groups during various stages of the marketing process.

| **BARN** | Group Size | | | |
|---|---|---|---|---|
| (prehandling) | Large | Small | SE | P-Value |
| Ear Temp. | 34.0 | 34.5 | 0.33 | 0.18 |
| Rectal Temp. | 39.2 | 39.5 | 0.09 | 0.02 |
| Cortisol | 11.4 | 10.4 | 0.70 | 0.32 |
| Breathing Score | 1.0 | 1.02 | 0.03 | 0.34 |
| Skin Score | 1.01 | 1.11 | 0.08 | 0.21 |
| **TRUCK** | Group Size | | | |
| | Large | Small | SE | P-Value |
| Ear Temp. | 32.2 | 33.8 | 1.19 | 0.01 |
| Rectal Temp. | 40.0 | 40.1 | 0.26 | 0.68 |
| Breathing Score | 1.08 | 1.10 | 0.05 | 0.68 |
| Skin Score | 1.20 | 1.21 | 0.10 | 0.93 |
| **PLANT** | Group Size | | | |
| | Large | Small | SE | P-Value |
| Ear Temp. | 32.7 | 33.5 | 0.66 | 0.10 |
| Rectal Temp. | 39.1 | 39.1 | 0.12 | 0.95 |
| Cortisol | 31.8 | 27.1 | 3.25 | 0.13 |
| Breathing Score | 1.07 | 1.04 | 0.03 | 0.35 |
| Skin Score | 1.38 | 1.33 | 0.08 | 0.64 |

**Table 2**. Assessment of handling of pigs from large and small groups during the loading process.

| | Group Size | | | |
|---|---|---|---|---|
| | Large | Small | SE | P-Value |
| Level of Encouragement | 2.83 | 2.90 | 0.08 | 0.47 |
| Number of Shocks/group | 8.30 | 12.03 | 3.37 | 0.21 |
| Duration of Loading/group | 52.58 | 78.71 | 10.84 | 0.09 |

**Table 3**. Meat quality assessment of pigs from large and small groups

| | Group Size | | | |
|---|---|---|---|---|
| | Large | Small | SE | P-Value |
| pH | 5.75 | 5.71 | 0.02 | 0.12 |
| Texture | 3.36 | 3.25 | 0.08 | 0.29 |
| Colour | 3.43 | 3.24 | 0.08 | 0.08 |
| Marbling | 2.51 | 2.71 | 0.13 | 0.04* |
| L* | 51.8 | 53.4 | 0.91 | 0.02* |
| a* | 2.60 | 2.95 | 0.23 | 0.05* |
| b* | 10.25 | 10.18 | 0.72 | 0.92 |
| Japanese Colour | 3.45 | 3.36 | 0.12 | 0.21 |
| Drip Loss | 9.74 | 9.88 | 0.45 | 0.77 |

Meat quality measures evidenced significant differences between treatments for marbling, and three of the Minolta light variables. Pigs from small groups had a higher degree of marbling and higher light reflectance (L*), but also a redder colour (a*), (Table 3, $P < 0.05$). The trends, although not statistically significant, among other meat quality scores would suggest slightly less response to stress in large group pigs ( see pH, color, and Japanese color).

This study represents a comparison of responses to handling of pigs from large and small groups on the same farm, and through the same loadout and transportation vehicle. As such, confounding that may occur when analysing treatments when farms represent different treatments was avoided. Under these conditions we found only minor differences in handling, although pigs from large groups did tend to load more quickly.

Meat quality effects due to handling stress may have been masked by the 3-4 hour lairage time used in this study. This length of holding is preferred within the industry because it does attenuate problems during marketing, particularly if short transportation times are involved.

## CONCLUSIONS

Pigs from small groups evidenced elevated rectal and ear surface temperatures early in the handling process, but no differences were found after arrival at the packing plant. Difficult groups of pigs were encountered when loading in both treatments, and similar levels of force, generally involving the use of the electric prod, were used. Pigs from small groups tended to take longer to load up the ramp than did pigs from large groups (78.7 vs 52.6 sec/group; $P < 0.10$). Meat quality differences were minor, with pigs from small groups having more marbling. No differences in meat quality scores reflective of differential responses to handling were evident.

## ACKNOWLEDGEMENTS

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork and the Saskatchewan Agricultural Development Fund. Specific program funding was also provided by the (U.S.) National Pork Board project #05-137. Technical support was provided by Sierens Equipment Ltd, Swan Lake, MB.

# Flaxseed Meal in Swine Rations: Growth Performance and Carcass Fatty Acid Profile

L. Eastwood, P.R. Kish, J.F. Patience and P. Leterme


## SUMMARY

Inclusion of up to 15% flaxseed meal (FSM) in the diets of growing and finishing pigs did not have any detrimental effects on overall growth performance, feed intake or feed conversion. Pigs fed diets containing FSM had increased levels of the omega-3 fatty acid α-linolenic acid (ALA) in both their backfat and loins. This may provide producers with an opportunity to sell their pork to specialized markets, and possibly attract a premium price for their product.


## INTRODUCTION

Flaxseed meal is a by-product of the flaxseed crushing industry. There has been a growing interest in the use of flaxseed and its related products such as FSM within the swine industry. Flaxseed is the richest plant-based source of ALA, which has been implicated in having many potential health benefits. The primary goal for use of flaxseed and its by-products within the animal industry is to create a product enriched with omega-3 fatty acids. Although FSM is a defatted product, it may still contain up to 12% oil dependent on the processing method used, and thus may still have potential to create an ALA enriched pork product. The FSM used for this study was produced by a double pressure technique using a screw press. There will be an increased willingness within the pork industry to use FSM in the diets of growing and finishing pigs if its inclusion does not compromise growth performance.

**Table 1**. Dietary composition for each phase, 0 and 15% flaxseed meal inclusion levels

| Phase | 1 (32-60kg) | | 2 (60-85kg) | | 3 (85-115kg) | |
|---|---|---|---|---|---|---|
| FSM in Diet | 0% | 15% | 0% | 15% | 0% | 15% |
| **Composition (g/kg as fed)** | | | | | | |
| Barley | 100 | 100 | 150 | 150 | 300 | 300 |
| Wheat | 596 | 515 | 572 | 498 | 464 | 376 |
| Peas | 150 | 150 | 180 | 180 | 150 | 150 |
| Soybean Meal | 125 | 60 | 75 | - | 60 | - |
| Flaxseed Meal | - | 150 | - | 150 | - | 150 |
| Premix | 26.2 | 21.7 | 21.9 | 19.5 | 20.7 | 18.5 |
| Lysine HCl | 2.2 | 2.8 | 1.0 | 1.7 | 0.2 | 0.5 |
| Canola Oil | | | | | | |
| **Analysis (% as fed)** | | | | | | |
| Crude Protein | 18.2 | 18.1 | 17.3 | 17.7 | 16.1 | 16.3 |
| Ether Extract | 1.9 | 3.4 | 1.9 | 3.8 | 2.1 | 4.2 |
| DE (Mcal/kg) | 3.230 | 3.240 | 3.215 | 3.245 | 3.210 | 3.250 |
| NE (Mcal/kg | 2.320 | 2.320 | 2.320 | 2.340 | 2.350 | 2.350 |
| SID Lysine | 0.83 | 0.85 | 0.67 | 0.66 | 0.54 | 0.54 |

## MATERIALS AND METHODS

This experiment used a total of 200 pigs (100 barrows and 100 gilts) from 32 kg initial weight through to market (115 kg). Pigs were randomly assigned to one of four dietary treatments containing 0, 5, 10 or 15% FSM included at the expense of barley and soybean meal. The diets were formulated in three phases (32-60kg, 60-85kg, 85-115kg); all diets within phase were formulated to approximately equal net energy and SID (standardized ileal digestible) lysine. Dietary formulations are shown in table 1.

Pigs were housed by gender in groups of 5 pigs per pen. All pigs were weighed bi-weekly and feed intakes recorded. This allowed for calculations of average daily gain (ADG), average daily feed intake (ADFI) and feed conversion (F:G). At the time of market, 6 pigs per treatment were randomly selected for carcass fatty acid analysis.

*"Incorporating flaxseed meal up to levels of 15% will not impact the growth performance of animals in the finishing barn"*

## RESULTS AND DISCUSSION

Table 2 shows the growth performance parameters. Average daily gain, average daily feed intake and feed conversion ratio were not statistically affected with the inclusion of up to 15% FSM during any phase. The days to market averaged 84, 84, 87 and 86 for 0, 5, 10 and 15% FSM ($P > 0.05$).

**Figure 1**. The Effect of Dietary FSM Inclusion on Backfat ALA Content

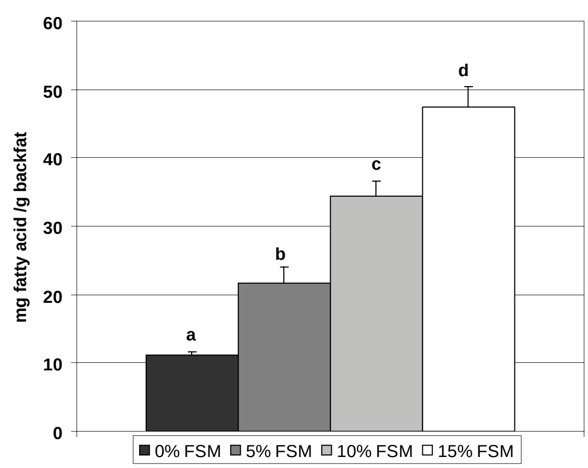
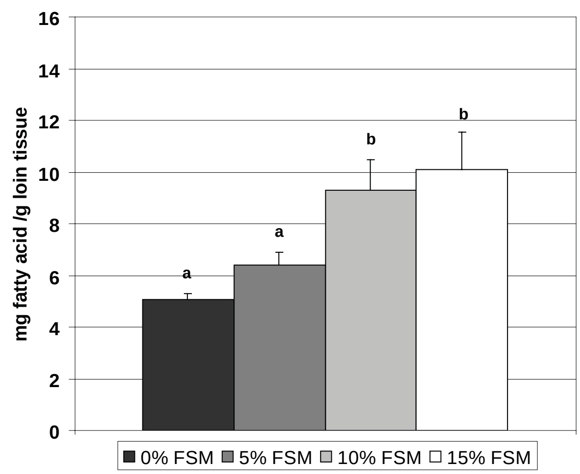


**Table 2**. The Effect of Dietary FSM Inclusion on Pig Performance

| FSM in Diet | 0% | 5% | 10% | 15% | SEM | P-Value |
|---|---|---|---|---|---|---|
| **Average Daily Gain (g/day)** | | | | | | |
| Phase 1 | 900 | 850 | 830 | 870 | 27 | 0.3 |
| Phase 2 | 1,000 | 990 | 1,000 | 950 | 32 | 0.7 |
| Phase 3 | 990 | 1,030 | 990 | 990 | 26 | 0.5 |
| Total | 950 | 940 | 910 | 920 | 21 | 0.6 |
| **Average Daily Feed Intake (g/day)** | | | | | | |
| Phase 1 | 2,070 | 1,990 | 2,010 | 2,060 | 102 | 0.7 |
| Phase 2 | 2,780 | 2,730 | 2,750 | 2,740 | 111 | 0.8 |
| Phase 3 | 3,180 | 3,210 | 3,080 | 3,150 | 99 | 0.4 |
| Total | 2,660 | 2,650 | 2,790 | 2,670 | 66 | 0.4 |
| **Feed:Gain** | | | | | | |
| Phase 1 | 2.29 | 2.38 | 2.50 | 2.32 | 92 | 0.3 |
| Phase 2 | 2.68 | 2.81 | 2.82 | 2.93 | 128 | 0.6 |
| Phase 3 | 3.14 | 3.07 | 3.37 | 3.19 | 143 | 0.5 |
| Total | 2.81 | 2.84 | 3.07 | 2.90 | 95 | 0.2 |

Phase 1 corresponds to pigs 32-60kg, phase 2: 60-85kg, phase 3: 85-115kg. Total refers to the entire experimental period (32-115kg).

**Figure 2**. The Effect of Dietary FSM Inclusion on Loin ALA Content




Inclusion of just 5% FSM into the diets of growing and finishing pigs significantly increased the amount of ALA in backfat (P<0.0001). Figure 1 shows the backfat fatty acid profile, showing a stepwise increase in the amount of ALA as the amount of FSM in the diet increased. The ALA increased from 11 mg/g of backfat up to 48 mg/g of backfat. Inclusion of 10% FSM in the diet significantly increased the amount of ALA in the loins of pigs (P<0.0001), as shown in Figure 2. ALA content of the loin tissue increased from 5 to 10 mg/g of loin tissue as FSM increased from 0 to 15%. No increase in the total fat content of the loin samples was observed (P=0.29), indicating that the fatty acid profile was enriched and not increased.

## CONCLUSION

The inclusion of up to 15% flaxseed meal in grower/finisher rations will have no detrimental effect on pig growth performance and thus will not disrupt pig flow through a barn. FSM is able to improve the omega-3 fatty acid content of pork without increasing total fat. This may allow producers to potentially market a product that can be sold in specialized markets and attract a premium price.

## ACKNOWLEDGEMENTS

Strategic program funding was provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Specific funding for this project was provided by Vandeputte s. a., Belgium.

# Flaxseed Meal in Swine Rations: Chemical Composition, Energy Content and Phosphorus Availability

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## SUMMARY

The chemical composition, digestible energy (DE), net energy (NE) and phosphorus (P) availability of flaxseed meal (FSM) were determined in separate digestibility studies. On a as fed basis, FSM contains 3.52 Mcal DE/kg and 2.445 Mcal NE/kg, has a crude protein content of 31.6% and an ether extract level of 12.2%. The presence of 2570 FTU/kg microbial phytase in diets containing 30% FSM increased the apparent digestibility of P by 40%.

## INTRODUCTION

Flaxseed meal is a by-product of the flax processing industry. There is potential to use FSM as an ingredient for swine; however, prior to including it as a regular ingredient, its full nutritional profile must be determined. This includes determination of the DE and NE values, as well as determining the chemical composition of the meal and the availability of minerals such as phosphorus. FSM contains a high level of total P; however, up to 70% of this is bound by phytic acid and is thus unavailable for absorption by monogastric animals such as pigs. Evaluation of the effects of including microbial phytase into FSM based diets is important when looking at P availability.

*"Inclusion of phytase into flaxseed meal diets can increase phosphorus digestibility up to 40%"*

## MATERIALS AND METHODS

The first objective was to determine the DE of FSM in both sows and growing pigs through digestibility trials, allowing for the estimation of NE. Individually housed pigs were fed diets containing 0 or 30% FSM (6 gestating sows (200-300 kg) and 8 barrows (70 kg) per diet). FSM was included at the expense of the basal diet which consisted of barley, wheat, soybean meal, and premix. Celite was included as an indigestible marker. Pigs were acclimated to their diets prior to a 3 day fecal collection period. The DE value of FSM was calculated by difference after analysis of the diets and the fecal samples. Net energy values were estimated according to the equation $NE = 0.7*DE + 1.61*EE + 0.48*ST - 0.91*CP - 0.87*ADF$ (Noblet et al., 1994) where EE is ether extract, ST is starch, CP is crude protein and ADF is acid detergent fibre.

The second objective was to determine the effects of including exogenous phytase (Phyzyme XP 5000G; EC 3.1.3.26, Danisco Animal Nutrition) on P availability. Barrows with average weights of 45 kg were assigned to one of 5 dietary treatments (8 pigs per treatment), each containing 30% FSM with increasing levels of exogenous phytase (0, 575, 1185, 2400 and 2570 FTU/kg diet). The semi-synthetic basal diet was composed of pea starch (50%), Solka-floc® (4%), casein (6%), dextrose (6%), vitamin/mineral premix (2%), canola oil (2%) and FSM (30%). This ensured that FSM was the only source of P, and celite® was included as an indigestible marker. Faecal samples were collected twice daily for 3 days after a dietary acclimation period. Faecal and diet samples were analyzed for total P content and these values were used to calculate the apparent P digestibility.

## RESULTS AND DISCUSSION

Table 1 shows the chemical composition of FSM and the determined values for both DE and NE in growing pigs and gestating sows. There were no significant differences found between groups of pigs for both the DE and NE values. In general, sows have a greater capacity to obtain energy from fibrous components of ingredients, and thus ingredients usually have a higher energy value for sows than for growing pigs. Since FSM is high in soluble fibre, it is possible that this difference between age groups was reduced. The energy value of FSM will depend highly on the oil content of the by-product, which is in turn, highly dependent on the processing methods used to extract the oil. The FSM used in these experiments was produced by screw press and contained 12% total oil.

In the P availability component of this study, analysis of the control diet showed that FSM itself has an endogenous phytase activity level of 423 FTU/kg. In diets containing 30% FSM, the apparent digestibility of P increased from 21% to 61% ($P<0.0001$) by increasing the level of exogenous phytase from 0 to 2570 FTU/kg diet (Figure 1). This increase in digestibility accounted for an increase of 196% in

**Table 1.** Chemical Composition, DE and NE of FSM

| Chemical Analysis | % D.M. |
|---|---|
| Dry Matter | 8.4 |
| Crude Protein | 31.6 |
| Ether Extract | 12.2 |
| Ash | 5.5 |
| ADF | 12.7 |
| NDF | 22.9 |
| Crude Fibre | 9.3 |
| Starch | 0.0 |
| Total Phosphorus | 0.8 |
| Gross Energy (Mcal/kg) | 4.740 |
| Digestible Energy - Grower (Mcal/kg) | 3.526 |
| Digestible Energy - Sows (Mcal/kg) | 3.517 |
| Net Energy - Grower (Mcal/kg) | 2.448 |
| Net Energy - Sows (Mcal/kg) | 2.441 |

the amount of P absorbed by the pig (0.74 to 2.18g P/kg diet). Inclusion of up to 575 FTU/kg diet accounted for half of the total increase in P digestibility (20%), thus increasing absorption by 88% (0.74 to 1.39g P/kg diet).

## CONCLUSION

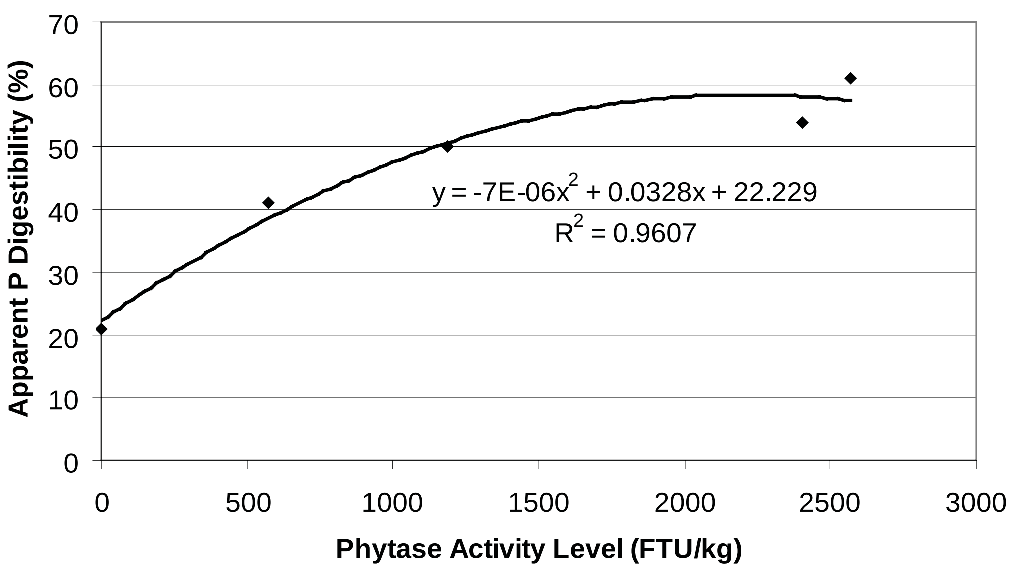
Flaxseed meal contains, on average, 3.520 Mcal DE/kg and 2.445 Mcal NE/kg dry matter. There was no difference between age groups in terms of the DE or NE value of FSM. The crude protein content of FSM is 31.6% DM and the ether extract content is 12.2%. Inclusion of microbial phytase in diets containing 30% FSM significantly improves the apparent digestibility of P which reduces the need to rely on dietary P supplementation. Microbial phytase inclusion at a level of 2,570 FTU/kg diet improved P digestibility by 40%, half of which occurred with just 575 FTU/kg inclusion.

## ACKNOWLEDGEMENTS

Strategic funding was provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Specific funding for this project was provided by Vandeputte s. a., Belgium.  Additional support also provided by Danisco Animal Nutrition.

**Table 2.** DE and NE Levels for Selected Ingredients (Kcal/kg as fed)

| Ingredient | DE | ME |
|---|---|---|
| Flaxseed Meal | 3,526 | 2,448 |
| Canola Meal | 2,885 | 1,610 |
| Soybean Meal | 3,490 | 1,935 |



# Feeding Extruded Flaxseed to Produce Omega-3 Enriched Pork

A.D. Beaulieu, J.F. Patience and I.U. Haq


## SUMMARY

Eighty pigs (initial body weight 31±3 kg) were fed diets supplemented with 5, 10 or 15% extruded flaxseed for either 4, 8 or 12 weeks prior to market. Performance was unaffected by flaxseed inclusion up to 15%. Enrichment of subcutaneous back fat with alpha linolenic acid (ALA, an omega-3 fatty acid) improved with increasing dietary levels and duration of feeding flaxseed. Consistency of ALA enrichment improved with the length of the feeding period.


## INTRODUCTION

Omega-3 fatty acids are well recognized for their human health benefits. The amount of omega-3 fatty acids present in the meat and meat products is low due to extensive use of feed ingredients deficient in omega-3 fatty acids. Flaxseed, a rich plant source of ALA, has recently gained attention as a source of ALA for growing pigs. This experiment was designed to study the impact of feeding diets containing 3 levels of extruded flaxseed for 4, 8 or 12 weeks on the ALA content of subcutaneous fat in pigs and on the consistency of the enrichment. Subcutaneous fat was sampled because it can be obtained easily by biopsy and changes in the FA composition of the backfat are indicative of changes in intra-muscular fat (marbling).

## MATERIALS AND METHODS

Eighty pigs (40 gilts and 40 barrows, initial body weight 31±3 kg) maintained in individual pens were fed diets supplemented with 5%, 10% or 15% extruded flaxseed for either 4, 8 or 12 weeks. Diets were based on wheat, barley and soybean meal and were formulated in three phases to meet the nutrient requirement of the pigs of each weight and age category (Table 1). The three levels of flaxseed (5%, 10% and 15%) were supplied as an extruded mixture of flaxseed and field peas (LinPro, 50:50 extruded mixture of flaxseed and field peas) using methodology determined in a previous experiment to optimize amino acid digestibility. Diets were formulated to contain equivalent proportions of field peas.

**Table 1**. Ingredient composition and calculated nutrient content of experimental diets: Phase 1a [week 1 to 4]

| Ingredients (%) | Control | Flax 5% | Flax 10% | Flax 15% |
|---|---|---|---|---|
| Wheat | 53.43 | 38.95 | 24.48 | 10 |
| Barley | 10 | 21.56 | 33.11 | 44.66 |
| Soybean Meal | 17.00 | 15.27 | 13.53 | 11.80 |
| Field Peas | 15.00 | 10.00 | 5.00 | 0.00 |
| Linpro | 0.00 | 10.00 | 20.00 | 30.00 |
| Tallow | 1.03 | 0.68 | 0.31 | 0.00 |
| Premix[b] | 3.54 | 3.54 | 3.54 | 3.54 |
| **Nutrients** | | | | |
| DE (Mcal/kg) | 3.17 | 3.17 | 3.27 | 3.30 |
| Crude Protein, % | 20.60 | 20.00 | 19.40 | 18.00 |
| AID Lysine, % | 0.94 | 0.95 | 0.95 | 0.96 |
| Calcium, % | 0.82 | 0.82 | 0.82 | 0.87 |
| Total phosphorus, % | 0.61 | 0.56 | 0.57 | 0.61 |

[a] Phase 2 and phase 3 diets were formulated using same ingredients with varying quantities to meet the requirement of pigs of that age and weight.
[b] Consist of dicalcium phosphate, limestone, vitamin mix, mineral mix, salt, lysine, threonine, methionine.

*"Consistency of the enrichment impoved with the length of feeding."*

## RESULTS AND DISCUSSION

Average daily feed intake tended to decrease (P=0.07, Table 2) but ADG was unaffected (P=0.46, Table 2) and thus G:F improved slightly (0.38 to 0.41; P=0.02, Table 2) with increasing flaxseed concentration. Alpha linolenic fatty acid concentrations in subcutaneous fat (as a % of total fatty acids) increased with increasing levels of flaxseed and duration of feeding (P<0.05, Figure 1). The maximum level of ALA (18.58%) was achieved by feeding the diet containing 15% flaxseed for 12 weeks. Moreover, the consistency of enrichment improved with the length of feeding (indicated by % CV, coefficient of variance, Figure 1).

## CONCLUSION

Up to 15% extruded flaxseed can be included in the grower and finisher pig diet without any adverse effect on the performance. Feeding extruded flaxseed to pigs results in ALA enrichment of the subcutaneous fat. The consistency of the enrichment improves with the length of time the flaxseed is included in the diet.

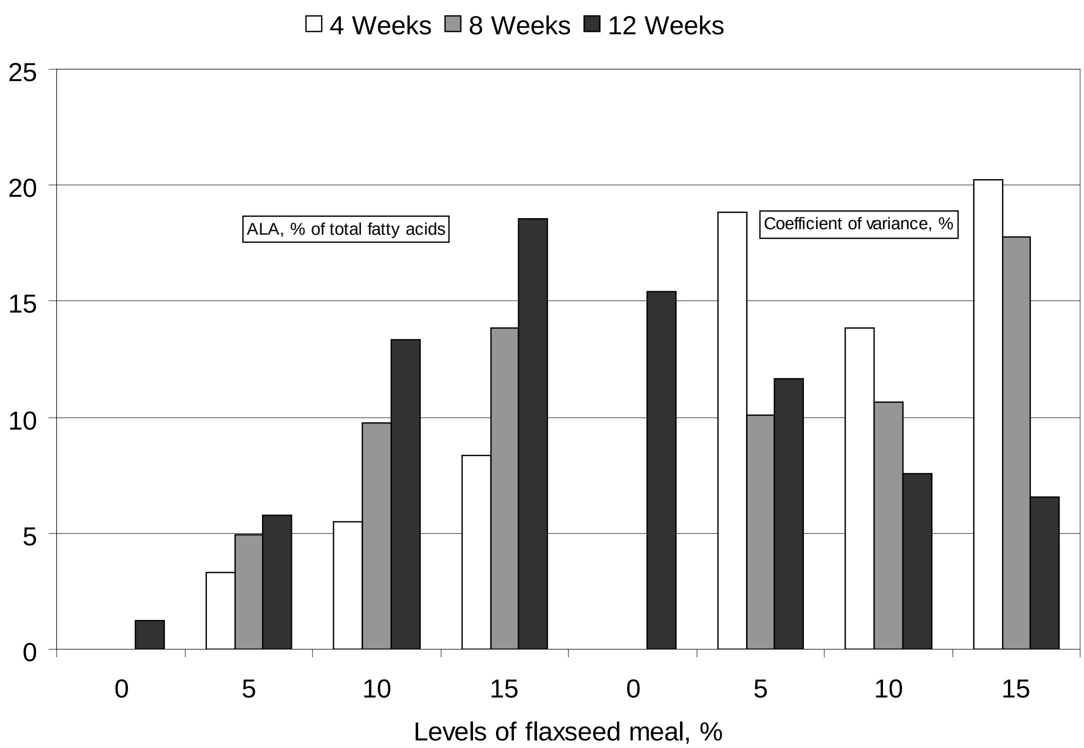

## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and the Saskatchewan Agriculture and Food Development Fund. Project funding was provided by Flax Canada and the Saskatchewan Agriculture Development Fund. We


**Table 2**. Performance of grower-finisher pigs fed different levels of flaxseed meal for different durations.

| | **Flaxseed Meal, %** | | | | |
|---|---|---|---|---|---|
| | 0 | 5 | 10 | 15 | P-Value |
| ADG (kg/day) | 0.969 | 0.998 | 0.979 | 0.998 | 0.459 |
| ADFI (kg/d) | 2.538 | 2.604 | 2.503 | 2.462 | 0.073 |
| G:F (kg/d) | 0.383 | 0.387 | 0.392 | 0.407 | 0.014 |
| | **Weeks** | | | | |
| | 4 | 8 | 12 | P-Value | |
| ADG (kg/day) | 1.003 | 1.001 | 0.954 | 0.008 | |
| ADFI (kg/d) | 2.583 | 2.544 | 2.454 | 0.054 | |
| G:F (kg/d) | 0.391 | 0.395 | 0.391 | 0.765 | |

**Figure 1**. The interactive effect of dietary levels and length of feeding flaxseed meal on the coefficient of variance and ALA profile of subcutaneous fat in pigs



# Hulless Barley as Health-Promoters for the Pig's Gastrointestinal Tract

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## SUMMARY

Different indigestible carbohydrates are used as substrates by health-promoting bacteria such as Lactobacilli in the pig gastrointestinal tract. Some specialty hulless barleys contain high amounts of these indigestible carbohydrates. An experiment aimed at evaluating the possibility to use hulless barleys as a health-promoting factor in swine nutrition. Hulless barleys were better digested than hulled barleys and oats, used as references. Their presence in the gut also generated the production of higher amounts of short-chain fatty acids and led to the disappearance of some pathogenic bacteria strains in the upper part of the gastrointestinal tract. This confirms the potential of specialty hulless barleys as health-promoters in swine nutrition.

## INTRODUCTION

The consumer is increasingly concerned about the impact of nutrition on his health. Namely, he wants pork products devoid of antibiotic residues because he fears that the latter could be responsible for the development of bacteria resistant to antibiotics. For their part, pork producers are aware that the pig gastrointestinal tract must remain healthy in order to maximize the use of the nutrients and to prevent the occurrence of diarrhoea. Different alternatives are currently tested in many laboratories. Among them, "prebiotics" are of particular interest. These plant extracts are used as substrates by health-promoting bacteria (Lactobacilli, Bifidobacteria) and the latter grow at the expense of pathogenic ones (Salmonella, E. coli) in the pig tract. However, their extraction is expensive and their efficacy not obvious, namely because their inclusion rate in the diet is limited. Moreover, diet composition is rarely considered when the efficacy of these compounds is evaluated.

*"Based on the findings from this project, hulless barley shows great potential to positively impact gut health of growing pigs"*

Some cereal non-starch polysaccharides (NSP), such as the β-glucans of barley, have demonstrated prebiotic properties. Whole hulless barleys would thus provide large amounts of fermentable NSP, namely β-glucans and it can thus be hypothesized that the intake of hulless barleys with high β-glucan levels will promote gut health. A series of experiments was carried out at Prairie Swine Centre to evaluate that hypothesis. The effect of different hulless barley varieties was compared to that of hulless barleys or oats.

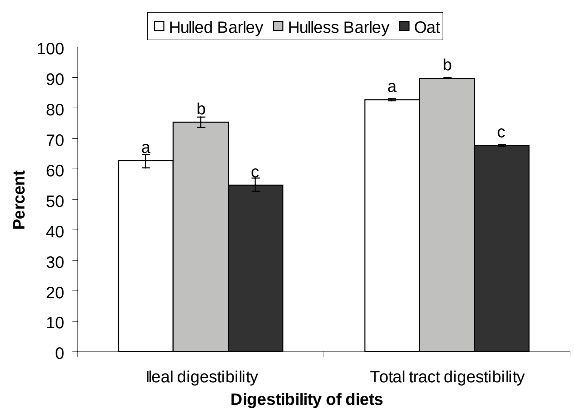
## MATERIALS AND METHODS

A total of 72 weaned pigs (initial weight 13 ± 2 kg) were fed individually a diet composed of 81.5% cereal, 6% whey, 9% soy protein isolate and 3.5% minerals, including an indigestible marker. The cereals were hulled barley (reference), 4 hulless barleys (SB 90300, SB 94893, CDC Fibar and CDC McGwire) with β-glucan contents ranging from 30 to 84 g/kg DM and 2 oat varieties (CDC Sol-Fi and CDC Baler) with β-glucan content 32 and 23 g/kg DM respectively. After an adaptation period of 12 d, faecal samples were collected for 3 d and on day-16, pigs were killed 4h after the last meal and the ileal and colonic contents were collected. Digesta samples were analysed for short-chain fatty acids (SCFA), lactic acid (LA) and ammonia. The DNA of the bacteria present in the samples was also isolated and analysed by molecular techniques in order to determine the composition of the bacterial population.

## RESULTS AND DISCUSSION

The ileal DM digestibility (Figure 1) was higher ($P<0.05$) for diets based on hulless barleys (75% on average), as compared to hulled barleys (62%) and oats (55%). Similar trends were found for total tract digestibility (Figure 1), varying from 90% in hulless barley to 68% in oats. The digestibility value of the hulless barley is comparable to that of wheat or corn.

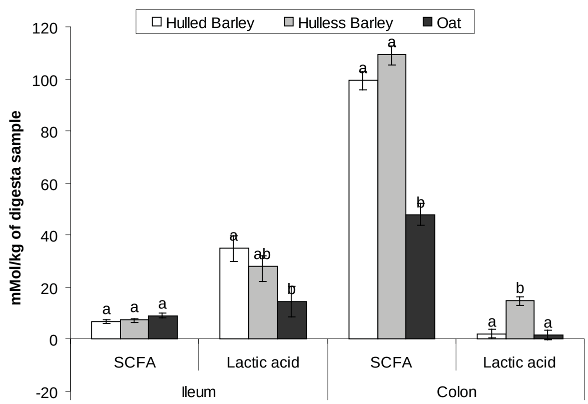
**Figure 1**. Ileal and total tract digestibility of different diets




Variation in digestibility among the different cereals is to be ascribed to the differences in fibre content. Hulless barleys contain higher levels of water-soluble fibres such as β-glucans, but are devoid of hulls. Obviously, the latter negatively affected the digestion of hulled barleys and of oats.

There were mixed results in terms of fermentation end-products (Figure 2). Short-chain fatty acid (SCFA) concentrations did not differ between the hulled and hulless barleys and oats ($P > 0.05$) at the ileum level whereas in the colon, the SCFA concentration was markedly (>50%) lower ($P < 0.05$) in pigs fed oats. The production of lactic acid in the colon was significantly ($P <0.0001$) higher in pigs fed hulless barleys, as compared to hulled barleys and oats. This confirms the fact that the dietary fibre fraction of hulless barleys is more fermentable than the hulls of common barleys and oats. This high fermentability will also enhance the development of bacteria such as Lactobacilli and Bifidobacteria, which are

**Figure 2**. Fermentation end products at the ileum and colon of pigs fed different types of barley and oats




beneficial to gut health (see below).

Ammonia production is the outcome of proteolysis in the intestinal tract and its concentration in the intestinal contents increases when there is not enough carbohydrate substrate available for fermentation by the microbiota. Ammonia is a harmful metabolite, especially for young piglets. Its concentration should thus be minimized, by providing the animal with less indigestible dietary proteins and more fermentable carbohydrates. In this study, ammonia production was significantly higher (P <0.05) in both hulled and hulless barleys, as compared to oats (Table 1).

However, the proportion of the SCFA and ammonia did not differ significantly (P < 0.05) in either group of pigs. Thus, in our current conditions, hulless barleys did not provide any advantage in terms of ammonia concentration in the gut.

The analysis of the microbial population in the intestines of pigs revealed that potentially pathogenic bacteria such as Streptococci and Enterobacteria disappear from the ileum of pigs fed with hulless barleys (Table 2). Although this observation will need confirmation, it is encouraging as it confirms the "prebiotic" potential of β-glucan in swine nutrition. On the contrary, no significant effect of cereal intake was observed on the bacterial population at the colonic level.

## CONCLUSION

The presence of large amounts of soluble β-glucans in some hulless barley varieties does not seem to be a concern for their overall nutritional value in swine since they were better digested than common hulled barleys and oats. The presence of higher amounts of fermentable fibre led to the production of larger amounts

Both oats and hulless barleys have high β-glucan content that could be of interest to improve pig gut health. Hulless barleys are better digested by the pig and have higher fermentation rates in the colon than oats and reduce the presence of harmful bacteria at the ileum level. Thus, hulless barley is of great interest for both swine nutrition and gut health.

## ACKNOWLEDGEMENTS

National Pork Board (project # 06-117) Alberta Barley Commission (project # 60-192) acknowledged for funding this study. The continuing core support of the Prairie Swine Centre received from Sask Pork, Manitoba Pork Council, Alberta Pork and the Saskatchewan Agriculture Development Fund is gratefully acknowledged. Authors also thank to Bryan Grimmelt for his support during laboratory analysis.

**Table 1.** SCFA and Ammonia produced in the colon of pigs fed different diets.

| Grain Type | SCFA* | Ammonia* | SCFA:Ammonia Ratio |
|---|---|---|---|
| Barley | $99.4 \pm 3.43^a$ | $26.5 \pm 2.07^a$ | $4.8 \pm 0.48^a$ |
| Hulless barley | $109.5 \pm 2.97^a$ | $26.8 \pm 1.85^a$ | $4.8 \pm 0.43^a$ |
| Oats | $47.9 \pm 4.20^b$ | $14.5 \pm 2.71^b$ | $3.6 \pm 0.63^b$ |
| P-Value | <0.0001 | 0.0008 | 0.2668 |

* mMol/kg of digesta sample
[a,b] values with different superscript within column are significantly different (P<0.05)

**Table 2.** Mean ± SD copy numbers (log copies/µl DNA) of 16S rRNA gene of microbial groups in Ileum and Colon genomic DNA. Numbers in parentheses indicate the number of colonized piglets

| Type of Barley β-Glucan Content (g/kg diet) | | Barley 24 | Hulless 30 | Hulless 42 | Hulless 65 | Hulless 84 |
|---|---|---|---|---|---|---|
| Lactobacilli | Ileum | $5.3 \pm 1.2^{ab}$ | $5.9 \pm 0.7^{ab}$ | $5.3 \pm 1.2^{ab}$ | $4.9 \pm 1.1^a$ | $4.6 \pm 1.2^a$ |
| | Colon | $7.2 \pm 0.2^a$ | $7.1 \pm 0.5^a$ | $6.9 \pm 0.4^a$ | $7.0 \pm 0.4^a$ | $6.9 \pm 0.5^a$ |
| Strepococci | Ileum | $2.9 \pm 1.2^{ab}$ | $2.4^a$ | $2.5 \pm 0.8^a$ | n.d. | n.d. |
| | Colon | $8.0 \pm 0.6^a$ | $7.7 \pm 0.5^a$ | $7.7 \pm 0.2^a$ | $7.6 \pm 0.3^a$ | $7.6 \pm 0.5^a$ |
| Enterobacteria | Ileum | $3.6 \pm 1.3^a$ | $2.6\ (1)^a$ | $3.0 \pm 1.1^a$ | n.d. | n.d. |
| | Colon | $2.7 \pm 1.1^a$ | $2.5 \pm 0.4^a$ | $2.6 \pm 0.8^a$ | $3.3 \pm 1.0^a$ | $2.7 \pm 0.8^a$ |

a,b Mean values with different superscript within row are significantly different (P <0.05)
n.d. Not detected

# High-Oil Oat Groats for Weaned Pigs

Pascal Leterme, Brian Rossnagel and John F. Patience


## SUMMARY

The interest for weaned pigs of oat groats with high oil content was evaluated. The groats contained 95 g oil, 159 g crude protein and 3.72 Mcal DE/kg DM. Weaned pigs fed for 4 weeks (7 to 22 kg) with diets containing graded levels (0, 15, 30, 45%) of oat groats, incorporated at the expense of wheat (85%) and soybean meal (15%), presented average daily gains similar to those obtained with wheat. In conclusion, high-oil oat groats can replace wheat in diets for weaned pigs.


## INTRODUCTION

After weaning, young pigs need highly palatable, digestible diets, devoid of antinutritional factors and with high digestible energy (DE) content. Feed ingredients corresponding to that description are generally expensive and choice is quite limited.

One alternative could be oat groats (dehulled oats) with high oil content. Oat groats are well consumed and digested by young pigs and have the highest lysine content among all the cereal species used in swine nutrition (Van Barneveld et al., 1998; J. Sci. Food Agric. 76, 277). They can substitute corn or wheat in weaned pig diets without any risk of adverse effect (Christison and Bell, 1980; Can. J. Anim. Sci. 60, 465). The DE content of oat groats is not higher than that of wheat or corn.

Dr B. Rossnagel, from the Crop Development Centre of the University of Sakatchewan, has recently developed new oat varieties with high oil content (> 9 % DM) that could become an interesting feed ingredient for weaned pigs, thanks to their presumed high DE content, if their nutritional advantage is confirmed. The present project aimed at determining the nutritional value of high-oil oat groats (HOOG) and their effect on the growth performances of weaned pigs.

*"While high-oil oat groats can successfully replace wheat in weaned pig diets, they do not present any advantage over wheat."*

## MATERIAL AND METHODS

High-oil oats were grown at the Crop Development Centre and then processed with an oat dehuller. They were ground by means of a hammer mill (9/64"). For the digestibility study, a diet composed of oats (94.6%), a mineral/vitamin premix (5%) and an indigestible marker (chromic oxide, 0.4%) was prepared. After adaptation to the diet, the faeces were collected for 3 days and, 4h after the last meal, the pigs were killed and their ileum content was collected and analysed for dry matter, nitrogen, amino acids and acid-insoluble ash. For the growth study, four diets containing 0, 15, 30 or 45% oat groats, were prepared (Table 1). 192 weaned pigs, divided in groups of 4 pigs (2 barrows, 2 gilts), were fed one of the 4 experimental diets (48 pigs/diet) for 4 weeks (starting 1 week after weaning). They were weighed weekly and feed intake was recorded.

## RESULTS AND DISCUSSION

Chemical composition, ileal AA digestibility and DE content

The composition of the oat groats was as follows: 90% dry matter and, in g/kg DM: 145 g crude protein, 95 g oil, 98 g NDF, 28 g ADF, 64 g ash, 6.3 g lysine, 2.2 g methionine (6.2 g S-containing AA) and 4.9 g threonine. The ileal digestibility of nitrogen, lysine, methionine, cysteine and threonine was, respectively, 80, 77, 85, 81 and 77%. The DE content was 3.71 Mcal/kg DM.

As compared to wheat, HOOG has a higher lysine content (4.3% of the protein vs 3.9% on average for wheat). On the contrary, the DE content is lower than that of wheat (± 3.90 Mcal DE/kg$^{DM}$), despite the higher oil content. This can probably be explained by the low oil digestibility of the HOOG: ± 20% only. The grinding was probably not fine enough to allow the release of the drops of oil entrapped within the cell walls.

Growth study

The results of growth performances obtained by the weaned pigs fed with graded levels of HOOG are detailed in Table 2. No significant effect was observed between treatments for the whole period. Feed intakes and feed conversion ratios were not affected either. Thus, HOOG are well ingested by weaned pigs. It must be pointed out here that HOOG mainly replaced wheat but also some soybean meal (Table 1). It is thus possible to take advantage of the high protein content and the relatively good quality of the oat proteins.

An advantage of HOOG over wheat was expected, since the former contain more oil and were supposed to have a higher energy value. As explained above, this is probably to be ascribed to the low oil digestibility.

**Table 1.** Composition of experimental diets (%/kg)

| Ingredient | 0% | 15% | 30% | 45% |
|---|---|---|---|---|
| Wheat | 63.0 | 50.4 | 37.9 | 25.3 |
| High-oil Oat Groats | 0.0 | 15.0 | 30.0 | 45.0 |
| Soybean Meal | 16.0 | 15.0 | 14.0 | 13.0 |
| Fish meal/Whey | 2.0/3.5 | 2.0/3.5 | 2.0/3.5 | 2.0/3.5 |
| Canola Oil | 4.4 | 3.1 | 1.7 | 0.4 |
| Mineral/Vitamin | 3.3 | 3.3 | 3.3 | 3.3 |
| Lysine 78% | 0.14 | 0.12 | 0.10 | 0.08 |
| Threonine | 0.08 | 0.06 | 0.05 | 0.03 |
| Methionine | 0.09 | 0.06 | 0.03 | |
| DE (Mcal/kg) | 3.61 | 3.63 | 3.65 | 3.67 |
| NE (Mcal/kg) | 2.35 | 2.35 | 2.35 | 2.35 |
| CP (g/kg) | 22.0 | 22.2 | 22.4 | 22.5 |
| SID Lys (g/kg) | 11.1 | 11.1 | 11.1 | 11.1 |
| SID Thr (g/kg) | 6.6 | 6.6 | 6.6 | 6.6 |
| SID SAA (g/kg) | 6.3 | 6.3 | 6.3 | 6.6 |
| SID Trp (g/kg) | 2.1 | 2.1 | 2.1 | 2.2 |
| Ca (g/kg) | 8.0 | 8.0 | 8.0 | 8.0 |
| Av. P (g/kg) | 4.0 | 4.0 | 4.0 | 4.0 |

**Table 2.** Growth performances of weaned pigs fed with graded levels of high-oil oat groats

| % High-Oil Oat Groats | 0% | 15% | 30% | 45% |
|---|---|---|---|---|
| **Week 1** | | | | |
| ADG (g) | 288 | 254 | 295 | 273 |
| ADFI (g) | 359 | 320 | 353 | 329 |
| F:C | 1.26 | 1.29 | 1.20 | 1.20 |
| **Week 2** | | | | |
| ADG (g) | 430 | 431 | 406 | 443 |
| ADFI (g) | 577 | 496 | 529 | 541 |
| F:C | 1.34 | 1.21 | 1.31 | 1.22 |
| **Week 3** | | | | |
| ADG (g) | 606 | 617 | 618 | 715 |
| ADFI (g) | 789 | 780 | 815 | 816 |
| F:C | 1.30 | 1.26 | 1.23 | 1.14 |
| **Week 4** | | | | |
| ADG (g) | 736 | 730 | 715 | 723 |
| ADFI (g) | 1,055 | 1,031 | 1,033 | 1,050 |
| F:C | 1.43 | 1.41 | 1.44 | 1.46 |

## IMPLICATIONS

HOOG did not present any advantage in the diet of weaned pigs, as compared to wheat. The reason could be the low oil digestibility, explained by an inadequate grinding. Further research is required to find the conditions for an optimal use of HOOG in weaned pig nutrition.

## ACKNOWLEDGEMENTS

Strategic funding is provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and food Development Fund.

# Digestible and Net Energy Content of Peas in Weaned Pigs, Growing Pigs and Gestating Sows

P. Leterme, R. Premkumar, P. Kish, and J.F. Patience


## SUMMARY

The digestible energy (DE) content of pea varieties grown in the Prairies in 2005 and 2006 was measured in growing pigs (25 and 50 kg) and in gestating sows (200 kg). Based on the DE content and the chemical composition of the peas, the net energy (NE) content of the latter was also estimated. The DE contents ranged from 3.23 to 4.55 Mcal DE/kg DM in growing pigs and from 3.44 to 4.05 Mcal DE/kg DM in sows. The DE content was, on average, .208 Mcal DE/kg DM higher in 50kg-pigs, as compared to the 20kg ones. No marked difference was observed between growing pigs and sows. The NE content was, on average, 69% that of DE. No correlation could be established between the DE content and the chemical composition of the peas.


## INTRODUCTION

Peas have become an essential feed ingredient in swine production, thanks to their high content in lysine and their good digestible (DE) and net energy (NE) content in pigs. Western Canada is a region of major pea production but the growing conditions are extremely variable from one year to another and one site to another. For example, a survey conducted in 2005 and 2006 showed that the crude protein content can vary from 19 to 29% of the dry matter and from 38 to 51% starch. However, little information is available on the variability in DE or NE content and on the factors that affect it. Namely, it would be interesting to dispose of prediction equations based on the chemical composition so that the actual value of pea samples could be predicted easily. The estimation could be improved even further if distinction could be made between DE measured in pigs and in sows. The latter have a better digestive capacity and the DE contents are usually higher in sows, as compared to growing pigs. The present study aimed at determining the DE and NE content in weaned pigs, growing pigs and gestating sows of different peas grown in Western Canada in 2005 and 2006 and at establishing prediction equations based on their chemical composition.

## MATERIAL AND METHODS

Different pea samples were collected in 2005 and 2006 in farms of Alberta, Saskatchewan and Manitoba and evaluated in weaned pigs (25kg), growing pigs (50kg) and gestating sows (200 kg on average) through digestibility trials. A basal diet, composed of cereals, soybean meal and minerals (including Celite, used as an indigestible marker (acid-soluble ash)), was prepared. Part of the basal diet was then substituted by 30% (growing pigs) or 40% of ground (hammer mill) peas. The animals were fed with the experimental diets (8 pigs and 6 sows/diet) for a period of 2 weeks and faecal samples were collected by grab sampling during the last three days. The DE content of the basal diet and of the pea-based diets was determined and the DE content of the peas alone was then calculated by difference. The NE content was then calculated by means of the following equation (Noblet et al., 1994, J. Anim. Sci. 73, 344):

**NE = 0.7 x DE + 1.6 x Oil + 0.48 x Starch - 0.9 x Crude Protein - 0.87 x ADF**
with the content in nutrients expressed in g/kg DM.

## RESULTS AND DISCUSSION

Table 1 shows the results of chemical composition and of DE and NE content of peas in gestating sows. The crude protein content ranged from 20 to 27% and the starch content from 42 to 51% of the dry matter. The variability in DE and NE content was also high: from 3.44 to 4.05 Mcal DE/kg DM and from 2.34 to 2.82 Mcal NE/kg DM. The variation was thus higher for the components (6 to 8.5%) than for the DE and content (5% on average). Attempts were made to establish a relationship between the chemical composition and the energy content so that the latter could be predicted from the composition. Unfortunately, no significant correlation could be established between any of the chemical components and the energy value. The relationship obtained between ADF (ligno-cellulose) and DE is illustrated in Figure 1 (r = -0.39). ADF is used to predict the energy value of cereals in pigs because it is highly indigestible and thus negatively affects the digestive processes. It is not the case for peas, probably because more than 90% of the pea dietary fibre is fermented in the gastrointestinal tract.

*"Digestible energy content of peas is higher in finisher pigs than weaned pigs."*

The DE and NE contents obtained in weaned and growing pigs are detailed in Table 2. The coefficient of variation was higher than that observed in gestating sows (8 vs 5%). The experiment was here limited to 5 varieties, which allowed us to study the varietal effect. Obviously, differences exist between varieties (Table 3): the average value obtained for 3 samples of the Admiral variety, for example, was 3.38 Mcal DE/kg DM whereas that of 5 samples of Cutlass reaches 3.90 Mcal DE/kg DM.

The DE and NE contents were markedly higher in growing pigs as compared to weaned pigs: the difference was 208 and 138 kcal/kg DM, respectively. The correlation between the results obtained for growing pigs and weaned pigs was high (r =0.78). The difference can be ascribed to a better digestive capacity of the larger pigs, namely their capacity to ferment more dietary fibre, thanks to a larger hindgut and a slower transit of the digesta. This better capacity of large pigs to digest fermentation is now recognized and the French tables of nutrition even propose different values of DE and NE contents for growing pigs and sows. However, in the present case, no difference in DE was observed between growing pigs and sows, possibly because the results were obtained from different samples and different experiments.

## IMPLICATIONS

Peas grown in different conditions present different chemical compositions and DE contents. However, no relationship could be established here between composition and energy content. On the other hand, our results confirm that large pigs better digest peas than weaned pigs and that it makes sense to consider different energy contents for weaned pigs and larger pigs.

## ACKNOWLEDGEMENTS

Strategic funding is provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and food Development Fund. Specific funding for this project was provided by the Saskatchewan Pulse Growers.

**Table 1.** Chemical composition (g/kg DM), DE and NE content of field pea varieties in gestating sows (Mcal/kg DM)

| Variety | Crude Protein | Starch | NDF | ADF | DE | NE |
|---|---|---|---|---|---|---|
| Admiral | 235 | 462 | 154 | 70 | 3.60 | 2.48 |
| Camry | 199 | 485 | 143 | 67 | 3.68 | 2.59 |
| Cooper I | 214 | 503 | 132 | 65 | 3.45 | 2.43 |
| Cooper II | 216 | 473 | 137 | 72 | 3.60 | 2.51 |
| Cutlass | 217 | 458 | 151 | 72 | 3.81 | 2.63 |
| Golden | 264 | 429 | 184 | 101 | 3.83 | 2.57 |
| Midas | 222 | 506 | 182 | 79 | 4.05 | 2.82 |
| Monterro | 232 | 480 | 152 | 72 | 3.60 | 2.49 |
| Mozart | 228 | 472 | 139 | 69 | 3.52 | 2.44 |
| Nitouche | 253 | 490 | 158 | 80 | 3.57 | 2.46 |
| Profi | 237 | 476 | 159 | 63 | 3.88 | 2.69 |
| Sage | 239 | 463 | 205 | 91 | 3.96 | 2.72 |
| Stratus I | 240 | 424 | 178 | 83 | 3.44 | 2.34 |
| Stratus II | 262 | 417 | 162 | 83 | 3.77 | 2.54 |
| Striker | 269 | 435 | 186 | 76 | 3.66 | 2.47 |
| **Mean** | **235** | **465** | **161** | **77** | **3.70** | **2.55** |
| SD | 20 | 28 | 21 | 10 | 0.18 | 0.12 |
| Min. | 199 | 417 | 132 | 63 | 3.44 | 2.34 |
| Max. | 269 | 506 | 205 | 101 | 4.05 | 2.82 |

**Table 2.** DE and NE content (kcal/kg DM) of field pea varities in weaned and growing pigs

| | DE | | NE | |
|---|---|---|---|---|
| **Variety** | **25kg** | **50kg** | **25kg** | **50kg** |
| Admiral | 3.36 | 3.31 | 2.43 | 2.45 |
| Admiral | 3.50 | 3.44 | 2.41 | 2.36 |
| Admiral | 3.26 | 3.18 | 2.44 | 2.28 |
| Bronco | 3.83 | 4.20 | 2.64 | 2.90 |
| Bronco | 3.93 | 4.11 | 2.75 | 2.88 |
| Cultass | 4.23 | 4.55 | 3.08 | 3.08 |
| Cultass | 4.30 | 4.40 | 3.01 | 3.06 |
| Cultass | 3.75 | 3.98 | 2.58 | 2.75 |
| Cultass | 3.63 | 3.61 | 2.52 | 2.51 |
| Cultass | 3.58 | 4.23 | 2.80 | 3.00 |
| Eclipse | 4.04 | 4.21 | 2.50 | 2.92 |
| Eclipse | 3.47 | 4.21 | 2.50 | 2.92 |
| Eclipse | 3.54 | 3.54 | 2.47 | 2.48 |
| Eclipse | 3.81 | 3.77 | 2.67 | 2.64 |
| Eclipse | 3.24 | 3.40 | 2.30 | 2.41 |
| Eclipse | 3.62 | 3.86 | 2.52 | 2.68 |
| Golden | 3.83 | 4.29 | 2.64 | 2.97 |
| Golden | 3.45 | 3.78 | 2.37 | 2.60 |
| Golden | 3.55 | 3.42 | 2.47 | 2.37 |
| Golden | 3.63 | 4.05 | 2.56 | 2.78 |
| Golden | 3.23 | 3.71 | 2.22 | 2.56 |
| **Mean** | **3.71** | **3.92** | **2.57** | **2.71** |
| Min. | 3.23 | 3.18 | 2.22 | 2.28 |
| Max. | 4.30 | 4..55 | 3..08 | 3.08 |

**Table 3.** DE content (kcal/kg DM) of 5 pea varieties in growing pigs

| Variety | n | DE |
|---|---|---|
| Admiral | 3 | 3.41 |
| Eclipse | 6 | 3.83 |
| Golden | 5 | 3.85 |
| Bronco | 5 | 4.16 |
| Cutlass | 5 | 4.15 |

# Impact of Feeding Micro-Aid® to Sows on Litter Performance

J.F. Patience[1],A.D. Beaulieu[1] and M.J. Rincker[2]

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## SUMMARY

The objectives of this experiment were to determine the impact of the plant extract, Micro-Aid®, on the levels of immunoglobulins in sow colostrum and piglet blood and subsequently on the impact on weight gain in piglets when included in the sow's diet at 125 ppm for either 5 or 30 days pre-farrowing.

The inclusion of Micro-Aid® in the sow's diet for 30 days pre-farrowing resulted in one additional piglet born alive per litter, with no effect on average birth weight or on piglet growth from birth until weaning.


## INTRODUCTION

Micro-Aid® is an all-natural product, produced from a plant extract which has been marketed primarily as a mediator of emissions from animal manures. However, it has also been shown to reduce intestinal ammonia production and to alter intestinal microbial populations.

There have also been field reports that the feeding of Micro-Aid® to sows increases the level of immunoglobulins in colostrum. Since field studies in Denmark have suggested that elevated immunoglobulin levels in colostrum enhance piglet growth this project was designed to determine the effect of Micro-Aid® on piglet growth.

## METHODOLOGY

Three dietary treatments were used: control (control), Micro-Aid® added at 125 ppm to the gestation diet and fed for 5 days prior to farrowing (MicroAid5) or Micro-Aid® added at 125 ppm to the gestation diet and fed for 30 days prior to anticipated farrowing date (MicroAid30). The diet, based on wheat, barley peas and soymeal, also contained vitamins, minerals, limestone, salt, dicalcium phosphate, choline chloride and canola oil and was not formulated specifically for this experiment. All diets were fed at 3.5 kg/sow/day, as per normal barn procedure, from day ~85 of gestation onward, irrespective of experimental treatment.

*"The inclusion of 125 ppm of Micro-Aid® in the diet of gestating sows for 30 days pre- farrowing resulted in 1 additional pig per litter. Primarily due to a decrease in stillborns."*

Cross-fostering was restricted to within treatment, but was allowed to occur across parity groups and had to be completed by 48 hours post-partum. Three average piglets from each litter were bled by venipuncture in the mid- to late-afternoon of the day following birth. Cross-fostered piglets were not used for blood collections.

## RESULTS

The sows receiving MicroAid® in their diet for 30 days prior to farrowing had an average of 12.4 live births per litter, which is greater ($P = 0.05$) than the 11.4 born alive in the control treatment (Table 1). A chi-square analysis comparing stillborns and born alive or total born dead, and correcting for the different litter numbers per treatment, confirmed that the numbers born dead differed between treatments. Total born dead (mummies and stillborns) as a percentage of the total born on the control treatment was 8.8%, while on the MicroAid5 and MicroAid30 it was 6.6 and 6.0%, respectively. Average bodyweight was unaffected by treatment ($P > 0.05$). Because of the greater number of piglets born on the MicroAid30 treatment, total litter bodyweight was increased on this treatment ($P < 0.05$). Treatment had no effect on the IgG concentration in the serum from the piglets on day 0 or in the colostrum ($P > 0.05$; table 2).

**Table 1.** Performance response to the inclusion of Micro-Aid® in the diet of sows for 30 or 5 days pre-farrowing.

| Parameter | Control | MicroAid5 | Micro-Aid30 | SEM | Value[a] |
|---|---|---|---|---|---|
| # of litters | 65 | 66 | 65 | | |
| Total pigs born alive[b] | 745 | 751 | 811 | | |
| Stillborns[b] | 65 | 40 | 44 | | |
| Mummies[b] | 7 | 13 | 8 | | |
| **Live pigs/litter, n** | | | | | |
| Day 0 | 11.4 | 11.7 | 12.4 | 0.4 | 0.14 |
| Day 5 | 10.3 | 10.3 | 10.5 | 0.3 | 0.87 |
| Day 12 | 10.1 | 9.8 | 10.1 | 0.3 | 0.76 |
| Weaning[c] | 10.1 | 9.7 | 9.9 | 0.3 | 0.76 |
| **Average BW, kg** | | | | | |
| Day 0 | 1.58 | 1.55 | 1.55 | 0.03 | 0.59 |
| Day 5 | 2.40 | 2.37 | 2.30 | 0.05 | 0.25 |
| Day 12 | 4.38 | 4.21 | 4.13 | 0.08 | 0.07 |
| Weaning[c] | 7.01 | 6.81 | 6.73 | 0.12 | 0.22 |
| Total Litter Wt, kg | 17.66 | 17.73 | 18.88 | 0.53 | 0.19 |
| Sow Wt Change[d], kg | -4.93 | -9.62 | -6.36 | 1.92 | 0.21 |

[a] Shown is the P value for treatment. Model contained the effect of treatment, replicate (n=2) and the treatment by replicate interaction. Litter and pig numbers shown are for the entire experiment and therefore could not be analyzed statistically.
[b] Total born alive, compared to born dead, or total born alive vs stillborns, control vs Micro-aid, 5 and 30, significantly different ($P < 0.01$) by Chi-square analysis.
[c] Day 19.
[d] Throughout lactation

## CONCLUSION

The inclusion of 125 ppm of Micro-Aid® in the diet of gestating sows for 30 days pre- farrowing resulted in 1 additional pig per litter. This result appears to be primarily due to a decrease in stillborns, rather than an effect via IgG concentrations delivered to the pigs prenatally. There was no effect of Micro-Aid® on average birth weight, nor growth of the piglets from birth to weaning.

## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund. The authors acknowledge generous support for this project from Distributors Processing Inc.

**Table 2.** IgG concentration (mg/ml) in colostrum from sows fed Micro-Aid® for 5 or 30 days prefarrowing and serum from piglets born to these sows

| Parameter | Control | MicroAid5 | Micro-Aid30 | SEM | Value[a] |
|---|---|---|---|---|---|
| Piglet serum IgG[a] | 35.8 | 35.9 | 34.2 | 1.05 | 0.45 |
| Colostrum IgG[b] | 745 | 751 | 811 | | |

a Obtained from 3 piglets per litter on day 1 post-farrowing.
b Obtained from the sow before or during farrowing, prior to 3 piglets suckling.

# The Efficacy of Eight Different Feed Additives on Mitigating the Effects of Deoxynivalenol (DON)

A.D. Beaulieu, J.F. Patience and D. Gillis


## SUMMARY

An experiment was conducted with nursery pigs to test the efficacy of 9 different feed additives on mitigating the effects of DON (2 ppm) contaminated feed. Sixty pens of pigs, 4 pig/pen were fed one of 12 diets for the 22 day experiment, beginning 7 days post-weaning. Treatments were a positive control, (non-contaminated corn) a negative control (2 ppm DON) and the negative control supplemented with one of 8 different feed additives, or in two cases a combination of feed additives. Consuming diets containing 2 ppm DON resulted in a 10% depression in feed intake which the feed additives did not reverse.


## INTRODUCTION

Deoxynivalenol (DON) is a trichothecene mycotoxin produced by fusarium moulds contaminating cereal and other grains, including corn and wheat. Gross symptoms of DON ingestion include vomiting and feed refusal and it can have serious if not dramatic effects on the financial viability of a commercial pig farm. There are several feed additives available which are reported to reduce the effect of the mycotoxin. Modes of action include binding the mycotoxin in the gut and preventing absorption, chemically transforming the toxin to decrease its toxicity, or enhancing immune system function. The overall objective of this experiment was to determine the effect of these feed additives on the performance of nursery pigs fed diets contaminated with DON.

> *"Average daily gain and ADFI of pigs on the positive control was superior to those consuming the DON contaminated diet, regardless of the feed additive used"*

## MATERIALS AND METHODS

This experiment used 5 nurseries, with 24 pens per nursery and 4 pigs/pen (initial BW 9.02 ± 0.36 kg). All pigs were fed 0.5 kg of Provision 1, then Provision 2 (FeedRite, Winnipeg, MB), until day 14 and treatment diets from day 15 to 35 post-weaning. Pigs were weighed on day -7 (7 days post-weaning) and on days 0 (14 days post-weaning, initiation of treatment diets) 8, 16, and 24 (nursery exit, day 35 post-weaning).

Treatment diets were formulated to meet or exceed all requirements for pigs of this age (Table 1). Samples of corn contaminated with known amounts of DON.were used for 35 % of the corn in diets 2 to 12 to provide 2 ppm DON in the final diet. This amount was used because a preliminary experiment indicated this level would cause a measurable reduction in feed intake but would not be fatal.

## RESULTS AND DISCUSSION

The concentrations of DON in diet samples are shown in Table 2. Concentrations ranged from "not-detected" in the positive control to 2.61 ppm in diet #11. Effects of treatment on overall performance are shown in Table 2. Pigs on the positive control tended to be heavier than those on the negative control by day 22 (0.50 kg, $P = 0.09$). Overall, pigs consuming diets contaminated with DON had reduced ADG and ADFI compared to those consuming the positive control diet free of DON ($P < 0.001$). Average daily gain and ADFI of pigs on the positive control was superior to those consuming the DON contaminated diet, regardless of the feed additive used. None of the feed additives ameliorated the effects of DON on feed intake or gain. Feed efficiency was unaffected by treatment ($P > 0.05$).

## CONCLUSIONS

Based on our preliminary experiment and a literature search we formulated the diets in this experiment to contain approximately 2 ppm DON. Analyses of the diets indicated a mean concentration in the DON containing diets of 1.99 ppm, however, concentrations ranged from 1.57 to 2.61 ppm. We are unable to determine if the variability shown in the treatment diets is the result of mixing, sampling, or analytical error. We suspect it may be a combination, and this illustrates some of the difficulties when working with mycotoxins. Very small amounts (ppm, parts per million) are toxic and it may exist as "pockets" within a grain which makes accurate sampling difficult.

None of the feed additives in this experiment effectively reduced the effects of the mycotoxins. There is no obvious explanation for this, but it could be because the response to the DON was so variable. The feed intake of the pigs on diets 4,5,and 8 was similar to the negative control, however, it didn't approach the feed intake of pigs on the positive control diet, and the feed intake of pigs on the other diets was actually less than those consuming the negative control.

In conclusion, approximately 2 ppm DON in the diet of nursery pigs will decrease growth and feed intake by almost 10 % if consumed for 3 weeks. The feed additives used in this experiment had no effect on ameliorating the effect of the mycotoxoin, regardless of their mode of action.


## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. Project funding from Hubbard Feeds, Mankato, MN is gratefully acknowledged.

**Table 1** Basal diet composition (as fed basis)[a]

| Ingredient | Percent |
|---|---|
| Corn[a] | 50.61 |
| Soybean Meal | 29.25 |
| Whey | 10.00 |
| Fish Meal | 4.00 |
| Canola Oil | 2.00 |
| Dicalcium Phosphate | 1.40 |
| Limestone | 0.50 |
| Vitamin Premix | 0.50 |
| Trace Mineral Premix | 0.50 |
| Celite | 0.40 |
| Salt | 0.30 |
| Lysine-HCl | 0.15 |
| Calcium Propionate | 0.10 |
| Antibiotic | 0.10 |
| Choline Chloride | 0.08 |
| DL-Methionine | 0.07 |
| Copper Sulphate | 0.04 |

[a] Composed of appropriate proportions of contaminated and "clean" corn.

**Table 2.** Analyzed concentrations of DON and moulds in treatment diets and effect on performance of nursery pigs (initial BW 9.02 kg) fed DON contaminated corn.

| | | | | Performance | | | |
|---|---|---|---|---|---|---|---|
| Trt # | Treatment | DON ppm | Mould CFU/g[a] | BW Day 24 | ADG, kg/d | ADFI, kg/d | Gain:Feed |
| 1 | Positive control[b] | Neg[c] | 850 | 21.72 | 0.58 | 0.88 | 0.67 |
| 2 | Negative control[d] | 1.57 | 900 | 21.10 | 0.55 | 0.80 | 0.69 |
| 3 | Trt 2 + Ing. A | 1.33 | 650 | 20.83[e] | 0.54[e] | 0.75[e] | 0.72 |
| 4 | Trt 2 + Ing. B | 1.75 | 3,000 | 21.27 | 0.56[e] | 0.80[e] | 0.71 |
| 5 | Trt 2 + Ing. C | 1.95 | 9,000 | 20.74[e] | 0.53[e] | 0.80[e] | 0.68 |
| 6 | Trt 2 + Ing. D | 1.76 | 4,500 | 20.75[e] | 0.53[e] | 0.79[e] | 0.69 |
| 7 | Trt 2 + Ing. E | 1.81 | 700 | 20.74[e] | 0.53[e] | 0.78[e] | 069 |
| 8 | Trt 2 + Ing. F | 1.87 | 2,000 | 21.06 | 0.55 | 0.80 | 0.69 |
| 9 | Trt 2 + Ing. G | 2.09 | 1,550 | 21.03 | 0.55[e] | 0.79[e] | 0.69 |
| 10 | Trt 2 + Ing. H | 2.56 | 650 | 20.46[e] | 0.52[e] | 0.74[e] | 0.70 |
| 11 | Trt 2 + Ing. F + G | 2.61 | 1,500 | 20.46[e] | 0.52[e] | 0.76[e] | 0.69 |
| 12 | Trt 2 + Ing. + E + B | 2.57 | 2,000 | 20.33[e,f] | 0.52[f] | 0.75[e] | 0.69 |
| **STATISTICS** | | | | | | | |
| | SEM | | | 0.25 | 0.01 | 0.03 | 0.02 |
| | Overall P-Value | | | 0.009 | 0.009 | 0.11 | 0.81 |
| | P-Value (Pdiff) | Trt 1 vs. Trt 2 | | 0.09 | 0.08 | 0.06 | 0.36 |
| | P-Value (Contrast) | Trt 1 vs. Trt 3-12 | | 0.0004 | 0.0003 | 0.0008 | 0.13 |
| | P-Value (Contrast) | Trt 2 vs. Trt 3-12 | | 0.20 | 0.20 | 0.35 | 0.77 |

a Colony forming units.. Moulds were primarily Penicillium ssp, Fusarium ssp and Mucor ssp.
b Used exclusively non-contaminated corn.
c Negligible
d Formulated to contain 2 ppm DON
e Different from trt 1, positive control ($P < 0.05$).

# Starch Kinetics and Fibre Fermentation of Peas in Pigs

P. Leterme, R. Premkumar, and J.F. Patience

**SUMMARY**

The digestible energy content of peas in pigs is variable but not explained by their chemical composition. Laboratory techniques that mimic the digestive and fermentative processes in the pig's digestive tract were used here to try to find an explanation. The results showed a wide range of variation in starch hydrolysis in the small intestine but no variation in fibre fermentation in the large intestine between pea varieties grown in different conditions. Moreover, no correlations were established either between the chemical composition and the rate of starch hydrolysis or between starch hydrolysis and the digestible energy content.

**INTRODUCTION**

The digestible (DE) and net energy (NE) content of peas in pigs is very variable and that variability mainly depends on genetic and environmental factors. On the contrary, it can hardly be explained by differences in chemical composition (see other article in the present report). In order to find out an explanation, other factors such as the rate of starch hydrolysis in the small intestine or the rate of fibre fermentation in the large intestine were investigated here and the results were correlated to the DE content of the peas and their chemical composition.

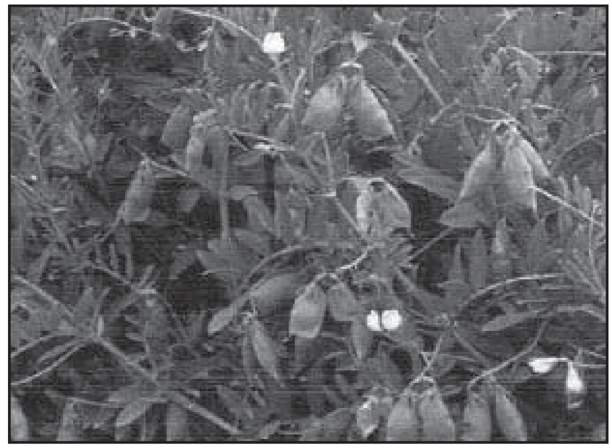
**MATERIALS AND METHODS**

Different pea samples were collected in farms from Alberta and Saskatchewan in 2006. In order to mimic the digestive processes in the upper part of the intestines, the samples were first treated with pepsin (proteolytic enzyme of the stomach), pancreatic enzymes (mixture of enzymes from the pancreas, including an amylase) and a dextrinase (enzyme that hydrolyses small chains of glucose). The kinetics of starch hydrolysis was established for each variety by measuring the concentration in glucose of the solution. The pea residues were then isolated by filtration and incubated at 39 °C for 48h in a solution containing minerals and bacteria collected from pig large intestines. The rate of fibre fermentation was obtained by measuring the gas production generated by the carbohydrate fermentation. The values of DE and the pea chemical composition used for the correlations were obtained in another study (see other article in the present report).

*"The digestible (DE) and net energy (NE) content of peas in pigs is very variable and that variability mainly depends on genetic and environmental factors."*

**RESULTS AND DISCUSSION**

Figure 1 illustrates the rate of starch hydrolysis obtained from 15 different pea varieties, as compared to corn starch. After 2h of incubation, important differences were already observed between varieties and these differences remained until the end of the incubation (6h). The final rate ranged from 70 to 92%. The reasons for



that high variation are not clear. All the varieties have the same quality of starch (amylose/amylopectin ratio and starch granule size and shape). Within the cells, the starch granules are mixed together with protein bodies (storage proteins). Starch hydrolysis will thus also depend on the rate of hydrolysis of the protein bodies and of the disruption of the cell walls. The disruption of the latter mainly depends on the grinding conditions. Previous work by the authors (J. Agric. Food Chem. 1998, 46, 1927) has shown that some cells are not disrupted even after fine grinding (< 1 mm) in lab conditions, which was the case here.

Whatever the reason can be, the question is to know if starch digestibility can be predicted and/or if there is a relationship between the latter and DE content or with the chemical composition.

The relationship between the NDF content and the rate of starch hydrolysis was low and not significant ($r = -0.48$; $P > 0.05$). The relationship with the ADF fraction was even lower ($r = -0.22$). The relationship with DE was not better ($r = -0.30$). Moreover, a negative relationship was not expected since starch is a net contributor of DE.

The variability between pea varieties in fibre fermentation was lower than that observed for starch hydrolysis (Figure 2). Fermentation was extremely fast and important: about 90% of the fibre carbohydrates were already fermented after 24h. The indigestible dietary compounds typically spend more than 40h in the large intestine. Their contribution to the total DE or NE content of the peas in the form of short-chain fatty acids is significant but must still be evaluated.

It can be suggested that the high variation in DE content of pea varieties grown in Western Canada can be ascribed more to variations in starch hydrolysis in the pig small intestine than to variations in pea fibre fermentation. Research continues at Prairie Swine Centre to understand the factors responsible for differences in starch hydrolysis and how these differences could be reduced. In particular, the effect of processing (grinding and pelleting) will be evaluated.

## IMPLICATIONS

The variation in nutritional value observed between pea samples grown in different conditions seems to be related to the kinetics of starch hydrolysis in the pig small intestine but not to the rate of fibre fermentation in the colon. Further studies at Prairie Swine Centre will evaluate the consequences of processing (pelleting and grinding) on those parameters and on the DE contents of peas in pigs.

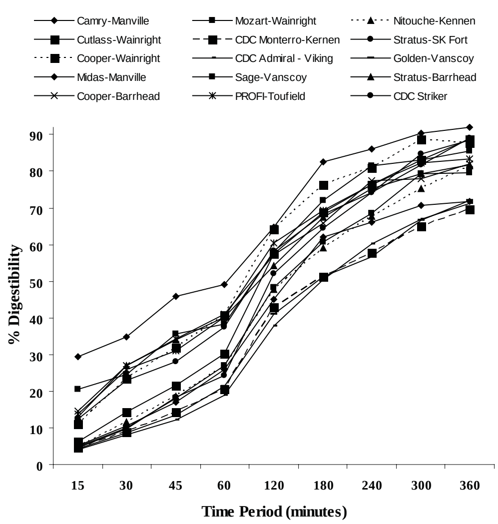



**Figure 1**. Kinetics of pea starch hydrolysis in the pig small intestine

## ACKNOWLEDGEMENTS

Strategic funding is provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and food Development Fund. Specific funding for this project was provided by the Alberta Pulse Growers.

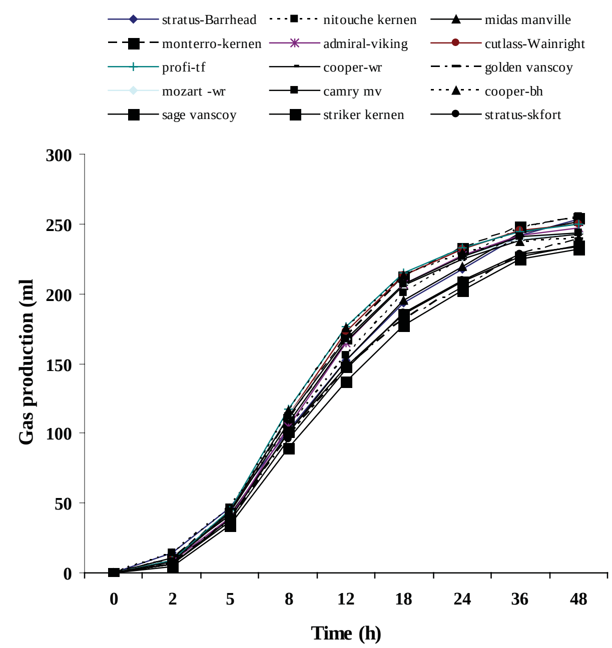



**Figure 2.** Kinetics of pea fibre fermentation in the pig large intestine.

# Response of Growing and Finishing Pigs to High and Low Crude Protein Diets

J.F. Patience, A.D. Beaulieu, and I.U. Haq


## SUMMARY

Supplementing a low protein diet with the limiting amino acids is often more cost effective than using an additional amount of the particular protein source. Two experiments conducted using grower and finisher pigs confirmed that performance could be maintained when either high or low crude protein diets are fed if amino acids are balanced and the diets are formulated to be similar in net energy.


## INTRODUCTION

Availability of crystalline amino acids has allowed reduction in the crude protein (CP) content of swine diets. Low CP diets supplemented with essential amino acids can decrease nitrogen excretion in the manure and may reduce diet costs. The objective of these experiments was to study the performance of growing and finishing pigs fed high or low CP (4% lower) diets supplemented with crystalline amino acids.

## MATERIALS AND METHODS

This work is part of a larger project. The high CP diets were formulated to meet the lysine requirement of the pig (Table 1). Low CP diets were formulated to provide the same amount of lysine but the CP was reduced from 20% to 16% in the grower and from 16% to 12% in the finisher diet. Diets were formulated to be equal in net energy and sodium bicarbonate was added to the low CP diets to maintain the dietary electrolyte balance.

## RESULTS AND DISCUSSION

During the grower experiment, average daily feed intake (ADFI) was numerically reduced when the pigs consumed the high CP diet ($P = 0.13$) and ADG was similar between treatments, resulting in an improved gain:feed ratio with the high CP diet ($P < 0.01$; Table 2). The CP content of the diet had no effect on pig performance during the finishing phase (Table 2).

*"Reducing CP levels by 4% in grower and finisher pig diets does not adversely impact performance when diets are formulated to be equivalent in true ideal AA digestibility, NE and dietary electrolyte balance"*

## CONCLUSION

Reducing CP levels by 4% in grower and finisher pig diets did not adversely impact performance when these diets were formulated to be equivalent in true ideal AA digestibility, NE and dietary electrolyte balance.


## ACKNOWLEDGMENT

Strategic funding provided by Sask Pork, Alberta Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund. Funding for this project from the National Pork Board is appreciated.

**Table 1.** Ingredient composition and calculated nutrient contents of experimental diets

| **Ingredients** | **Grower (25 to 55kg)** | | **Finisher (75 to 120kg)** | |
|---|---|---|---|---|
| (% as fed) | High CP | Low CP | High CP | Low CP |
| Corn | 60.50 | 73.51 | 77.25 | 87.80 |
| Soybean Meal | 34.50 | 20.80 | 18.7 | 7.40 |
| Tallow | 1.13 | 0.00 | 0.87 | 0.00 |
| Lysine | 0.00 | 0.43 | 0.03 | 0.38 |
| Methionine | 0.00 | 0.11 | 0.00 | 0.02 |
| Tryptophan | 0.00 | 0.05 | 0.00 | 0.06 |
| Threonine | 0.00 | 0.05 | 0.00 | 0.06 |
| Valine | 0.00 | 0.05 | 0.00 | 0.03 |
| Isoleucine | 0.00 | 0.00 | 0.00 | 0.03 |
| Other[a] | 3.87 | 5.69 | 3.17 | 4.80 |
| **Nutrients** | | | | |
| DE, Mcal/kg | 3.51 | 3.41 | 3.50 | 3.42 |
| NE, Mcal/kg[b] | 2.30 | 2.30 | 2.40 | 2.40 |
| Crude Protein, % | 20.44 | 16.94 | 16.13 | 12.31 |
| Calcium, % | 0.70 | 0.70 | 0.50 | 0.52 |
| Phosphorus, % total | 0.60 | 0.60 | 0.45 | 0.47 |
| TID Lys, % | 1.02 | 1.02 | 0.66 | 0.66 |
| TID, Met, % | 0.29 | 0.36 | 0.22 | 0.26 |
| dEB, meg/kg | 221 | 222 | 145 | 146 |

[a] Consisting of dicalcium phosphate, limestone, salt, sodium bicarbonate, potassium carbonate, vitamins, minerals and celite.
[b] Estimated according to CVB (1998).

**Table 2.** Performance of grower and finisher pigs fed high or low CP diets.

| | Grower (25 to 55kg) | | | | Finisher (75 to 120kg) | | | |
|---|---|---|---|---|---|---|---|---|
| | High CP | Low CP | SEM | R-Value | High CP | Low CP | SEM | R-Value |
| Initial bdy weight (kg) | 25.28 | 25.26 | 0.30 | 0.98 | 77.14 | 77.39 | 0.88 | 0.84 |
| Final body weight (kg) | 52.79 | 53.56 | 1.36 | 0.70 | 116.1 | 113.8 | 1.83 | 0.39 |
| ADG (kg/d) | 0.98 | 1.01 | 0.04 | 0.67 | 1.11 | 1.04 | 0.10 | 0.34 |
| ADFI (kg/d) | 1.78 | 2.00 | 0.10 | 0.13 | 3.42 | 3.30 | 0.11 | 0.43 |
| G:F | 0.55 | 0.51 | 0.01 | 0.01 | 0.32 | 0.32 | 0.01 | 0.51 |

# Impact of Piglet Birth Weight on the Eating Quality of Pork

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## SUMMARY

Data was collected from 98 litters to determine if birth weight affected the final eating quality of pork. Except for constant monitoring during farrowing and periodic measurements of body weight, farrowing and piglet management were according to normal barn practises. From 24 litters, selected because they had at least 12 piglets born alive and which represented a range of body weight, 4 pigs were sent to Lacombe Research Station when they reached 120 kg, for extensive meat quality and sensory analysis.

Except for some minor (and probably non-relevant) exceptions birth weight had no effect on carcass quality, weight of primal cuts, overall palatability, chemical properties, or histological properties of the meat ($P > 0.05$).

*"There was no effect of birth weight on carcass quality, physical, or histological properties of the meat or overall eating quality."*

## INTRODUCTION

Piglets born in large litters are, on average, smaller (PSC Annual Research Report 2006; p. 36-38). Low birth weight has been associated with fewer total muscle fibres at birth and larger fibres at market weight. It has been suggested that this may affect the eating quality of pork.

In our previous paper we showed that birth weight had no effect on carcass quality. This paper extends these results and examines the effect of birth weight on the chemical and sensory properties of pork which may influence eating quality. The specific objective of this portion of the study was to determine if the eating quality of pork obtained from pigs with low birth weight differed from that of their larger litter-mates.

## MATERIALS AND METHODS

Birth order, birth weight, total number born and total number born alive were recorded for 98 farrowings at PSC Elstow (n=1114 piglets born alive). Farrowing and piglet management, including cross-fostering, iron injections, castration and tail docking followed normal barn procedures. Birth weight was divided into 4 quartiles: Q1, 0.8 to 1.2 kg; Q2, 1.25 to 1.45 kg; Q3, 1.50 to 1.70 kg and Q4, 1.75 to 2.50 kg. Pigs ≤ 750 grams BW were excluded (n=48 piglets). Detailed meat composition data were obtained from a subset of 24 litters; 1 pig per quartile per litter. Animals were slaughtered and dressed in a simulated commercial manner at AAFC Lacombe Research Centre. Full grade and carcass dissection data were collected 24 h and 48 h post-mortem and eating quality data was measured using a trained taste panel.

## DISCUSSION AND RESULTS

Birth weight had no effect on the proportions of total lean, bone or fat ($P > 0.10$; Table 1). Except for flavour desirability which was reduced in the middle-weight pigs ($P < 0.02$), the sensory qualities of pork were unaffected by birth weight ($P > 0.10$, Table 2). Moisture (mg/g) was reduced, and intramuscular fat was increased in lower birth weight pigs ($P < 0.04$; Table 3). Cooktime (sec/g) was reduced in middle weight pigs ($P = 0.03$; Table 3). Twenty-four hour pH, crude protein, shear force, and pork colour were all similar among birth weight quartiles ($P > 0.20$). Sarcomere length was increased in the highest birth weight pigs (Table 4, $P < 0.02$), however, proportions (Table 4) and mean area (data not shown) of slow oxidative, fast oxidative glycolytic, and fast glycolytic muscle fibres were unaffected by birth weight ($P > 0.20$).

## CONCLUSIONS AND IMPLICATIONS

There was no effect of birth weight on carcass quality, physical, or histological properties of the meat or overall eating quality. Selecting pigs at birth based on body weight would allow producers to sort pigs based on days to market, but would not be an effective critieria to predict final eating quality of the meat. Increasing litter size can be used by producers to increase productivity with no adverse effect on pig performance or meat quality.

## ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork,Alberta Pork, the Manitoba Pork council and the Saskatchewan Agriculture Development Fund. The authors acknowledge support for this project from PIC Canada and the Alberta Livestock Industry Development Fund.

**Table 1.** The effect of birth weight on proportions of lean, bone, and fat[1]

| | Birth Weight, kg | | | | | |
|---|---|---|---|---|---|---|
| | **0.80-1.20** | **1.25-1.45** | **1.50-1.70** | **1.75-2.00** | **SEM** | **P-Value** |
| Total Lean | 622.81 | 634.46 | 641.96 | 629.67 | 7.61 | 0.33 |
| Total Bone | 98.84 | 101.62 | 102.45 | 100.96 | 1.54 | 0.67 |
| Total Fat | 277.34 | 263.91 | 255.59 | 269.38 | 7.54 | 0.22 |
| Body cavity | 7.72 | 7.77 | 7.00 | 7.92 | 0.32 | 0.17 |
| Intermuscular | 61.67 | 57.48 | 54.06 | 58.75 | 2.14 | 0.09 |
| Subcutaneous | 207.95 | 198.66 | 197.53 | 202.71 | 5.79 | 0.40 |

[1] g kg pig-1. Data obtained from 96 pigs, 24 from each weight quartile.

**Table 2.** The effect of birth weight on the sensory qualities of pork[1]

| | Birth Weight, kg | | | | | |
|---|---|---|---|---|---|---|
| | **0.80-1.20** | **1.25-1.45** | **1.50-1.70** | **1.75-2.00** | **SEM** | **P-Value** |
| Flavour intensity | 4.31 | 4.22 | 4.20 | 4.16 | 0.06 | 0.39 |
| Flavour desirability | 4.40[a] | 4.09[b] | 4.19[b] | 4.26[ab] | 0.07 | 0.02 |
| Juiciness | 4.66 | 4.57 | 4.61 | 4.76 | 0.08 | 0.42 |
| Connective tissue | 6.97 | 6.99 | 7.01 | 7.07 | 0.05 | 0.61 |
| Tenderness | 5.33 | 5.38 | 5.33 | 5.54 | 0.11 | 0.46 |
| Palatability | 4.04 | 3.85 | 3.94 | 4.07 | 0.09 | 0.16 |

[1]Data obtained from 96 pigs, 24 from each birth weight quartile.
[2]1=bland, 8 = intense; [3]1=undesirable, 8=desirable; [4]1=dry, 8=juicy;
[5]1=abundant, 8=none detected; [6]1=extremely tough, 8=extremely tender;
[7]1=extremely undesirable; 8=extremely desirable
[ab]Row means with different superscripts differ ($P < 0.05$).

**Table 3.** The effect of birth weight on pH, chemical properties and colour of pork[1]

| | Birth Weight, kg | | | | | |
|---|---|---|---|---|---|---|
| | **0.80-1.20** | **1.25-1.45** | **1.50-1.70** | **1.75-2.00** | **SEM** | **P-Value** |
| pH, 24-Hour | 5.69 | 5.71 | 5.67 | 5.68 | 0.03 | 0.70 |
| Proximate Analysis, mg/g | | | | | | |
| Moisture | 743.80[a] | 746.43[ab] | 749.76[b] | 749.31[b] | 1.41 | 0.01 |
| Intramuscular fat | 35.12[a] | 30.07[b] | 25.75[b] | 29.09[b] | 0.18 | 0.04 |
| Crude Protein | 218.99 | 220.34 | 220.21 | 217.49 | 0.11 | 0.23 |
| Shear, kg | 5.61 | 5.22 | 5.66 | 5.24 | 0.17 | 0.13 |
| Cooktime, sec/g | 7.41[a] | 6.88[ab] | 6.57[b] | 7.52[a] | 0.25 | 0.03 |
| L*, 48-hour | 52.68 | 51.96 | 52.09 | 52.72 | 0.52 | 0.64 |
| Chroma, 48-hour | 13.52 | 13.47 | 13.37 | 13.08 | 0.31 | 0.77 |
| Hue, 48-hour | 30.61 | 29.48 | 29.80 | 29.31 | 0.63 | 0.49 |

[1]Data obtained from 96 pigs, 24 from each birth weight quartile.
[ab]Row means with different superscripts differ ($P < 0.05$).

**Table 4.** The effect of birth weight on the histological properties of pork[1]

| | Birth Weight, kg | | | | | |
|---|---|---|---|---|---|---|
| | **0.80-1.20** | **1.25-1.45** | **1.50-1.70** | **1.75-2.00** | **SEM** | **P-Value** |
| Sacromere length, µm | 2.00[a] | 1.97[a] | 1.97[a] | 2.06[b] | 0.02 | 0.02 |
| Porportion of | | | | | | |
| Slow oxidative | 18.4 | 17.9 | 19.5 | 18.8 | 0.58 | 0.23 |
| Fast oxidative | 27.1 | 27.3 | 26.5 | 27.0 | 0.94 | 0.94 |
| Fast glycolytic | 54.5 | 54.8 | 53.9 | 54.3 | 0.97 | 0.94 |

[1]Data obtained from 96 pigs, 24 from each birth weight quartile.
[ab]Row means with different superscripts differ ($P < 0.05$).

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# Financial Support

Prairie Swine Centre Inc. wants to recognize the many individuals and agencies that supported the research and technology transfer programs this year. Their support is essential to the ongoing developments that will keep Canadian pork producers at the forefront of applied technology.

In addition to industry and government funding, the University of Saskatchewan contracts the facilities and services of PSCI for research and teaching. This ongoing agreement provides income for the Centre in return for the use of modern production and research facilities.

The following organizations have provided funding or donations in kind to support public research at the Centre for the 2007 year.

## PROGRAM SPONSORS

- Saskatchewan Pork Development Board
- Saskatchewan Agriculture & Food-ADF
- Manitoba Pork Council
- Alberta Pork Producers Development Corporation
- University of Saskatchewan

## MAJOR PROJECT SPONSORS

- Natural Sciences and Engineering Research Council of Canada
- National Pork Board
- Advancing Canadian Agriculture and Agri-Food Saskatchewan
- Pulse Crop Development Board
- Alberta Livestock Industry Development Fund
- Vandeputte
- Canadian Adaptation and Rural Development
- Canola Council of Canada
- Saskatchewan Canola Development Commission

## PROJECT SPONSORS

- Ontario Pork Producers Marketing Board
- Alberta Barley Commission
- Agriculture and Agri-Food Canada
- Syngenta Biotechnology
- Degussa Canada Inc.
- Danisco Animal Nutrition
- Cement Association of Canada
- Maple Leaf Foods
- Manitoba Pork
- Sierens Equipment
- Adisseo
- Pig Improvement Company
- Ontario Farm Animal Council
- Elanco (Division of Eli Lilly Canada Ltd)
- Hubbard Feed
- Distributors Processing

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