

# NOVEL SWINE FEEDING PROGRAMS TO ENHANCE COMPETITIVENESS AND PORK DIFFERENTIATION: THE CANADIAN FEED & PORK VALUE CHAIN

## PROJECT LEADERS

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## PROJECT OBJECTIVE

To develop knowledge to support a unique Canadian feed management strategy and feed ingredient database for optimum productivity that also considers nutrient excretion, reduced antibiotic use during the growth phase, and pork quality. This unique database combines digestibility and bioavailability trials and novel feedstuff analyses.

**Relevant information on nutritional value of co-products was developed and gathered in a database. When formulating pigs' diet, this new knowledge of co-products can be used and help to reduce feed costs.**

## FINAL RESULTS

### FEEDSTUFF DATA

#### 1. Co-product digestibility and enzymes

*(Ruurd Zijlstra, University of Alberta)*

Activities within this project enabled the following key findings:

- Treatments targeted to reduce the impact of fiber and protein may increase the digestibility and fermentability of wheat co-products from flour milling.
- Carbohydrases better unlocked the fiber-starch-protein matrix for fermentation than the combination of Carbohydrases+Protease, indicating that the substrate for Carbohydrases hinders degradation of the distillers dried grains with solubles (DDGS) matrix. The matrix of corn DDGS is less imbedded and hence more fermentable than wheat DDGS.
- The energy content of diets based on Canadian feedstuffs of major importance for pig production was determined. Measured net energy contents ranked feedstuffs similarly to NRC (1998).
- Some grain legumes provide more digestible energy (DE) with higher apparent total tract digestibility (ATTD) of energy than corn; thus, can serve as an alternative feed ingredient for growing pigs. However, variation due to type and composition of grain legume should be considered in pig diet formulation. The current in vitro digestibility technique needs further development to better predict the ATTD of energy in grain legumes.
- The NE values of field pea (FP), juncea canola meals (JCM), and wheat millrun (WM) were similar to that of soybean meal (SBM). However, the NE value of napus canola meals (NCM) was lower than that of SBM, likely due to the lower energy digestibility and the known higher fiber content of the NCM than of SBM. The NE values of FP and NCM were lower than the NRC (2012) values by 16% and 5%, respectively, whereas the NE value of WM was higher the NRC (2012) value by 8%.
- Nutrient profiles and digestibility of wheat co-products from flour milling (WFM) vary widely; although some WFM have a DE content comparable to corn. Thus, type and composition of wheat co-products should be considered for pig feed formulation. The existing in vitro technique accurately predicts ATTD of energy in WFM.



- In 2013, the overall findings of the project were part of:
  - Summary articles in Pig Progress, Animal Frontiers, Symposia of the American Association of Swine Veterinarians and American Society of Animal Science, as a book chapter, and will be submitted as a symposium article to the Journal of Animal Science in September, 2013
  - One research article in Western Hog Journal
  - Six research abstracts
  - Two submitted research articles

## **2. Starch digestion and fiber fermentation**

*(Ruurd Zijlstra, University of Alberta)*

Several studies were conducted and enabled to develop a database on starch digestion and fiber fermentation.

- The in vitro trial showed that physicochemical properties of fiber and starch type affect fermentation kinetics and short-chain fatty acid (SCFA) production; and influence the net portal appearance (NPA) of glucose, glucagon-like peptide-1 (GLP-1) and insulin production.
- High amylose starch increased methane (CH<sub>4</sub>) production and reduced NE content due to increased fermentation instead of digestion.
- Slowly-digestible starch increased ileal glucose and decreased ileal short chain fatty acid (SCFA) transporter mRNA abundance, possibly due to an increased presence of glucose in the lumen of the ileum. Effects of starch on colonic SCFA transporter mRNA abundance were inconsistent, with slowly-digestible starch increasing monocarboxylic acid transporter-1 (MCT1) but decreasing Na<sup>+</sup>-coupled monocarboxylate transporter (SMCT).
- Manipulating dietary amylose content altered the microbial profile of Lactobacillus spp (LAC) in the cecum and colon and Bacteroides-Prevotella-Porphyrmonas (BAC) in the colon; however, amylose content did not affect crypt depth and villus height.
- Slowly-digestible starch influenced signalling pathways for glucose and SCFA transport. Although studies indicate sweet taste receptor T1R3 is directly related to Na<sup>+</sup>-dependent glucose transporter-1 (SGLT1) expression. Results suggest multiple pathways may be responsible for absorption and metabolism of glucose and SCFA.
- Increasing amylose content can modulate gut microbial profiles, volatile fatty acid concentrations, and pH that may play a protective role against pathogenic bacteria.
- For 50 feedstuff samples that contained starch (cereal and pulses), in vitro starch digestion kinetics were determined indicating that starch digestion kinetics vary among feedstuffs, but not to the same extent as purified starch feedstuffs that differ in starch chemistry.
- In 2013, the overall findings of the project were part of:

- One research abstract.
- One manuscript was prepared and is undergoing review by the co-authors.
- One manuscript was prepared, but requires additional data.

## **3. Intestinal microbial composition**

*(Andrew Van Kessel, University of Saskatchewan)*

This project enabled to establish a model to examine the impact on intestinal health of lower quality protein sources common in by-product feed ingredients.

It was demonstrated that diets containing high levels of heat damaged soybean meal resulted in high levels of protein fermentation products in the colon. The addition of sugar beet pulp and wheat bran as fiber sources lowered the levels of these putative toxins although not to the level observed with low protein content. Independent of fiber content, diets containing high levels of heat damaged soybean meal were also associated with evidence of colon inflammation, including increased mucus and reorganization of cell junctions to maintain barrier function. Increased protein fermentation in colon could not be confirmed with high levels of pea protein formulated using either CDC Fibar, hullless barley (high β-glucan), CDC McGwire, hullless barley (low β-glucan), or pea starch as the primary carbohydrate source. Carbohydrate source interactions with protein unpredictably affected protein digestibility.

## **4. Liquid feeding of grower pigs – in vitro steeping and fermentation studies**

*(Kees de Lange, University of Guelph)*

The nutritional value of a large number of corn DDGS samples supplied to Ontario were determined based on nutritional analyses, near infrared spectroscopy (NIRS) and objective color measurements, as well as in vitro and in vivo nutrient digestibility. Results confirmed substantial variability between samples. Even if color provided a reasonable prediction of the nutritional value of individual DDGS samples, this simple measure had limitations.

***New user-friendly software is now available to estimate nutrient requirements of different categories of pigs under varying conditions. This information is already published in NRC 2012.***

## **MODEL**

### **5. Model development**

*(Kees de Lange, University of Guelph)*

The project enabled the development of user-friendly software to estimate the nutrient requirements of different categories of swine under varying conditions. New knowledge about nutrition utilization in growing-finishing pigs was integrated into two different



packages of user-friendly software. It was used for the evaluation of the financial and environmental impact of alternative feeding management strategies for individual growing-finishing pig units (NRC 2012 and PorkMaster). New applications of this software are to predict nutrient requirements of entire male pigs that are immunized against gonadotrophin releasing factor (GnRF; for control of boar taint) and to estimate nutrient losses into the environment.

**Additional software (PorkMaster), which includes a feed ingredient data base and a least-cost feed formulation package, has been made available to industry experts and allows assessment of financial and environmental impacts of alternative feeding strategies for individual growing-finishing pig units.**

## VALIDATION

### **6. Validation of the net energy value of wheat DDGS for growing-finishing pigs under commercial scale conditions**

*(Ruurd Zijlstra, University of Alberta and Eduardo Beltranena, Alberta Agriculture and Rural Development)*

When pigs were fed diets with assumed net energy values of wheat DDGS of 1.5, 1.7, 1.9, 2.1, 2.3 to 2.5 Mcal/kg; net energy value of wheat DDGS was confirmed at 2.1 and 2.15 Mcal/kg. The benefit of having validated the NE value of wheat DDGS under commercial pig production conditions gives industry nutritionists practical confidence on a value that was previously based merely on calculations.



### **7. Increasing dietary inclusions of yellow-seeded, expeller-pressed, juncea canola meal on pig growth performance, carcass characteristics and lipid composition of pork grown under commercial scale**

*(Ruurd Zijlstra, University of Alberta and Eduardo Beltranena, Alberta Agriculture and Rural Development)*

Increasing dietary inclusions of extruded and expeller-pressed B. juncea canola meal up to 200 g/kg linearly reduced feed disappearance, weight gain, carcass weight, loin depth, and increased jowl fat unsaturation. The reduction in feed intake was attributed to high 3-butenyl (10 µmol/g) content, a bitterer glucosinolate compared with others found in conventional canola meal. Despite the promise of improved feed efficiency owing to the higher dietary energy value of B. juncea compared with conventional canola meal, its high 3-butenyl levels would prove deterrent.

### **8. Liquid feeding - pig performance studies**

*(Kees de Lange, University of Guelph)*

Across all five DDGS liquid feeding studies, inconsistent pig growth performance responses to using fiber degrading enzymes and microbial inoculants were observed. In the first two studies, beneficial and additive effects of using enzymes and microbial inoculants in swine liquid feeding were observed, which coincided with substantial increases in lactic acid content in steeped DDGS. Such responses were not seen in the subsequent studies. Additional studies are warranted to better control DDGS fermentation conditions and better understand interactions between different batches of DDGS and the use of enzymes and microbial inoculants. Indeed, very preliminary in vitro test results indicate differences in initial pH during steeping of different batches of DDGS.

