

## Performance, Digestibility and Carcass Characteristics of Growing/Finishing Pigs Fed Barley-Based Diets Supplemented with an Extruded or Unextruded Blend of Peas and Canola Seed or Meal

P. A. Thacker\* and Shiyan Qiao<sup>1</sup>

Department of Animal Science, University of Saskatchewan, 51 Campus Drive  
Saskatoon, Saskatchewan, S7N 5A8, Canada

**ABSTRACT** : Seventy-two crossbred pigs weighing an average of 41.5 kg were assigned on the basis of sex, weight and litter to one of four dietary treatments in a factorial (4 treatments × 2 sexes) arrangement. The control diet was based on barley and soybean meal while the experimental treatments consisted of diets in which a portion of the dietary protein was supplied by 20% of a 50:50 blend of extruded (130°C for 20 to 25 sec) peas and full-fat canola seed, 20% of a 50:50 blend of unextruded peas and full-fat canola seed or a diet containing 10% peas, 6% canola meal and 4% canola oil (to equal the level of canola oil provided by 10% whole canola seed). Digestibility coefficients for dry matter, crude protein and gross energy were significantly higher ( $p < 0.05$ ) for the control diet than for the other three diets. Extrusion produced no beneficial effects ( $p > 0.05$ ) on nutrient digestibility and there were no differences in digestibility between the diet based on intact canola seed compared with the diet containing canola meal and oil. Choice of protein supplement had no significant effects on gain, feed intake or feed conversion during the grower or finisher phases and over the entire experimental period. Extrusion of the pea-canola blend produced no beneficial effects on pig performance as the performance of pigs fed either the extruded or unextruded blend of peas and canola seed was similar. In addition, the performance of pigs fed diets containing intact canola seed was similar to that of pigs fed canola meal and oil. Castrates gained faster and consumed more feed than gilts ( $p < 0.05$ ). However, their feed conversion was poorer than that of the gilts during the finisher period. There were no significant differences in carcass traits between pigs fed the control and any of the experimental treatments. Extrusion had no effect on carcass traits and the carcasses of pigs fed canola meal and oil did not differ from those of pigs fed whole canola seed. Castrates had a significantly lower dressing percentage, lower estimated lean yield but greater loin fat depth than gilts ( $p < 0.05$ ). The results of this experiment indicate that peas in combination with canola seed or canola meal are an acceptable alternative to soybean meal as a protein supplement for use in growing-finishing swine diets. Extrusion did not appear to have any beneficial effects on the nutritional value of the canola seed-pea blend as nutrient digestibility, growth performance and carcass traits were similar for pigs fed the unextruded blend of peas and canola seed compared with the extruded product. Since the process adds to the cost of the raw products, its use is unlikely to be economical. (*Asian-Aust. J. Anim. Sci.* 2002, Vol 15, No. 1: 102-105)

**Key Words** : Peas, Canola Seed, Extrusion, Swine, Digestibility, Growth

### INTRODUCTION

Soybean meal is the most commonly used source of supplementary protein for swine production and it is generally a consistent, high quality product (Swick, 1994). However, as transportation costs for feed increase, swine producers will have to maximize the use of locally produced feedstuffs. Therefore, it is important that alternative sources of supplementary protein be developed.

Recent efforts to diversify crop production in western Canada have led to rapid growth in canola and pea production. Full-fat canola seed (low glucosinolate, low erucic acid rapeseed) provides dietary protein and may also be used as an energy supplement to displace fats and oils in

swine diets (Aherne and Bell, 1990). Handling problems during grinding and storage attributed to the high oil content of the canola seed can be counteracted by mixing the canola seed with other ingredients such as ground peas. Peas and canola meal are complementary in amino acid composition (Aherne and Bell, 1990; Castell, 1990) each contributing to overall lysine and methionine balance respectively.

Heat-labile, anti-nutritional factors occur in both canola seed and peas. Glucosinolates, sinapine and tannins are present in canola seed (Bell, 1993; Campbell and Schone, 1998) while peas contain lectins, protease inhibitors and tannins (Castell, 1990). As a consequence, the performance of pigs fed canola seed (Froseth and Peters, 1981) and peas (O'Doherty and Keady, 2000) has been shown to be improved as result of extrusion heating.

Recently, an extruded blend of peas and full-fat canola seed has been produced and marketed under the trade name "Extrapro". The nutritional value of this product has not been tested with swine. Therefore, a feeding trial was

\* Address reprint request to P. A. Thacker. Tel: +306-966-4159, Fax: +306-966-4151, E-mail: Thacker@admin.usask.ca

<sup>1</sup> Ministry of Agriculture Feed Industry Centre, China Agricultural University, No. 2 Yuanmingyuan West Road, Beijing, China 100094.

Received May 29, 2001; Accepted September 17, 2001

conducted to determine the nutritional value of an extruded blend of peas and full-fat canola seed and to compare this product with a combination of unheated peas and canola seed as well as with a diet containing peas, canola meal and canola oil.

## MATERIALS AND METHODS

### Growth trial

Seventy-two crossbred pigs (Camborough 15 Line female × Canabred sire, Pig Improvement Canada Ltd, Acme Alberta) weighing an average of  $41.5 \pm 4.2$  kg were assigned on the basis of sex, weight and litter to one of four dietary treatments in a factorial (4 treatments × 2 sexes) arrangement. The control diet was based on barley and soybean meal while the experimental treatments consisted of diets in which a portion of the dietary protein was supplied by 20% of a 50:50 blend of extruded peas and canola seed marketed under the brand name of Extrapro (Oleet Processing Ltd, Regina, Saskatchewan), 20% of a 50:50 blend of ground unextruded peas and canola seed or a fourth diet in which the 20% replacement consisted of 6% canola meal and 4% canola oil (to mimic the composition of whole canola seed) as well as 10% unextruded peas. The ground peas and canola seed were extruded for 20 to 25 sec using an Instapro Extruder (Instapro Inc., Des Moines, Iowa) at a temperature of 130°C.

During the growing period (41.5 to 59.5 kg), the experimental diets were formulated to supply 16.2% crude protein (table 1) while in the finishing period (59.5 to 96.1 kg), the diets were formulated to supply approximately 14.2% crude protein (table 2). All diets were supplemented with sufficient vitamins and minerals to meet or exceed the levels recommended by the National Research Council (1998). The diets were pelleted using low-pressure steam at approximately 60°C. The trial was run for 56 days and concluded when the pigs reached an average weight of 96.1 kg.

The pigs were housed in groups of four in  $2.7 \pm 3.6$  m concrete floored pens and were provided water ad libitum. The pens were equipped with four individual feeders. Each pig was allowed access to its own individual feeder for 30 min twice daily (07:00 h and 15:00 h). Individual body weights, feed consumptions and feed conversion were recorded weekly. Eight castrates and ten gilts were fed each diet. Pigs were assigned to feeders in such a way as to minimize the potential for treatment effects to be confounded with environmental effects.

### Digestibility determination

Total tract digestibility coefficients for dry matter, crude protein and gross energy were determined using six castrates per treatment starting at an average weight of 52.5 kg. The

pigs were housed under identical conditions as those used in the growth trial and were fed the same diets as those used during the growing stage modified only by the addition of 0.5% chromic oxide as a digestibility marker. The marked feed was provided for a seven day acclimatization period, followed by a three day fecal collection. Fecal collection was made by bringing animals into a clean room immediately after feeding and recovering freshly voided feces. The fecal samples were frozen for storage. Prior to analysis, the samples were dried in a forced air oven dryer at 66°C for 60 h, followed by fine grinding (0.5 mm screen).

### Carcass measurements

All pigs were maintained on their respective diets following the conclusion of the performance trial and were slaughtered at a commercial abattoir at an average weight of 103.4 kg. Carcass weight was recorded and dressing percentage calculated. Carcass fat and lean measurements were obtained with a Destron PG 100 probe placed over the 3<sup>rd</sup> and 4<sup>th</sup> last ribs, 70 mm off the midline. These values were then used in calculating Carcass Value Indices according to the table of differentials in effect at the time of the experiment (Saskatchewan Pork Producers Marketing Board, 1997).

### Chemical analysis

Analysis of feed samples for dry matter, crude protein, acid detergent fibre (ADF), ash and ether extract (EE) were conducted according to the methods of the Association of Official Analytical Chemists (1980). An adiabatic oxygen bomb calorimeter (Parr, Moline, Illinois) was used to determine gross energy content. Chromic oxide was determined by the method of Fenton and Fenton (1979).

### Statistical analysis

Pig performance and carcass data were analyzed as a  $4 \times 2$  factorial using the General Linear Models procedure of the Statistical Analysis System Institute, Inc. (SAS 1990) with the factors in the model consisting of protein supplement, sex and their two way interaction. The digestibility trial was analyzed as a one way ANOVA.

## RESULTS

The chemical composition of the grower and finisher diets are presented in tables 1 and 2. As expected, the diets containing full-fat canola seed either extruded or unextruded and the diet containing 4% canola oil and meal had a higher EE content than did the control diet based on barley and soybean meal. Similarly, the diets containing canola seed or canola meal had a higher ADF content than did the control.

The effect of the different protein supplements on digestibility coefficients for dry matter, crude protein and

gross energy are presented in table 3. Digestibility coefficients were significantly higher ( $p < 0.05$ ) for the control diet than for any of the remaining diets. Extrusion produced no beneficial effect on nutrient digestibility and there were no significant ( $p > 0.05$ ) differences in digestibility coefficients between the diet based on intact canola seed compared with canola meal plus oil.

Performance data is presented in table 4. Choice of protein supplement had no significant effects on gain, feed intake or feed conversion during the grower and finisher phases or over the entire experimental period. Extrusion of the pea-canola blend produced no beneficial effects on pig performance and the performance of pigs fed canola meal and canola oil was similar to that of pigs fed intact canola seed.

During the finishing period, as well as the entire experimental period, castrates gained faster and consumed more feed than gilts ( $p < 0.05$ ). However, their feed conversion was poorer than that of the gilts during the finisher period.

The effect of protein supplements on carcass traits are shown in table 5. There were no significant differences between the control and any of the experimental treatments. Extrusion had no effect on carcass traits and the carcasses of pigs fed canola meal and oil did not differ from those of pigs fed whole canola seed. Castrates had a significantly lower dressing percentage, lower estimated lean yield but greater loin fat depth than gilts ( $p < 0.05$ ).

## DISCUSSION

The results of this experiment indicate that peas in combination with canola seed or canola meal are an acceptable alternative to soybean meal as a protein supplement for use in growing-finishing swine diets. Both pig performance and carcass traits were unaffected by the choice of dietary protein.

There is little published information about the nutritional value of blends of peas and canola seed or meal when fed to swine. However, there is considerable information about the use of these products when fed individually. For example, several studies have demonstrated the considerable potential of peas as a feed ingredient for use in growing-finishing pig diets (Bell and Wilson, 1970; Davies, 1984a, b; Grosjean and Gatel, 1986; Castell et al., 1988; Savage and Deo, 1989) with most studies indicating little reduction in performance when peas were included at levels of up to 30% of the diet (Castell, 1990). Similarly, full-fat canola seed has been successfully fed to pigs at levels of between 10 and 15% of the diet (Castell and Falk, 1980; Salo, 1980).

Unfortunately, problems arise when full-fat canola seed is incorporated into a diet. The principle concern is that the

meshed screen on a hammer mill has a tendency to become plugged when processing whole canola seed as a result of its high oil content. However, this is not an issue when using either "Extrapro" or unextruded peas and canola seed since the blend of ingredients flows readily through the grinding equipment. The improved handling qualities of these products compared with canola seed alone may be sufficient incentive to encourage their incorporation into diets where inclusion of a high-fat product is desired.

Extrusion did not appear to have any beneficial effects on the nutritional value of the pea-canola seed blend as nutrient digestibility, growth performance and carcass traits were similar for pigs fed the unextruded blend of peas and canola seed compared with the extruded product. As such, these results were disappointing as it has been suggested by earlier studies that extrusion of ground peas increased starch digestibility (Bengala Freire et al., 1998) and reduced the activity of several anti-nutritional factors (Orue et al., 1998). Other workers have reported improvements in daily gain and nutrient digestibility as a result of extrusion of pig diets containing peas (O'Doherty and Keady, 2000, 2001). In addition, the performance of pigs fed canola seed has been shown to be improved as result of extrusion heating (Froseth and Peters, 1981). It is difficult to explain why previous studies have observed beneficial effects when canola seed and peas are extruded separately, while no improvements were seen in the present study when the two products were processed in combination.

The results of the present experiment indicate that pigs fed unextruded peas and canola seed performed similarly to pigs fed a diet formulated using a similar level of peas but containing canola meal and canola oil (at the same level as would be present in 10% canola seed). As such, these results contradict an earlier study in which it was observed that pigs fed intact canola seed did not perform as well as those fed canola meal and oil (Thacker, 1998).

In conclusion, the results of this experiment indicate that peas in combination with canola seed or canola meal are an acceptable alternative to soybean meal as a protein supplement for use in growing-finishing swine diets. Extrusion did not appear to have any beneficial effects on the nutritional value of the canola seed-pea blend as nutrient digestibility, growth performance and carcass traits were similar for pigs fed the unextruded blend of peas and canola seed compared with the extruded product. Since the process adds to the cost of the raw product, its use is unlikely to be economical.

## REFERENCES

- Aheme, F. X. and J. M. Bell. 1990. Canola seed: Full-fat. In: *Non-Traditional Feed Sources for Use in Swine Production* (Ed. P. A. Thacker and R. N. Kirkwood). Butterworth Publishers, Stoneham, Massachusetts, pp. 79-90.

- Association of Analytical Chemists. 1980. Official Methods of Analysis, 13th ed, AOAC, Washington, DC.
- Bell, J. M. and A. G. Wilson. 1970. An evaluation of field peas as a protein and energy source for swine rations. *Can. J. Anim. Sci.* 50:15-23.
- Bell, J. M. 1993. Factors affecting the nutritional value of canola meal: A review. *Can. J. Anim. Sci.* 73:679-697.
- Bengala Freiere, J., A. Aumaitre, J. Peiniau and Y. Lebreton. 1991. Apparent ileal digestibility of starch and  $\alpha$ -galactosides from peas by early weaned pigs: Effect of extrusion. In: *Digestive Physiology in Pigs* (Ed. M. W. A. Verstegen, J. Huisman and L. A. den Hartog). Pudoc, Wageningen, The Netherlands, pp. 395-399.
- Campbell, L. D. and F. Schone. 1998. Effects of antinutritional factors in rapeseed. In: *Recent Advances of Research in Antinutritional Factors in Legume Seeds and Rapeseed* (Ed. A. J. M. Jansman, G. D. Hill, J. Huisman and A. F. B. van der Poel). Wageningen Pers, Wageningen, The Netherlands, pp. 185-198.
- Castell, A. G. 1990. Field peas. In: *Nontraditional Feed Sources for Use in Swine Production* (Ed. P. A. Thacker and R. N. Kirkwood). Butterworths, Stoneham, Massachusetts, pp. 185-196.
- Castell, A. G. and L. Falk. 1980. Effects of dietary canola seed on pig performance and backfat composition. *Can. J. Anim. Sci.* 60:795-797.
- Castell, A. G., L. R. Neden and K. Mount. 1988. Potential of field pea (*Pisum sativum*) screenings as feed for market pigs. *Can. J. Anim. Sci.* 68:577-579.
- Davies, R. L. 1984a. Field peas as a feed for growing and finishing pigs. I. Nutrient levels in commercial crops. *Aust. J. Exp. Agric. Anim. Husb.* 24:350-353.
- Davies, R. L. 1984b. Field peas as a feed for growing and finishing pigs. 2. Effects of substituting peas for meat meal or fish meal in conventional diets. *Aust. J. Exp. Agric. Anim. Husb.* 24:507-511.
- Fenton, T. W. and M. Fenton. 1979. An improved procedure for the determination of chromic oxide in feed and faeces. *Can. J. Anim. Sci.* 59:631-634.
- Froseth, J. A. and D. M. Peters. 1981. Feeding rapeseed meal and raw or extruded whole rapeseed to growing-finishing pigs. Washington State University, Pullman Swine Day Producer Report No. 11.
- Grosjean, F. and F. Gatel. 1986. Peas for pigs. *Pigs News Inform.* 7:443-448.
- NRC. 1998. Nutrient Requirements of Domestic Animals. No. 2. Nutrient Requirements of Swine. 10th ed. NAS-NRC, Washington, DC.
- O'Doherty, J. V. and U. Keady. 2000. The nutritive value of extruded and raw peas for growing and finishing pigs. *Anim. Sci.* 70:265-274.
- O'Doherty, J. V. and U. Keady. 2001. The effect of expander processing and extrusion on the nutritive value of peas for pigs. *Anim. Sci.* 72:43-53.
- Orue, E., J. Butron, F. Ibanez, R. Alonso and F. Marzo. 1998. The effect of germination and extrusion on the nutritional quality of peas (*Pisum sativum* L. cv. Ballet). In: *Recent Advances of Research in Antinutritional Factors in Legume Seeds and Rapeseed* (Ed. A. J. M. Jansman, G. D. Hill, J. Huisman and A. F. B. van der Poel). Wageningen Pers, Wageningen, The Netherlands, pp. 417-420.
- Salo, M. L. 1980. Nutritive value of full fat rapeseeds for growing pigs. *J. Sci. Agric. Soc. Finland* 52:1-6.
- Saskatchewan Pork Producers Marketing Board. 1997. Export Hog Settlement Grid. Saskatoon, Sask. p. 2.
- Savage, G. P. and S. Deo. 1989. The nutritional value of peas: A literature review. *Nutr. Abstr. Rev. Series A*:65-87.
- SAS. 1990. SAS Users Guide, Version 8, SAS Institute Inc., Cary, NC.
- Swick, R. A. 1994. Soybean meal quality. American Soybean Association Technical Bulletin PO11-1994.
- Thacker, P. A. 1998. Effect of micronization of full-fat canola seed on performance and carcass characteristics of growing-finishing pigs. *Anim. Feed Sci. Technol.* 71:89-97.