Novel Feed Grains and Pulses in Western Canada

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Introduction

The crop and swine industries in western Canada continue facing increasing global competitiveness challenges. Corn yields in the US continue to rise while barley and wheat in Canada lag behind. Soybean prices keep dropping as the South American crop increases yearly. The feed market will soon be flooded with cheap, variable American corn distillers. Canola meal prices will likely drop not only to keep up a competitive ratio to soybean meal but also due to oversupply fuelled by the fast growth of the bio-diesel industry. To top all this up is a narrowing of the Canadian to US currency.

Feed remains the single most important component affecting cost of hog production. But our focus should not be limited to replacing imported feedstuffs in order to remain competitive. We not only need high-energy feedstuffs that would competitively propel hogs through the production cycle but also high crop yields per unit of land. This dual approach should therefore results in more separable lean pork produced per unit of land. Getting more out of the cultivated land and more out of our grain and pulses is a complementary approach sure to drive profitability and competitiveness for both crop growers and pork producers.

This paper summarizes recent research findings on two novel feed crops, triticale and zero-tannin (ZT) fababean. It also provides a perspective as to where the new feed industry in North America is heading. Co-products are the way of the future. And these two crops will lead us into this new era.

■ Triticale, a Better Feed Grain than Wheat?

The primary driver for considering triticale as feed grain was its higher yield than wheat. Most importantly, the highest yields have been in the Brown soils of the dryer southern Prairies. The second driver was its alluded "higher" net energy value compared to corn. Therefore, triticale should outperform wheat in hog diets. However, animal performance data to convince nutritionists and hog producers of the virtues of feeding triticale is scarce. Furthermore, animal performance data comparing triticale varieties to each other did not exist.

The objectives of this study were to evaluate the feeding value of triticale as a replacement for wheat (HRS or CPS), which is the western Canadian grain standard in nursery diets for pigs; and to compare the performance of weaned pigs offered different triticale varieties. For the trial, 288 weaned pigs were selected. The pigs were offered the regular production phase diets during the first week post-weaning. Pigs were then offered free access to the test diets for the 7 – 35d post-weaning period. Faecal grab samples were collected during the last three days of the trial to determine digestibility values for relevant dietary nutrients.

For the overall trial and the first three weeks, replacing wheat with triticale did not affect daily feed disappearance or weight gain (**Table 1**). For the last week of the study, pigs offered the HRS, CPS wheat or AC Ultima diets consumed more feed than those offered the Pronghorn, Bobcat or Pika diets. As a result, feed efficiency differed among the diets. Pigs fed the triticale diets had better overall feed efficiency than those fed either the HRS or CPS wheat diet. A similar response was also seen during the first two weeks of the study. Triticale varieties resulted in similar overall pig performance. AC Ultima was the most comparable triticale variety to CPS and HRS wheat in terms of animal response.

Table 1. Effect of dietary grain on overall growth performance of young pigs fed either wheat or triticale based diets (7.6 to 22.8 kg liveweight)[ab]

	Wheat		**Spring Triticale**		**Winter Triticale**		**SEM**	***P***
	HRS	CPS	AC Ultima	Prong horn	Bobcat	Pika		
Daily feed disappear-ance, g	811	819	798	789	789	786	11.2	0.19
Daily weight gain, g	535	549	541	543	550	546	10.4	0.93
Gain:feed, g:g	0.68*a*	0.69*a*	0.72*b*	0.72*b*	0.72*b*	0.72*b*	0.01	<0.05

[ab]Means in a row without the same superscripts differ ($P < 0.05$)

In terms of nutrient digestibility (percentage of digested nutrients), pigs generally absorbed more nutrients from CPS than HRS wheat (**Table 2**). But most important, pigs utilized more energy and retained more protein, calcium and phosphorus from all four varieties of triticale compared to both varieties of wheat. This finding mostly explained the higher overall feed conversion. The digestibility of nutrients in triticale varieties was closer to CPS than to HRS wheat. Excretion of phosphorus, a mineral which soil accumulation creates concerns in lands with heavy manure application, was highest for pigs fed wheat, intermediate for those fed the winter triticale and the least for pigs fed the spring triticale grain varieties.

Table 2. Nutrient digestibility coefficients for young pigs fed either wheat or triticale based diets (7.6 – 22.8 kg liveweight)[abcd]

	Wheat		**Spring Triticale**		**Winter Triticale**			
	HRS	CPS	AC Ultima	Prong-horn	Bobcat	Pika	SEM	*P*
Dry matter, %	87.1 *c*	88.3 *b*	88.6 *ab*	88.8 *ab*	88.8 *ab*	89.3 *a*	0.3	0.005
Crude protein, %	81.2 *b*	83.5 *a*	84.6 *a*	84.9 *a*	84.9 *a*	84.9 *a*	0.8	0.011
Gross energy, %	87.2 *b*	88.8 *a*	88.5 *a*	89.1 *a*	89.0 *a*	89.2 *a*	0.4	0.011
Ca, %	51.8 *b*	58.4 *ab*	63.7 *a*	52.0 *b*	59.2 *ab*	60.1 *a*	2.9	0.002
P, %	53.7 *d*	57.6 *c*	64.6 *a*	61.4 *ab*	55.9 *cd*	59.2 *bc*	1.3	0.001

[abcd]Means in a row without the same superscripts differ ($P < 0.05$; Duncan multiple range test)

The improved feed efficiency or energy digestibility when triticale replaced CPS or HRS wheat, respectively, in the diets suggest that the four triticale samples had a slightly higher digestible energy (DE) as well as net energy value (4 to 6%) than the HRS or CPS wheat samples. A higher starch and fat content and lower protein and fibre content in triticale would support a higher net energy value in triticale than wheat. Improved feed conversion efficiency combined with higher grain yield implies that triticale can produce more pork per area of cultivated land than wheat.

Increased protein, calcium and phosphorus digestibility compared to wheat not only implies reduced nutrient excretion but also lower nutrient supplementation from other dietary sources. Therefore, triticale diets can be formulated at a lower cost than wheat or barley diets. Triticale should

therefore command a premium price as feed grain compared to wheat or barley.

Due to funding constraints, this study was limited to four triticale and two wheat samples. More animal work is therefore required with a much greater number of samples to confirm these results and rank these grain samples among many others.

■ Zero-Tannin Fababean, a Better Pulse than Field Pea?

The primary driver for considering ZT fababean was yield. In years with adequate rainfall, it out-yields pea in the Black and Grey Wooded soils zones of central and north-western Alberta (Park et al 1999), where pork expansion is more likely to occur. The second driver was air nitrogen fixing. In contrast to pea, dry bean, chickpea and lentil, ZT fababean allows air nitrogen-fixing beyond blooming until the plant dries (Park et al 1999). The third driver was its high energy and protein content, which may displace imported soybean meal (Dening et al 2004).

Old fababean varieties were limited in their use in swine diets. A high content of anti-nutritional factors, mainly tannins, limited their dietary inclusion (Grala et al 1993). However, the new zero-tannin white-flowered varieties, such as Snowbird, have a tannin content lower than 1% (Park et al 1999). Tannins have been reduced, but we suspected that there might be other anti-nutritional factors that could hinder digestion in pigs. Legumes, in general, have complex carbohydrates that can cause digestive upset in young animals (Marquardt et al 1974, Muduuli et al 1981). We therefore tested this in weaned pigs by offering 0, 10, 20, 30, and 40% ZT fababean. We were surprised that young pigs tolerated well up 40% without detrimental effect on performance (**Table 3**). Weaned pigs did not require any adaptation period to ZT fababean. They performed as well as controls fed soybean meal even for the first week on trial.

We have previously reported that growing-finishing hogs performed similarly overall when fed up to 30% ZT fababean in substitution for soybean (Dening et al 2004). However, weight gain was reduced for barrows but not gilts for the grower period. Furthermore, gilts but not barrows showed reduced carcass lean and index. No comparison to the locally grown feed pulse standard (field pea) was made. It was imperative to elucidate potential negative effects on performance, carcass traits and pork quality as these may directly impact producer profitability and might jeopardize Canadian pork exports.

The primary objective of our latest trial with ZT fababean was to generate additional performance data on a commercial scale. This trial also compared the performance of hogs fed ZT fababean not only against those fed imported

soybean meal again, but also for the first time, against hogs fed the locally-grown field pea. The trial also provided the opportunity to collect additional carcass data and to evaluate the effects of the dietary supplemental protein sources on carcass cutout yield and pork quality.

Table 3. Growth performance of young pigs fed increasing levels of fababean in substitution for soybean meal from 14 – 35 days post-weaning (10 – 23 kg liveweight)[a]

	0% FABA 22.1% SBM	10% FABA 16.6% SBM	20% FABA 11.1% SBM	30% FABA 5.5% SBM	40% FABA 0% SBM	SEM
Feed disappearance, g/d						
14 – 21 d	660	672	652	621	620	33
21 – 28 d	897	876	880	872	856	33
28 – 35 d	1072	1056	1039	1026	1057	33
Overall	876	868	857	840	845	19
Weight gain, g/d						
14 – 21 d	481	474	466	468	455	25
21 – 28 d	591	573	579	580	561	25
28 – 35 d	663	693	665	667	694	25
Overall	579	580	570	572	570	15
Feed:gain, g:g						
14 – 21 d	1.37	1.41	1.40	1.35	1.38	0.05
21 – 28 d	1.52	1.54	1.53	1.52	1.59	0.05
28 – 35 d	1.63	1.53	1.56	1.54	1.53	0.05
Overall	1.50	1.49	1.49	1.47	1.50	0.03

[a]Means within row were not different ($P > 0.05$)

Approximately 1000 crossbred pigs were part of this study conducted at the Drumloche Research Barn, near Irma, managed by Gowans Feed Consulting. The hogs were offered diets where the supplemental protein sources was ZT fababean, ½ZT fababean:½ soybean meal, field pea or soybean meal. Most hogs were slaughtered at Britco in Langley, BC. Ninety-eight hogs were shipped to Sturgeon Valley Pork for slaughter instead. The half carcasses of the latter group were then shipped to AAFC Lacombe for dissection and pork quality measurements.

Table 4 summarizes the preliminary performance results. For all dietary treatments and irrespective of gender and phase, growth performance was excellent. Pigs averaged 1.018 kg/d over the 10 weeks preceding the first pull to slaughter when pens became incomplete. Daily feed disappearance and feed:gain for the same period averaged 2.68 and 2.70 kg, respectively. Feed cost per kilo gained averaged $0.39. Gross income after feed cost averaged $56.68. Carcass fat and loin depth averaged 20.5 and 65.2 mm, respectively, resulting in 60.0% separable pork yield, irrespective of gender. There were not treatment effects on primal cuts lean yield, but the pork of fababean and ½ZT

fababean:½ soybean meal was a bit darker that field pea and soybean meal fed controls. Drip loss from chops of hogs fed fababean or ½ZT fababean:½ soybean meal was lower than that of pigs fed soybean meal or field pea.The latter findings will be of great interest to packers exporting to Asian markets.

Table 4. Growth performance of hogs fed zero-tannin, Snowbird fababean or field pea in substitution for soybean meal (31 – 108 kg liveweight)[ab]

	SBM	Faba	Faba/Soy	Pea
Initial weight, kg	31.8	31.0	31.8	30.7
5-wk end weight, kg	65.9	65.1	65.9	65.0
Daily weight gain, kg	0.983	0.968	0.981	0.978
Daily feed disappearance, kg	2.19	2.22	2.24	2.21
Feed:gain, kg:kg	2.23	2.29	2.29	2.26
11-wk end weight, kg	108.6	108.6	108.9	107.8
Daily weight gain, kg	1.008	1.035	1.018	1.011
Daily feed disappearance, kg	3.07	3.06	3.08	3.05
Feed:gain, kg:kg	3.05	2.96	3.02	3.01
0 – 11 wk overall				
Daily weight gain, kg	0.996	1.004	1.001	0.996
Daily feed disappearance, kg	2.67	2.67	2.70	2.67
Feed:gain, kg:kg	2.68	2.66	2.69	2.67
Feed cost, $/kg gained	0.400	0.396	0.386	0.384
Income over feed cost $/pig	55.8	57.0	57.0	57.0
Carcass wt, kg	94.6	93.8	94.6	94.7
Carcass fat, mm	20.9	19.9	20.7	20.5
Carcass lean, mm	65.4	65.3	65.3	64.7
Carcass yield %	59.89	60.27	59.97	59.99

[a]Preliminary results
[b]Means within row were not different ($P > 0.05$)

Feed cost per kilo gained was the lowest for hogs fed the pea diet and highest for the hogs fed the soybean meal diet. However, income over feed cost was

the same for the fababean, ½ZT fababean:½ soybean meal and field pea treatments. These preliminary results need to be confirmed yet and will include a tie to agronomics. Despite similar hog growth performance compared to pea, higher fababean yield may result in more pork produced per area of cultivated land.

■ Co-products of Triticale and ZT Fababean Leading Us to the Future

Triticale and ZT fababean have not only proven to be promising feedstuffs in their raw form, but offer the potential to be further value-added as food, feed and bio-industrial co-products.

Alberta Agriculture, the University of Alberta, Agriculture and Agri-Food Canada and several industry partners are working on a bio-refinery initiative for triticale. Triticale grain may be segregated into several components (protein, starch, fibre) prior to fermenting the starch to ethanol resulting in a more efficient process than the current fermentation scheme producing high fibre distillers grain. The potential for a whole array of co-products make this triticale initiative very enticing.

Closer to reality than the proposed bio-refinery initiative for Triticale is co-product production from Prairie-grown pulse crops. We have already successfully fractionated ZT fababean and field pea into starch and high protein concentrates. No high cost wet separation followed by sophisticated spray-drying is required. In this low cost and fast process, we take 28% crude protein ZT fababean to a 70% crude protein concentrate in minutes! And as expected, the protein content and yield of the protein fraction is substantially higher in ZT fababean compared to field pea. Furthermore, preliminary laboratory results suggest that we are not only obtaining segregation of the protein from the starch but also the latter is separating into its basic components in both pulse crops. We hope the protein concentrates will find markets in breakfast bars, high-protein snacks, aquaculture and pet foods, baby animal diets. The starch fractions will find markets in the bakery, paint and paper industry among a few.

■ Conclusions

In summary, our excitement with triticale and ZT fababean is not merely founded on their resulting animal performance when fed in raw form. Triticale offers higher yield, disease and drought tolerance, high net energy for swine. ZT fababean offers higher yield, longer N-fixing, high energy and protein. The potential to produce more lean pork per unit of land is there. And both crops

can be further value-added as co-products of interest to the food, feed and bio-industrial industries. Looks like we got two winners to champion our future!

References

Dening, B. 2004. Zero-tannin fababean as a new pig feed for Alberta. Western Hog Journal Vol. 26, No. 2, pp 39 – 45.

Grala, W., A.J.M. Jansman, P. van Leeuwen, J. Huisman, G.J.M. van Kempen, M.W.A. Verstegen, P. van Leeuwen. 1993. Nutritional value of faba beans (Vicia faba L.) fed to young pigs. Journal of Animal and Feed-Sciences 2:4, 169-179.

Gunawardena, C., W. Robertson, M. Young, R. Zijlstra, and E. Beltranena. 2007. Zero-tannin fababean, field pea and soybean meal as dietary protein sources for growing – finishing pigs. In Proceedings of the Midwestern Animal Science Meeting. Des Moines. Abstract submitted.

Marquardt, R.R., L.D. Campbell, S.C. Stothers and J.A. McKirdy. 1974. Growth response of chicks and rats fed diets containing four cultivars of raw and autoclaved faba beans. Cdn. J. Anim. Sci. 54:177 – 182.

Muduuli, D.S., R.R. Marquardt and W. Guenter. 1981. Effect of dietary vicine on the reproductive performance of laying hens. Cdn. J. Anim. Sci. 61:757 – 764.

Omogbenigun, O., R. Zijlstra, D. Salmon and E. Beltranena. 2006. Triticale, an excellent feed grain for weaned pigs. Western Hog Journal Vol. 28, No. 3, pp 48 - 53.

Omogbenigun, O., R. Zijlstra and E. Beltranena. 2005. Zero-tannin fababean can fully replace soybean meal in late nursery diets. Western Hog Journal Vol. 27, No. 2, pp 47.

Park, B., K. Lopetinsky, R. Bjorklund, T. Buss., S. Eppich, P. Laflamme, N. Miller, M. Olson., K. Piquette. 1999. Pulse crops in Alberta. Alberta Agriculture, Food & Rural Development.