SHORT COMMUNICATION

Triticale as a replacement for wheat in diets for weaned pigs

E. Beltranena[1,2], D. F. Salmon[1], L. A. Goonewardene[1], and R. T. Zijlstra[2,3]

[1]Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada T6H 5T6; and [2]Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta, Canada T6G 2P5.
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Beltranena, E., Salmon, D. F., Goonewardene, L. A. and Zijlstra, R. T. 2008. **Triticale as a replacement for wheat in diets for weaned pigs.** Can. J. Anim. Sci. **88**: 631–635. The nutritional value of triticale for weaned pigs is poorly characterized. Six mash diets containing either 66.5% one of two wheat samples or one of four winter or spring triticale cultivars were fed to 72 pens of weaned pigs for 28 d. Average daily feed intake and gain did not differ between pigs fed wheat and triticale diets ($P > 0.05$). Replacing wheat with triticale increased feed efficiency by 0.02 for spring triticale and 0.03 for winter triticale ($P < 0.001$). Apparent total tract digestibility of dry matter, crude protein, and gross energy was 1.2, 2.5, and 1.0% higher, respectively, for the triticale diets than the wheat diets ($P < 0.05$). The nutritional value of the four triticale samples was 1.5% higher for energy than the two wheat samples included in western Canada diets for weaned pigs.

Key words: Digestibility, growth, triticale, weaned pig, wheat

Beltranena, E., Salmon, D. F., Goonewardene, L. A. et Zijlstra, R. T. 2008. **La triticale en tant que succédané du blé dans la ration des porcelets sevrés**. Can. J. Anim. Sci. **88**: 631–635. On connaît mal la valeur nutritive de la triticale pour les porcelets sevrés. Six pâtées contenant 66,5 % d'un de deux échantillons de blé ou d'un de quatre cultivars de triticale de printemps ou d'hiver ont été servies à des porcelets sevrés gardés dans 72 enclos pendant 28 jours. La prise alimentaire et le gain quotidien moyen étaient les mêmes pour les sujets engraissés avec le blé ou la triticale ($P > 0{,}05$). Remplacer le blé par de la triticale rehausse la valorisation des aliments de 0,02 pour la triticale de printemps et de 0,03 pour celle d'hiver ($P < 0{,}001$). La digestibilité apparente totale de la matière sèche, de la protéine brute et de l'énergie brute de la triticale dépassait celle du blé respectivement de 1,2, de 2,5 et de 1,0 % ($P < 0{,}05$). Les quatre échantillons de triticale contenaient 1,5 % plus d'énergie que les deux lots de blé employés pour nourrir les porcelets sevrés élevés dans l'Ouest canadien.

Mots clés: Digestibilité, croissance, triticale, porcelets sevrés, blé

The competitiveness of the western Canadian pork industry is under pressure, in part due to lagging feed grain productivity (Grier and Mussell 2007). Triticale (× *Triticosecale* Wittmack) is a hybrid of wheat (*Triticum*) and rye (*Secale*) that may have a higher yield than Canada Prairie Spring Red (CPSR) wheat under certain growing conditions (McLeod et al. 2001). However, Canada remains a minor player in global triticale production, in part due to a lack of reliable Canadian information about triticale and its potential for forage and feed uses (Briggs 2001).

Triticale cultivars developed after 1975 are low in trypsin inhibitors, and palatability of triticale is thus currently less of a concern (Radecki and Miller 1990). Growth performance experiments conducted with grower-finisher pigs indicate that triticale included in diets balanced for amino acids may provide a similar growth performance as wheat or corn (Coffey and Gerrits 1988; Myer et al. 1996), and has a higher amino acid and starch digestibility than barley (Fernández-Fígares et al. 2008). However, relatively little is known about the nutritional value of triticale for weaned pigs; studies conducted in the distant past suggest that triticale may reduce growth performance of young pigs relative to corn (Hale and Utley 1985). The hypothesis tested in the present study was that weaned pigs fed either winter or spring triticale as the sole dietary cereal grain can achieve a similar growth as weaned pigs fed wheat. The objectives were to characterize and compare average daily feed intake (ADFI), average daily gain (ADG), feed efficiency (gain:feed), and apparent total tract nutrient digestibility of weaned pigs fed diets

Abbreviations: ADFI, average daily feed intake; **ADG,** average daily gain; **CP,** crude protein; **CPSR,** Canada Prairie Spring Red; **CWRS,** Canada Western Red Spring; **DM,** dry matter; **NE,** net energy

[3]*To whom correspondence should be addressed (e-mail: ruurd.zijlstra@ualberta.ca).*

containing either wheat, spring triticale, or winter triticale as the main feedstuff.

The six wheat and triticale samples were grown in Alberta: the spring triticale cultivars AC Ultima and Pronghorn in Ponoka and Brooks, respectively, the winter triticale cultivars Bobcat and Pika in Wetaskiwin and Foremost, respectively, and the Canada Western Red Spring (CWRS; also known as Hard Red Spring) and CPSR wheat in Wetaskiwin. Pigs were fed one of six mash diets containing one of these six samples (Table 1). The experimental diets also contained soybean meal, whey permeate, herring meal, and soy protein concentrate (Soycomil, ADM, Decatur, IL) as supplemental protein sources to acquire an adequate amino acid balance [National Research Council (NRC) 1998]. The wheat and triticale diets were formulated to provide 2.35 Mcal net energy (NE) kg^{-1} and 5.0 g standardized ileal digestible lysine $Mcal^{-1}$ NE, with other amino acids as a ratio to lysine (NRC 1998). The NE and amino acid values used for feed formulation were an average of NRC (1998) and Sauvant et al. (2004). A premix was added to meet or exceed mineral and vitamin requirements (NRC 1998) and acid insoluble ash (Celite, Celite Corp., World Minerals Co. Lompoc, CA) was added as a digestibility marker.

The animal protocol for the study was approved by the University of Alberta Faculty Animal Policy and Welfare Committee, and followed principles established by the Canadian Council on Animal Care (1993). The experiment was conducted at the Swine Research and Technology Centre at the University of Alberta (Edmonton, AB). In total, 288 crossbred pigs (Duroc sire × Large White/Landrace F1; Genex Hybrid; Hypor, Regina, SK) were weaned at 20 ± 1 d of age and selected based on a similar weaning weight (7.6 ± 1.1 kg). Heavy and light barrows and gilts were randomized within gender so that two barrow and two gilts were housed within each of 72 pens. Following weaning, pigs were fed commercial Phase 1 and 2 diets (Unifeed, Edmonton, AB) for 7 d. Pigs were then fed the experimental diets for 28 d.

Pigs were housed in floor pens (1.1×1.5) equipped with a nipple drinker, multiple-space feeder, and slatted plastic flooring. Pigs had free access to feed and water during the entire experiment. Freshly voided faeces were collected by grab sampling from 0800 to 1600 during the last 3 d of the trial. Faeces samples were quickly frozen at –20°C and subsequently freeze-dried. Ingredient, diet, and faeces samples were ground through a 1-mm screen.

Ingredient, diet, and faeces were analyzed for moisture [method 930.15; Association of Official Analytical Chemists (AOAC) 1990], crude protein ($N \times 6.25$; method 988.05; AOAC 1990), and calcium and phosphorus (method 985.01; AOAC 1990). Diet and faeces were analyzed for acid-insoluble ash (McCarthy et al. 1974) and gross energy by bomb calorimetry. Based on the results of the chemical analyses, apparent total tract nutrient digestibility was calculated using the acid insoluble ash concentration of feed and faeces using the indicator or index method (Adeola 2001). To calculate pen ADG, individual pigs were weighed every 7 d. To calculate pen ADFI, feed added and left over was weighed every 7 d of the 28-d study. Feed efficiency was calculated as ADG/ADFI. Performance variables were reported for day 0 to 28.

Pen was considered the experimental unit. The MIXED procedure of SAS (SAS Institute, Inc. 1996) was used to analyze the variance of the performance variables (Wang and Goonewardene 2004), except for nutrient digestibility, which was analyzed using the general linear models procedure. Wheat and either spring or winter triticale and winter and spring triticale were compared for the measured variables using preplanned contrasts.

The six ingredient and diet samples were similar in concentration of acid detergent fibre, calcium, and phosphorus (Table 2). The four triticale samples were on average 0.8% higher in crude protein and 0.8% lower in neutral detergent fibre than the two wheat samples. The six diets did not differ substantially in gross energy content.

For the entire experiment (day 0 to 28), replacing wheat with either spring or winter triticale did not affect ADFI and ADG of pigs ($P > 0.05$; Table 3). Replacing wheat with triticale increased feed efficiency by 0.02 for spring triticale and 0.03 for winter triticale for day 0 to 28 ($P < 0.001$). The growth performance variables did not differ between winter and spring triticale ($P > 0.05$).

Apparent total tract digestibility of dry matter, crude protein (CP), gross energy, calcium, and phosphorus

Table 1. Ingredients composition of the experimental diets fed to weaned pigs

Ingredient	%
Test ingredient (wheat or triticale)	66.47
Soybean meal	12.50
Whey permeate	7.50
Herring meal	5.00
Soy protein concentrate	2.50
Canola oil	2.50
Limestone	0.90
Celite	0.80
Mono-dicalcium phosphate	0.50
Salt	0.50
L-Lysine-HCl	0.30
L-Threonine	0.17
Mineral premix[z]	0.10
Vitamin premix[y]	0.10
DL-Methionine	0.08
Choline chloride	0.05
L-Tryptophan	0.03

[z]Provided per kg of diet: Zn, 150 mg; Cu, 100 mg; Fe, 85 mg; Mn, 40 mg; I, 0.36 mg; Se, 0.3 mg.
[y]Provided per kg of diet: vitamin A, 15 000 IU; vitamin D, 1500 IU; vitamin E, 40 IU; niacin, 47.5 mg; pantothenic acid, 31.25 mg; riboflavin, 8.75 mg; pyridoxine, 3.3 mg; vitamin K, 2.06 mg; biotin, 0.12 mg; vitamin B_{12}, 0.044 mg.

Table 2. Analyzed nutrients in ingredient samples and experimental diets

	Wheat		Spring triticale		Winter triticale	
Analyzed nutrients	CWRS	CPSR	AC Ultima	Pronghorn	Bobcat	Pika
Ingredients (% DM)						
Moisture	12.9	9.9	10.1	11.9	11.6	9.9
Crude protein	13.5	14.9	13.0	15.8	15.4	15.2
Acid detergent fibre	3.8	4.3	4.1	4.2	3.6	4.2
Neutral detergent fibre	12.5	11.4	12.3	10.5	10.6	11.5
Calcium	0.05	0.06	0.04	0.03	0.04	0.04
Phosphorus	0.40	0.45	0.35	0.40	0.26	0.37
Diets						
Moisture (% DM)	11.8	10.5	10.6	10.5	10.9	9.5
Crude protein (% DM)	22.3	23.0	22.7	23.9	24.2	23.6
Acid detergent fibre (% DM)	4.4	4.2	4.1	4.2	4.5	4.0
Neutral detergent fibre (% DM)	11.6	11.3	13.1	10.3	10.9	11.6
Calcium (% DM)	0.91	0.90	1.01	0.88	0.94	0.92
Phosphorus (% DM)	0.67	0.72	0.71	0.69	0.62	0.70
Gross energy (Mcal kg^{-1} DM)	4.41	4.39	4.39	4.42	4.41	4.43

was 1.2, 2.5, 1.0, 3.7, and 4.6% higher, respectively, on average for the triticale diets than the wheat diets ($P<0.05$; Table 3). Nutrient digestibility did not differ between winter and spring triticale ($P>0.05$), except that P digestibility was 5.5% higher for spring than winter triticale ($P<0.001$). Achieved diet DE content was 3.85, 3.90, 3.89, 3.94, 3.92, and 3.95 Mcal kg^{-1} DM for the CWRS, CPSR, AC Ultima, Pronghorn, Bobcat, and Pika samples, respectively. Using the 66.47% inclusion rate of wheat or triticale in test diets, the DE content of the four triticale samples was on average 1.5% higher than the two wheat samples.

To improve the competitiveness of the Canadian pork industry, cultivation of feed grains with a higher yield or additional cultivation of feed grains in areas with marginal growing conditions should be part of a solution package. Triticale might improve feed grain yield in marginal growing conditions (McLeod et al. 2001); however, growth performance of pigs fed triticale should then be maintained at a level equivalent to feeding the predominant feed grains for pigs in the western Canadian prairies, i.e., wheat. To test the hypothesis rigorously, an approach using weaned pigs that passed the initial period following weaning was selected, because these pigs can be fed diets containing a high amount of the test feedstuff cereal grain. The weaned pig is likely a model that is more sensitive than the grower-finisher pig to detect effects of remaining anti-nutritional factors or other feed components that may cause reductions in voluntary feed intake, digestion, or nutrient retention, because gut maturation has not been completed (Pluske et al. 1997).

Feedstuff samples vary in chemical characteristics and thus nutritional quality. Therefore, an approach to include two samples for each of three feedstuffs was selected so that so that averaged values per feedstuff would be closer to the population mean than with one sample. The higher CP content and lower NDF content for triticale than wheat in the present study are in contrast to a lower CP content and equivalent NDF content for triticale and wheat in North American and European databases (e.g., NRC 1998; Sauvant et al. 2004). A lower NDF content has been correlated with an increased apparent total tract energy digestibility and digestible energy content in wheat (Zijlstra et al. 1999), and explains the higher total tract energy digestibility and DE content for triticale than wheat diets in the present study. Fibre can also reduce digestibility of other macronutrients, explaining the higher DM and CP digestibility for triticale than wheat diets in the present study. Triticale cultivated in western Canada can thus match and sometimes surpass the energy and amino acid quality of wheat. The DE and NE contents of triticale are normally listed lower than of those of wheat in databases (e.g., Centraal Veevoeder Bureau, 2003; Sauvant et al. 2004), even though the NE content of triticale is sometimes, mistakenly, listed higher than that of wheat and even corn (NRC 1998). Nutrient digestibility was not different between spring and winter triticale, indicating that time of seeding does not change nutritional composition of triticale. Caution should be taken by extrapolating the findings of the present study to the entire feed industry. A small number of samples per feedstuff was included that might not be representative of the entire triticale and wheat population.

Of the growth performance variables, feed efficiency was higher for triticale than wheat, reflecting the higher nutrient digestibility for triticale than wheat, whereas ADFI and ADG were not different. However, the design of the present study does not exclude the possibility that one amino acid was limiting in a wheat diet, thereby explaining the difference in feed efficiency, because the CP content was higher in the triticale diets (e.g., 22.3% in CWRS diet versus 24.5% in Bobcat diet). As described, most experiments feeding triticale to swine have been conducted with grower-finisher pigs;

Table 3. Growth performance and apparent total tract nutrient digestibility of weaned pigs fed either wheat or triticale

Variable[z]	Wheat		Spring triticale		Winter triticale		SEM	*P* value		
	CWRS	CPSR	AC Ultima	Pronghorn	Bobcat	Pika		Wheat vs. spring triticale	Wheat vs. winter triticale	Spring vs. winter triticale
Performance, day 0 to 28										
ADFI (g d^{-1})	814	814	792	779	784	785	21.8	0.187	0.102	0.748
ADG (g d^{-1})	536	545	538	536	546	544	13.1	0.920	0.924	0.845
Feed efficiency	0.66	0.67	0.68	0.69	0.70	0.69	0.01	0.001	0.001	0.534
Nutrient digestibility (%)										
Dry matter	87.1	88.3	88.6	88.8	88.8	89.3	0.3	0.009	0.001	0.759
Crude protein	81.2	83.5	84.6	84.9	84.9	84.9	0.8	0.008	0.005	0.903
Gross energy	87.2	88.8	88.5	89.1	89.0	89.2	0.4	0.032	0.044	0.717
Calcium	51.8	58.4	63.7	52.0	59.2	60.1	2.9	0.135	0.017	0.501
Phosphorus	53.7	57.6	64.6	61.4	55.8	59.2	1.3	< 0.001	0.651	< 0.001

[z]Means are based on 12 pen observation per diet.

however, in the first part of a feeding trial bringing pigs to slaughter, weaned pigs fed triticale in diets replacing corn and rebalanced for energy and amino acid content, nutrient content resulted in similar ADG, ADFI, and feed efficiency (Coffey and Gerrits 1988). As far as we understand, the present study is one of the few published studies indicating that weaned pigs fed triticale can achieve an identical ADG as weaned pigs fed wheat, with a 1:1 replacement, suggesting that feeding of triticale instead of wheat can be implemented rapidly and without major concern for remaining anti-nutritional factors. For grower-finisher pigs, the lack of effects of a switch from feeding corn and hull-less barley as the main cereal grain to triticale on ADG, ADFI and carcass quality had already been established under western Canadian conditions (Jaikaran et al. 1998).

In summary, weaned pigs fed triticale as the sole dietary cereal grain can achieve growth at least similar to that of weaned pigs fed wheat. The outcome indicates that the cultivation of triticale instead of wheat as a feed grain should be part of a solution to improve the competitiveness of the western Canadian pork industry.

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