ISSN 1644-0714
ISSN 2300-6145 (online)
www.asp.zut.edu.pl

ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol. Zootechnica 14(3) 2015, 15–24*

EFFECT OF CEREAL GRAIN TYPE USED IN DIETS ON THE FATTENING PERFORMANCE AND SLAUGHTER VALUE OF PIGS

Teresa Banaszkiewicz, Karol Kaszperuk, Teresa Bombik

University of Natural Sciences and Humanities in Siedlce, Poland

Abstract. The aim of the study was to evaluate production performance, carcass yields, and pork quality of pigs fed diets including barley and triticale. The experiment involved 16 growing pigs obtained from the Danish DanAvI breeding system, in 2 groups, 8 pigs each (4 gilts and 4 barrows). The feeding trial took 74 days. The control pigs were offered diets containing ground barley, whereas the test pigs were fed ground triticale. Body weight, feed conversion, pork yield as well as heart and liver weights were determined. After cooling, the right side of the carcass was measured for length and backfat thickness, which was followed by fabrication. Body weight gains, feed intake, and cold dressing percentage within groups did not vary significantly. Also differences in carcass meat content (60.1% – control, 57.2% – test group) were statistically non-significant. The control pigs (fed barley) had significantly larger livers (1.52% of body weight); however, carcass lengths and backfat thickness were similar within groups. Loin dissection analysis revealed a significantly higher percentage of meat in test pigs, i.e. those fed the diet with ground triticale (52%). No significant differences were found between groups in terms of sensory evaluation. Triticale may represent a complete replacement for barley in diets for growing pigs, due to its positive effects on the performance and slaughter traits that are important from the consumer's standpoint.

Key words: pigs, barley, triticale, production performance, slaughter value, meat quality evaluation

Corresponding author: Teresa Banaszkiewicz, University of Natural Sciences and Humanities in Siedlce, Faculty of Life Sciences, Bolesława Prusa 14, 08-110 Siedlce, Poland, e-mail: banaszt@ap.siedlce.pl

INTRODUCTION

Barley is considered a major feed grain in Poland, which can be used with virtually no restrictions in diets for growing pigs [Fabijańska et al. 2002]. Ground barley is well utilized by pigs and positively affects the carcass quality. Some authors suggest that alternative cereal grains, such as triticale, can also yield good results in the feeding of growing/finishing pigs [Myer and Lozano del Rio 2004, Beltranena and Zijlstra 2007, Beltranena et al. 2008]. Triticale contains more protein compared to other cereal grains. Its application in swine nutrition is not limited by fiber content. The grain combines the positive traits of wheat (good quality grain) with the positive features of rye (vitality and fertility, disease resistance, high lysine content). The positive outcomes of feeding trials using triticale, as reported by Kondracki and Olkowski [1997], Fernandez-Figares et al. [2008] and Omogbenigum et al. [2006], may be associated with better utilization of certain nutrients from barley than from triticale. New cultivars of both barley and triticale are constantly introduced for cultivation and new pig hybrids are produced for farming. Hence, studies were undertaken which were designed to evaluate the production and slaughter performance, as well as pork quality, of growing/finishing pigs fed diets containing ground barley or triticale.

MATERIAL AND METHODS

The trial was carried out on a commercial pig farm and involved 16 crossbred LY♀ × DD♂ pigs developed in the Danish breeding system DanAvI (♀ DanHybrid LY and ♂ Danish Duroc, DD), allotted to two groups, 8 pigs each (4 gilts and 4 barrows). The trial took 74 days, including 27 days growing (grower diet) followed by 47 days finishing (finisher diet). Diet compositions used in the feeding trial are presented in Table 1. The nutritional value of the diets was balanced according to NRC [1998]. Pigs were given *ad libitum* access to feed and water. The control group (barley) was fed grower and finisher diets containing ground maize (35%) and ground barley cv. Kos (45% grower feed and 50% finisher). The diets were supplemented with soybean meal and protein concentrate. The diet of the test group (triticale) contained ground triticale cv. Wontario instead of barley.

During the feeding trial, individual body weights were recorded on the commencement of the trial, on the completion of the growing period, and on the completion of the trial; feed conversion in each production stage was measured through weighing the amount of the feed given. Based on these data, we calculated body weight gains of individual pigs (as the difference between the final and initial body weight in the growing and finishing periods of production) and feed conver-

Table 1. Percentage composition and nutritive value of diets for fattening pigs

Tabela 1. Skład procentowy i wartość pokarmowa mieszanek dla tuczników

Components Komponenty	Grower diet Mieszanka grower		Finisher diet Mieszanka finiszer	
	C (barley) (jęczmienna)	T (triticale) (pszenżytnia)	C (barley) (jęczmienna)	T (triticale) (pszenżytnia)
Ground maize – Śruta kukurydziana	35	35	35	35
Ground barley – Śruta jęczmienna	45	–	50	–
Ground triticale – Śruta pszenżytnia	–	45	–	50
Protein concentrate – Koncentrat białkowy	15	15	10	10
Soybean meal – Śruta poekstrakcyjna sojowa	5	5	5	5
Nutritional value of 1 kg feed – Wartość pokarmowa 1 kg mieszanki				
metabolizable energy, MJ energia metaboliczna, MJ	13.53	13.93	13.39	13.84
crude protein, g białko ogólne, g	161	165	149	152

sion per 1 kg gain during feeding the grower and finisher diets, as well as for the entire period (as a ratio of the amount of feed consumed to the overall gain).

On the completion of the feeding trial, the pigs were slaughtered in a slaughter facility. Directly after slaughter, the meatiness was evaluated using the W-03 needle apparatus; also, heart, liver, and warm carcass weights were measured. Next, the carcasses were chilled for 24 hours, cut into half-carcasses and weighed. On the right side of the carcass, using a measuring tape, we measured the carcass length (as the distance between the anterior edge of the junction between the first rib and the sternum and the anterior edge of the pubic bone section); we also measured fat thickness at five sites of the carcass, i.e. over the shoulder, on the back past the last thoracic vertebra, and at three sites over the cross section of the loin. The measurements were carried out using a calipers after cutting the carcass in two.

Thereafter, both halves of the carcass were cut into particular cuts following the methods by the Swine Slaughter Quality Control Station (SKURTCh). Also loin and ham were dissected and their meat, fat, and bones were separated. Based on the data on the slaughter analysis, we calculated the cold dressing percentage, heart and liver weight in relation to body weight, and the percentage content of loin and ham elements in this weight. During the dissection analysis, samples for sensory evaluation were collected from *m. longissimus lumborum* and *m. semimembranosus*.

The sensory evaluation was carried out by a group of 7 panelists, according to the methods described by Baryłko-Pikielna and Matuszewska [2009], using the 5-point scale of Tilgner [1957].

The resulting data were processed statistically using the Statistica ver. 10 package. Significance of differences between groups was tested with the *t*-test [Ruszczyc 1981].

RESULTS

The difference in body weight of the pigs, about 3 kg at the beginning of the test period, remained at this level until its completion. On the completion of the growing period (feeding the grower diets), the body weight of the control pigs fed with barley averaged 72.8 kg and was by 3.9 kg higher compared to the test pigs (fed triticale). At the end of the finishing, the test pigs attained a higher body weight, 116.3 kg on average. The test pigs reached 69.1 kg and 113.2 kg in the respective production stages (Table 2). The differences in the body weight, however, were statistically non-significant.

Table 2. Fattening results

Tabela 2. Wyniki tuczu

Specification – Wyszczególnienie	Groups – Grupy		SEM
	C (barley) (jęczmienna)	T (triticale) (przenżytnia)	
Body weight, kg – Masa ciała, kg			
initial – początkowa	48.6	45.6	1.12
after growing – po I okresie (mieszanka grower)	72.8	69.1	1.40
on slaughter – po zakończeniu tuczu	116.3	113.2	2.65
Total individual gain, kg – Łączny przyrost jednej sztuki, kg			
growing – I okres	24.2	23.5	0.88
finishing – II okres	43.5	44.1	1.90
total growing/finishing – cały okres tuczu	67.7	67.5	2.50
Daily gain, g – Przyrost dobowy, g			
growing – I okres	896	869	32.52
finishing – II okres	925	938	40.41
total growing/finishing – cały okres tuczu	915	913	33.85
Feed conversion, kg · kg^{-1} – Zużycie paszy, kg · kg^{-1}			
growing – I okres	3.00	3.19	0.03
finishing – II okres	3.48	3.37	0.05
total growing/finishing – cały okres tuczu	3.30	3.31	0.06

Body weight gains in each production stage, as well as during the entire fattening period, were similar within the groups (cumulated gains 67.7 kg in the control and 67.5 kg in the test group. Also feed conversion per 1 kg of gain in the 1st and the 2nd production periods, as well as over the entire test period, did not

differ significantly between the groups and was 3.3 kg in the control (barley) and 3.31 kg in the test group (triticale).

Cold dressing percentage of the pigs from either group (Table 3) was similar, 78.6% in the control and 78.9% in the test group. Carcass yield in both groups was high, with a non-significant difference of about 3% between the groups (60.1%, control, and 57.2%, test group).

Table 3. Results of post-slaughter analysis

Tabela 3. Wyniki oceny poubojowej

Specification – Wyszczególnienie	Groups – Grupy		SEM
	C (barley) (jęczmienna)	T (triticale) (przenżytnia)	
Cold carcass weight, kg – Masa tuszy zimnej, kg	91.40	89.40	2.08
Cold dressing percentage, % – Wydajność rzeźna zimna, %	78.60	78.90	0.21
Meatiness, % – Mięsność, %	60.10	57.20	1.23
Percentage of heart in BW, % – Udział serca w masie ciała, %	0.40	0.35	0.01
Percentage of liver in BW, % – Udział wątroby w masie ciała, %	1.52[b]	1.35[a]	0.05
Carcass length, cm – Długość tuszy, cm	83	83	0.70
Backfat thickness, mm – Grubość słoniny, mm			
over shoulder – nad łopatką	34	34	1.75
over 1st loin – nad I kręgiem krzyżowym	23	19	1.95
over 2nd loin – nad II kręgiem krzyżowym	27	27	2.88
over 3rd loin – nad III kręgiem krzyżowym	12	15	1.27
on back – na grzbiecie	20	21	1.95
mean backfat thickness (from 5 sites) – średnia grubość słoniny (z 5 punktów)	23.2	23.2	1.25
Weight of right loin, kg – Masa prawego schabu, kg	7.17	7.12	0.24
Percentage in loin, % – Udział w schabie, %			
meat – mięsa	51.60[b]	52.00[a]	1.88
hide with backfat – skóry ze słoniną	22.10	21.80	1.81
bones – kości	19.10	19.40	0.77
Weight of right ham, kg – Masa prawej szynki, kg	11.98	11.74	0.37
Percentage in ham, % – Udział w szynce, %			
meat – mięsa	74.30	73.60	1.17
bones – kości	7.60	7.70	0.22
hide with backfat – skóry ze słoniną	15.00	14.10	0.96

[a], [b] – means marked with different letters differ significantly at ($P \leq 0.05$).
[a], [b] – wartości średnie oznaczone różnymi literami różnią się istotnie ($P \leq 0,05$).

The percentage of heart and liver has been presented in Table 3. The proportion of the heart to the body weight was similar, whereas significant differences were found in the liver. Significantly larger livers were found in the control pigs fed with barley (Table 3).

Pigs from both groups were characterized by the same carcass length, and the mean backfat thickness in five points was also equal (23.3 mm). The results of loin and ham dissection (Table 3) indicate a significantly higher lean percentage in the carcasses of the test group (triticale). No significant differences were found, however, between the groups when it comes to ham percentage analysis. The percentages of pork, bones, and hide with backfat in this cut were similar.

The sensory evaluation of meat (Table 4) did not reveal significant differences between the groups, either. Although the scores for each particular organoleptic characteristic were similar in both groups, a trend of better scores in relation to *m. longissimus lumborum* may be seen after application of triticale (by 0.3 pts for juiciness and by 0.2 pts for tenderness). In reference to *m. semimembranosus*, application of triticale non-significantly reduced the score it attained (Table 4).

DISCUSSION

Introducing triticale instead of barley to the diet offered during the growing and finishing stages did not affect the production performance of the pigs, such as body weight, weight gains or feed efficiency; during the period of finisher diet application though, a tendency could be observed of an improvement in body weight gains. Such outcomes could have resulted from a higher, according to Cornejo et al. [1973], energy content of triticale compared to barley, and from a higher content of amino acids and sugars [Fernandez-Figares et al. 2008]. Smith and Pearson [1989], who completely replaced barley with triticale, attained a comparable level of body weight gains and improved feed utilization, which was explained by the authors with a higher lysine content and better availability of triticale energy. Our results indicate that triticale can entirely replace barley in diets offered to growing pigs, without compromising performance parameters.

The meat content observed in our trial was high (57.2 and 60.1%). According to Szyndler-Nędza [2006], this parameter for the entire pork production industry in Poland averages 52.6%. Tereszkiewicz et al. [2010], on the other hand, report that Pietrain pigs attain a higher meat content (62.36%).

Significantly larger livers were obtained from pigs fed diets that contained barley. The weight of internal organs may be affected by the anti-nutritional factors in the ration, e.g. insoluble non-starch polysaccharides (NSPs). In such cases, the organs secrete additional amounts of enzymes, which may be followed by an increase in their weight.

In a feeding trial by Karunajeewa and Tham [1984], in which triticale was used instead of barley, no influence of the type of grain on the liver weight and its content of lipids was observed. This, according Elongovan et al. [2011], could have been due to a low content of soluble NSPs in both types of cereals. Also

Table 4. Results of muscles sensory evaluation

Tabela 4. Wyniki oceny organoleptycznej mięśni

Qualifiers – Wyróżniki jakościowe	Groups – Grupy		SEM
	C (barley) K (jęczmienna)	T (triticale) D (przenżytnia)	
M. longissimus lumborum			
Aroma – Zapach	3.85	4.10	0.35
intensity – natężenie	3.60	4.00	0.40
desirability – pożądalność	4.10	4.20	0.32
Juiciness – Soczystość	3.90	4.20	0.28
Tenderness – Kruchość	3.90	4.10	0.28
Palatability – Smakowitość	4.30	4.30	0.23
intensity – natężenie	4.30	4.30	0.21
desirability – pożądalność	4.30	4.30	0.28
M. semimembranosus			
Smell – Zapach	4.21	4.13	0.14
intensity – natężenie	4.33	4.25	0.24
desirability – pożądalność	4.08	4.00	0.14
Juiciness – Soczystość	4.33	4.25	0.19
Tenderness – Kruchość	4.25	3.92	0.18
Palatability – Smakowitość	4.38	4.25	0.17
intensity – natężenie	4.33	4.17	0.17
desirability – pożądalność	4.42	4.33	0.19

Józefiak et al. [2007] found no influence of the type of grain (triticale, rye and wheat) on the liver weight, whereas Brenes et al. [1993], as a result of an addition of β-glucanase in barley-based diets, observed a reduction in the liver weight by 8%. The liver is the site of short-chain fatty acids metabolism.

The fatness of carcasses, expressed as backfat thickness, did not differ significantly in both groups. According to Smith and Pearson [1989], the dressing percentage and backfat thickness in porkers did not depend on the type of grain used in the diet.

The data presented in Tables 3 and 4, which refer to the effect of triticale on slaughter performance and pork sensory evaluation, do generally correspond with those reported by Jaikaran et al. [1998], who stated that the performance of growing pigs offered triticale was similar to that attained by pigs fed feeds based on hulled barley. The introduction of triticale to compound diets significantly increased the share of meat in loin (Table 3). According to Hurnik [2004], an increase in the share of lean occurs when the gain in the muscle tissue outperforms the growth of fat. Henry and Walker [1994] proposed that to improve the growth in the mass of muscle, lysine content in the feed after introduction of triticale should be higher.

An analysis of the sensory evaluation results for aroma, juiciness, tenderness and flavor indicates a certain tendency to improve the organoleptic characteristics of the *longissimus lumborum* muscle in the group fed ground triticale, which can be an important feature from the consumer's point of view.

CONCLUSIONS

1. Triticale can be a complete replacement for barley in diets offered to growing LY♀ × DD♂ crossbred pigs.
2. Feeding a diet containing triticale improved the percentage of meat in loin, as well as the sensory parameters of the *longissimus lumborum* muscle, which is important for product acceptability by the consumer.

REFERENCES

Baryłko-Pikielna, N., Matuszewska, I. (2009). Sensoryczne badania żywności. Podstawy. Metody. Zastosowania [Sensory analysis of food. Basics. Methods. Applications]. Wyd. Nauk PTTŻ, Kraków [in Polish].

Beltranena, E., Zijilstra, R.T. (2007). Novel feed grains and pulses in Western Canada. Adv. Pork Prod., 18, 229–236.

Beltranena, E., Salmon, D.F., Goonewardene, L.A., Zijilstra, R.T. (2008). Triticale as a replacement for wheat in diets for weaned pigs. J. Anim. Sci., 88, 631–635.

Brenes, A., Smith, J., Guenter, W., Marquardt, R.R. (1993). Effect of enzyme supplementation on the performance and digestive tract size of broiler chickens fed wheat- and barley-based diet. Poult. Sci., 69, 623–633.

Cornejo, S., Potocnjak, J., Holmes, J.H., Robinson, D.W. (1973). Comparative nutritional value of Triticale for swine. J. Anim. Sci., 36, 1, 87–93.

Elongovan, A.V., Bruivan, M., Jessop, R., Iji, P.A. (2011). The potential of high-yielding triticale varieties in the diet of broiler chickens. Asian J. Poult. Sci., 5, 68–76.

Fabijańska, M., Kosieradzka, I., Sokół, J.L., Bekta, M., Bobel, B.K. (2002). Polskie odmiany zbóż nagoziarnistych w żywieniu zwierząt [Polish cultivars of naked cereal grains in animal nutrition]. Zesz. Nauk. Prz. Hod., 60, 197–199 [in Polish].

Fernandez-Figares, I., Garcia, M.A., Ruiz, R., Rubio, L.A. (2008). Evaluation of barley and triticale as feed ingredients in growing Iberian pigs: amino acids carbohydrate ileal digestibility. J. Sci. Food Agric., 88, 870–876.

Henry, Y., Walker, N. (1994). Response of pigs to dietary energy and protein with particular reference to the early finishing period. Irish J. Agric. Food Res., 33, 149–155.

Hurnik, D. (2004). Loin eye size and what factors driver it? The Atlantic Swine Research Partnership Inc, Annu. Rep., 18–20.

Jaikaran, S., Robertson, W.M., Salmon, D.F., Aherne, F.X., Hickling, D. (1998). Comparison of live performance of market pigs fed triticale, maize or hulles barley based diet. Proc.4th Int. Triticale Symp. Int. Triticale Assoc., Red Deer and Lacombe, AB, 1, 185–195.

Józefiak, D., Rutkowski, A., Jensen, B.B., Engberg, R.M. (2007). Effect of dietary inclusion of triticale, rye, and wheat and xylanase supplementation on growth performance of broiler chickens and fermentation in the gastrointestinal tract. Anim. Feed Sci. Technol., 132, 79–93.

Karunajeewa, H., Tham, S.H. (1984). The replacement value of triticale for barley in layer diets with or without rice pollard. J. Sci. Food Agric., 35, 9, 970–976.

Kondracki, S., Olkowski, B. (1997). Strawność mieszanek pełnoporcjowych dla tuczników w zależności od zawartości pszenżyta odmiany Malno [Digestibility of complete feeds for growing/finishing pigs depending on the content of triticale cv. Malno]. Biul. Nauk. Przem. Pasz., 2, 21–25 [in Polish].

Myer, R., Lozano del Rio, A.J. (2004). Triticale as animal feed, triticale improvement and production. FAO plant production and protection paper, Rome, 49–58.

NRC (1998). Nutrient Requirements of Swine. National Research Council, 10th ed. Washington, DC: National Academic Press.

Omogbenigum, O., Zijlstra, R., Salmon, D., Beltranena, E. (2006). Triticale, an excellent feed grain for weaned pigs. West. Hog. J., 28, 48–53

Ruszczyc, Z. (1981). Metodyka doświadczeń zootechnicznych [Experimental methods in animal husbandry]. PWRiL, Warszawa [in Polish].

Smith, W.C., Pearson, G. (1989). Partial and total replacement of barley by triticale in diets for growing pigs. N. Z. J. Agric. Res., 32, 447–452.

Szyndler-Nędza, M. (2006). Rola i znaczenie rodzimych ras świń oraz możliwości ich ochrony w ramach programu operacyjnego rozwoju obszarów wiejskich na lata 2007––2013 [The role and importance of native swine breeds and their possible protection under the operational program for rural development for the years 2007–2013]. Wiad. Zootech. R. XLIV, 9–14 [in Polish].

Tilgner, D.J. (1957). Analiza organoleptyczna żywności [Food sensory evaluation]. WPLiS, Warszawa, 363 [in Polish].

Tereszkiewicz, K., Molenda, P., Ruda, M., Korona, R. (2010). Fat content and fat distribution in the carcasses of Pietrain pigs. Acta Sci. Pol. Zootechnica, 9(1), 31–40.

WPŁYW RODZAJU ZASTOSOWANEGO ZBOŻA W MIESZANKACH NA WYNIKI TUCZU ORAZ WARTOŚĆ POUBOJOWĄ TUCZNIKÓW

Streszczenie. Celem badań była ocena wyników produkcyjnych, rzeźnych oraz jakości mięsa tuczników żywionych mieszankami z jęczmieniem lub pszenżytem. Badania przeprowadzono na 16 tucznikach pochodzących z duńskiego systemu hodowlanego DanAvI, podzielonych na dwie grupy po 8 osobników (4 loszki i 4 wieprzki). Doświadczenie trwało 74 dni. Grupa K otrzymywała mieszanki zawierające śrutę jęczmienną, natomiast D pszenżytnią. Podczas doświadczenia kontrolowano masę ciała tuczników oraz spożycie mieszanek, a po uboju określono mięsność oraz masę podrobów. Po schłodzeniu, na prawej półtuszy określono długość tusz i grubość słoniny, a następnie poddano ją dysekcji. Przyrosty masy ciała, zużycie paszy oraz wydajność rzeźna zimna w grupach nie różniły się istotnie. Również różnice w mięsności (60,1% – grupa K i 57,2% grupa D), nie zostały potwierdzone statystycznie. Tuczniki z grupy K (jęczmiennej) miały istotnie większą wątrobę (1,52% w masie ciała), ale długość tusz oraz grubość słoniny były zbliżone w grupach. Analiza dysekcyjna schabu wykazała istotnie większy udział mięsa u tuczników z grupy D żywionej mieszanką zawierającą śrutę pszenżytnią (52%). Nie stwierdzono istotnych różnic między grupami w ocenie organoleptycznej mięsa. Pszenżyto może być całkowitym zamiennikiem jęczmienia w dietach dla rosnących świń ponieważ korzystnie wpływa na cechy produkcyjne oraz rzeźne, ważne dla konsumenta.

Słowa kluczowe: świnie, jęczmień, pszenżyto, wyniki produkcyjne, wartość rzeźna, ocena mięsa.

Accepted for print: 25.09.2015

For citation: Banaszkiewicz, T., Kaszperuk, K., Bombik, T. (2015). Effect of cereal grain type used in diets on the fattening performance and slaughter value of pigs. Acta Sci. Pol. Zootechnica, 14(3), 15–24.