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# FEEDING DIETS BASED ON BARLEY OR TRITICALE DURING FATTENING OF HIGH-MEAT PIC PIGS: EFFECTS ON CARCASS CHARACTERISTICS AND MEAT QUALITY PARAMETERS

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*This study was conducted to compare performance, carcass and meat quality parameters in high-meat fattening hybride PIC pigs fed barley or triticale based diets. Sixty, 12 week old weaner piglets of similar mean body weight (30 kg ± 0.4) were randomly divided into two groups of 30 each, and assigned to one of the two dietary treatment groups designated as group B (fed bar ley based diets) and group T (fed triticale based diets). The pigs fed T based diets showed 8% higher growth rate ($p<0.05$) at 11% lower feed conversion ratio. Post slaughter parameters in pigs fed triticale based diets were more desirable than in those fed barley based diets. T fed pigs had higher loin eye area and smaller suet weight ($p<0.01$). Dressing percentage, carcass length, fleshiness, back fat thickness, dry matter, crude ash, crude protein and ether extract and pH of meat were similar in both groups. Meat from T fed pigs had slightly darker colour of m. semimembranosus, and higher water holding capacity of m. longisimus lumborum ($p<0.05$). Feeding triticale based diets to PIC pigs has beneficial effects on performance and characteristics carcass. Triticale could totally replace barley in rations for fattening high meat PIC swine.*

*Key words: barley, meat quality, PIC swine, triticale*

## INTRODUCTION

Currently, pig processors preference is centered on high quality meat with low backfat levels and high lean content. The quality of pig meat is influenced by a large number of genetic and non genetic factors including dietary factors (Dugan *et al*., 2004). The gene technology is used for optimal development of pork meat quality (De Vries *et al*., 2000). The strains of pigs referred to as PIC (Pig Improvement Company, www.pic.com) swine have been developed for optimal lean production, excellent growth rate, feed efficiency, and low back fat levels.

Barley has been commonly used as the main ingredient in diets for fattening pigs, but development of new breeds, as well as changes in preferences of the meat processing industry, prompted feed science to evaluate alternative grains. Triticale (grain developed by crossing wheat and rye) is gaining ground as an

attractive alternative to barley and other cereal grains (Myer and Lozano del Rio, 2004). Triticale is also an attractive crop choice in the environments where growing conditions are not favourable or in low-input systems (Erekul and Kohn, 2006; Dogan *et al*., 2009). The favourable conditions for growing triticale are in Europe, USA, Canada, and Australia (Tophver *et al*., 2005), but most triticale is currently produced in Europe.

Because of its agronomic attributes and dietary quality, triticale has the potential for a broad application in animal feeds. In particular, triticale grain has attracted international interest for its application as a major ingredient of swine feed.

Triticale is a good source of carbohydrates and protein, and in comparison to barley has slightly higher metabolizable energy value (13.3 MJ vs 12.2 MJ) and crude protein (12.5% vs 11.3%) respectively NRC (1998). Other findings indicate that triticale has higher digestibility and higher biological value of protein relative to wheat and barley (Kondracki, 1991; Kondracki and Olkowski, 1997). Furthermore, relative to barley, triticale shows better digestibility of amino acids and carbohydrates (van Barneveld and Cooper, 2002). It is also noteworthy that triticale is a relatively soft grain, with a hardness index almost half of that observed for wheat or barley (Fernandez-Figares *et al*., 2008), and therefore less mechanical energy would be required for grinding triticale grain prior to mixing it into livestock diets.

Research has shown that triticale can be used as a substitute for corn or hulless barley in the diets of growing-finishing pigs, without compromising muscle quality or palatability (Jaikaran *et al*., 1998). According to (Myer, 2002), application of triticale in swine feed has been very successful. However, there is a scarcity of research on the application of triticale in feeding modern high meat PIC swine, and in particular, there is notable insufficiency of data regarding carcass characteristics and meat quality. Accordingly, the present study was designed to evaluate the effects of diets based on barley or triticale with primary objectives focused on carcass characteristics and meat quality parameters, whereas only basic performance parameters were monitored.

## MATERIAL AND METHODS

Hybride offsprings of PIC obtained from crossing the lines of PIC 408 with Camborough 24 were used in this experiment. Sixty, 12 weeks old weaners of similar body weight (30 kg ± 0.4) were randomly divided into two groups of 30, and assigned to one of the two dietary treatments: B (fed barley based diets) and T (fed triticale based diets). Sex ratio was similar in both groups.

Pigs were raised using a two-phase dietary feeding program where the first-phase diets were fed for 92 days and second-phase diets were fed for 53 days.

All diets were formulated to meet nutritional requirements (NRC, 1998). Composition and nutritive value of diets are given in Table 1. The animals of each group were kept in two stalls. Feed and water were provided *ad libitum*. Body weight and feed intake were recorded after fattening.

Table 1. Composition and nutritive value of diets for pigs

| Ingredient (%) | Group | | | |
|---|---|---|---|---|
| | Barley | Triticale[1] | Barley | Triticale[1] |
| | Phase one | | Phase two | |
| Barley meal | 79.50 | – | 86.00 | – |
| Triticale meal | – | 81.50 | – | 88.00 |
| Soybean meal | 18.00 | 16.00 | 12.00 | 10.00 |
| L-lysine | 0.12 | 0.22 | 0.10 | 0.20 |
| DL-methionine | 0.02 | 0.06 | – | – |
| Dicalcium phosphate | 0.90 | 0.80 | 0.30 | 0.50 |
| Limestone | 0.66 | 0.62 | 0.90 | 0.60 |
| Salt | 0.30 | 0.30 | 0.20 | 0.20 |
| Mineral – Vitamin Premix | 0.50 | 0.50 | 0.50 | 0.50 |
| Nutritive value | | | | |
| Metabolizable energy, MJ | 12.25 | 13.07 | 12.29 | 13.17 |
| Crude protein, % | 17.10 | 17.14 | 15.07 | 15.16 |
| Lysine,% | 0.94 | 1.01 | 0.77 | 0.83 |
| Metionine + cystine, % | 0.58 | 0.62 | 0.51 | 0.51 |
| Threonine, % | 0.61 | 0.60 | 0.53 | 0.52 |
| Tryptophane, % | 0.20 | 0.19 | 0.18 | 0.17 |
| Calcium, % | 0.54 | 0.50 | 0.48 | 0.44 |
| Phosphorus, % | 0.51 | 0.54 | 0.44 | 0.48 |
| Sodium, % | 0.14 | 0.14 | 0.09 | 0.09 |

[1]Triticale had higher nutritive value compared to barley, hence slightly increased metabolizable energy content in diets based on this cereal. Also, these diets were balanced in such a way that the lysine content was slightly higher than barley based diets in order to keep the same energy:lysine ratio in both types of diets.

After the second phase, 20 animals with body weights close to the average body weight in each group were slaughtered. Immediately after the slaughter, meatiness was tested using the DRAMINSKI electronic-linear device choirometer (http://www.draminski.com). Acidity measurements were performed using Mettler Toledo pH meter (SG8-ELK). First recording of *longissimus* muscle was obtained 45 minutes after slaughter (pH 45 min). Next, the carcasses were placed in the chilling room at 2-4°C, and the second recording of acidity (pH 24 hours) was performed 24 hours after the first measurement of acidity.

The carcass length, belly thickness, and height and width of loin eye were measured using the right halves of each carcass. Carcass length was measured from the anterior edge of the symphysis pubis to the recess of the first rib. The

belly thickness was measured at the level of cut between two carcass halves using a slide calliper. The measurements were carried out in five locations: above the shoulder, mid back (between the last thoracic vertebra and the first lumbar vertebrae) and over the loin (at the level of sacral vertebrae: I, II, III).

The width of loin eye was measured at the widest point of the eye muscle, and the height of the eye at the highest part of the section, which was measured at the right angle to the width. Samples of m. *longissimus lumborum* and m. *semimembranosus* muscles were taken from each half carcass in order to analyze physical and chemical features.

The contents of dry matter, crude ash, total protein and crude fat in meat samples were analyzed according to (AOAC, 1990), water holding capacity (i.e. free water content) as described by (Grau and Hamm, 1953), and the intensity of colour experssed as lightness (CIE L*) using Minolta Chroma Meter CR-310.

A sensory evaluation of thermally processed meat was conducted as described by Barylko-Pikielna (1975). A 5-point scale was applied, taking into account the following quality attributes of cooked meat: aroma, juiciness, tenderness, and taste. The sensory evaluation was conducted by a 10-member testing panel of trained analysts.

Results were statistically analyzed using t-Student test or U-Mann-Whitney test (sensory data) according to procedures described by (Petrie and Watson, 2006) using the computer package Microsoft Excel 2003.

## RESULTS

Overall, in comparison to the barley fed group, the pigs fed triticale based diets showed better performance parameters ($p<0.05$) with 8.7 % increase in final body weight (106.3 kg *vs.* 115.6 kg) and 11% higher average daily gain (688 g *vs.* 768 g) and decreased fed : gain ratio by 11% (3.12 *vs*. 2.78 kg/kg).

Higher body weight of pigs fed triticale diets resulted in significantly ($p<0.05$) higher cold carcass weight at comparable dressing percentage (Table 2). There were no significant effects ($p>0.05$) of cereal kind on meatiness, carcass length and back fat thickness. However, pigs fed triticale based diets had larger loin eye area and smaller suet weight (both $p<0.01$), and tended to have slighty thinner backfat over loin.

Chemical meat analysis did not show any significant differences ($p>0.05$) in the content of dry matter, crude ash, crude protein, and crude fat between dietary groups (Table 3). Water holding capacity of meat was generally higher in triticale fed pigs, but the difference was significant ($p<0.05$) only for *longissimus lumborum* muscle. There were no significant effects ($p>0.05$) of cereal selection on meat pH measured at 45 min or 24 h.

Meat from triticale fed pigs appeared slightly darker (L*), but the difference was significant ($p<0.05$) only in the case of *semimembranosus* muscle.

Overall, substitution of barley with triticale tended to improve the organoleptic characteristics of meat (Figs. 1 and 2) with the median scores for juiciness, tenderness, and taste of meat from m. *longissimus lumborum* being significantly ($p<0.05$) higher in triticale fed pigs.

Table 2. Comparison of carcass characteristics of pigs fed barley and triticale based diets

| Specification | Group | | | |
|---|---|---|---|---|
| | Barley | Triticale | SEM | Significance§ |
| Body weight at slaughter, kg | 105.17 | 110.83 | 1.41 | p<0.01 |
| Cold carcass weight, kg | 83.70 | 87.00 | 1.32 | p<0.05 |
| Cold dressing, % | 79.62 | 78.45 | 1.87 | NS |
| Meatiness, % | 57.47 | 58.40 | 0.47 | p<0.05 |
| Carcass length, cm | 80.17 | 81.00 | 0.39 | NS |
| Backfat thickness, cm | | | | |
| – Over the shoulder | 3.12 | 3.30 | 0.20 | NS |
| – Mid back | 2.00 | 1.90 | 0.24 | NS |
| – Over loin I | 1.72 | 1.65 | 0.15 | NS |
| – Over loin II | 1.10 | 0.93 | 0.11 | p<0.05 |
| – Over loin III | 2.00 | 1.92 | 0.17 | NS |
| – Average from 5 measurements | 1.97 | 1.86 | 0.19 | NS |
| Loin eye area, $cm^2$ | 42.93 | 45.85 | 0.88 | p<0.01 |
| Weight of suet, kg | 1.20 | 0.94 | 0.09 | p<0.01 |

SE – standard error; § – t-Student test; NS – non significant

Table 3. Comparison of physical and chemical properties of meat from pigs fed barley and triticale based diets

| Specification | Group | | | |
|---|---|---|---|---|
| | Barley | Triticale | SEM | Signifcance§ |
| Muscle: | | | | |
| *longissimus lumborum* | | | | |
| – Dry mater (%) | 27.33 | 27.46 | 0.41 | NS |
| – Crude ash (%) | 1.16 | 1.12 | 0.02 | NS |
| – Crude protein (%) | 22.82 | 23.29 | 0.18 | NS |
| – Crude fat (%) | 3.45 | 3.31 | 0.72 | NS |
| *semimembranosus* | | | | |
| – Dry mater (%) | 25.13 | 25.12 | 0.19 | NS |
| – Crude ash (%) | 1.18 | 1.17 | 0.01 | NS |
| – Crude protein (%) | 22.94 | 23.08 | 0.12 | NS |
| – Crude fat (%) | 1.33 | 1.06 | 0.01 | NS |
| Water holding capacity (%) | | | | |
| *longissimus lumborum* | 20.00 | 23.93 | 1.55 | p<0.01 |
| *semimembranosus* | 17.60 | 19.07 | 1.35 | NS |
| Meat colour (L*) | | | | |
| *longissimus lumborum* | 48.22 | 47.30 | 0.76 | NS |
| *semimembranosus* | 44.02 | 41.78 | 0.89 | p<0.05 |
| $pH_{45}$ | 6.34 | 6.32 | 0.07 | NS |
| $pH_{24}$ | 5.82 | 5.79 | 0.08 | NS |

SE – standard error; § – t-Student test; NS – non significant

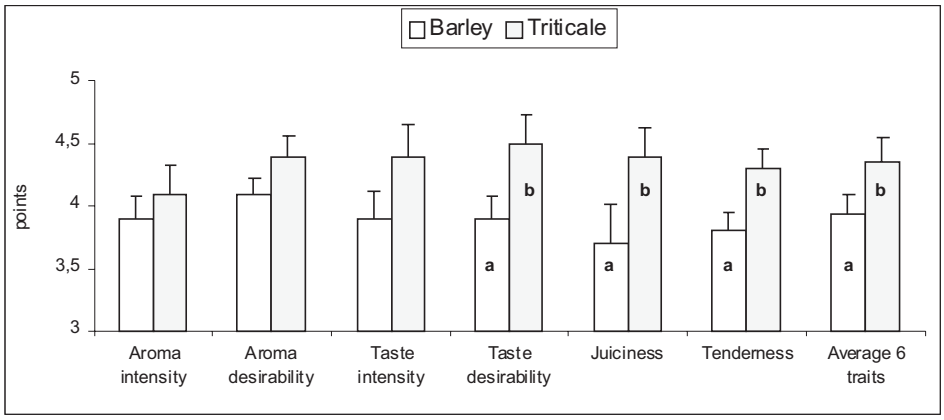


Figure 1. Sensory properties of meat from *longissimus lumborum* muscle
a,b – significant difference $p<0.05$ (U-Mann-Whitney test)

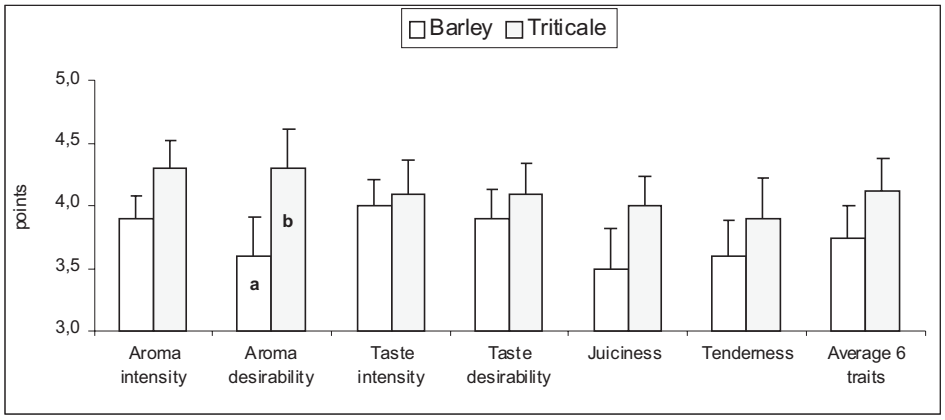


Figure 2. Sensory properties of meat from *semimembranosus* muscle
a,b – significant difference $p<0.05$ (U-Mann-Whitney test)

## DISCUSSION

Our findings indicate that triticale used in diets for high-meat PIC pigs has desirable effects on performances and meat quality. In comparison to barley based diets, triticale based diets improved growth rate of pigs at lower feed conversion.

Although evaluation of nutrient digestibility was beyond the scope of our primary objectives, in the context of the data reported by Kondracki (1991), Kondracki and Olkowski (1997), Fernandez-Figares *et al*. (2008), Beltranea *et al*. (2008), Beltranea and Zijlstra (2007), Omogbenigum *et al*. (2006) it is likely that

improved performance in triticale group observed in our study was associated with the higher utilization of nutrients.

There is only a handful of scientific data on the effects of triticale on carcass characteristics and meat sensory parameters. Generally, our results corroborate the findings of Jaikaran *et al.* (1998) who reported that growing-finishing pigs fed triticale had similar carcass quality to those fed dehulled barley. However, Sullivan *et al*. (2007) found that a decreased impact of triticale decreased loin eye area in barrows. The findings from the present study indicate that pigs fed triticale based diets had comparable dressing percentage, meatiness, carcass length and back fat thickness, but had significantly ($p<0.05$) higher carcass weight, larger loin eye area, and less suet.

The loin-eye is associated with the lean growth of pigs. This lean growth is when the growth is dominated by accrual of the muscles, rather than fat (Hurnik, 2004). The growth of muscle improved once lysine levels were increased (Henry and Walker, 1994). In our study, triticale based diets had slightly higher level of lysine, and this may have had a positive effect on carcass characteristics.

Proximate chemical composition, as well as meat acidity, was not different between groups. Generally meat pH, color lightness, and water holding capacity from both groups were within the range of values for normal meat (Joo *et al*., 1999). However, meat from the triticale group appeared darker ($p<0.05$), and had a higher water holding capacity ($p<0.05$). Moreover, it is noteworthy that feeding triticale based diets improved some sensory attributes of meat. Of note, taken together, these are important attributes of meat quality from the consumer acceptance standpoint.

## CONCLUSION

Triticale can be used as a substitute for barley in the diets for growing-finishing PIC pigs. Furthermore, feeding triticale based diets to PIC pigs offers several benefits. Carcass characteristics were improved in some aspects of physical parameters, as well as sensory parameters that are important for consumer approval of the product. Over and above the beneficial effects on carcass qualities, PIC pigs fed triticale based diets showed better growth.

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## UTICAJ ISHRANE BAZIRANE NA JEČMU I TRITIKALE KONCENTRATU NA KARAKTERISTIKE TRUPOVA I KVALITET MESA MESNATIH RASA SVINJA

TURYK ZOFIA, OSEK MARIA, JANOCHA ALINA i OLKOWSKI B

SADRŽAJ

Ovo istraživanje je sprovedeno radi poređenja proizvodnih performansi, karakteristka trupova i parametara kvaliteta mesa kod visoko tovnih hibrida PIC (Pig Impovement Company) svinja koje se hrane koncentratima baziranim na ječmu ili tritikalu. Šezdeset prasadi, u uzrastu od 12 nedelja, prosečne telesne mase 30 ± 0,4 kg, je metodom slučajnog izbora podeljeno u dve grupe od po 30 jedinki. Prva grupa (B) je hranjena koncentratom čija je osnova ječam dok je u koncentratu druge grupe (T) osnova bio tritikal. Svinje iz T grupe su imale veći prirast za 8% ($p<0,05$) pri nižoj konverziji hrane za 11%. Klanični parametri su kod svinja grupe T, ocenjeni kao znatno poželjniji u odnosu na svinje koje su hranjene ječmom. Slabinski predeo je kod jedinki T grupe bio dug i one su imale manju težinu sala ($p<0,01$ za oba parametra). Randman mesa, dužina trupa, mesnatost, procenat suve materije, procenat pepela, procenat sirovih proteina i osobine mesnog ekstrakta i pH mesa su bili slični u obe ogledne grupe. Meso iz T grupe je imalo nešto tamniju boju *m*. *semimembranosus*-a i veći kapacitet zadržavanja vode (*m*. *longisimus lumborum*) (za oba parametra $p<0,05$). Ishrana PIC svinja tritikalom povoljno utiče na performanse i karakteristike trupova zaklanih svinja i tritikale može da zameni ječam u tovu mesnatih PIC svinja.