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Influence of Duroc sire lines on carcass and meat quality traits of commercial crossbred pigs

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Abstract Carcass and meat quality traits of commercial crossbred pigs which came from two Duroc sire lines were investigated. New and old Duroc sire lines were used to produce three-way cross-bred commercial finishing pigs (Duroc x Large White x Landrace). Five castrated male and five female pigs from each pig sire line were selected and slaughtered. The carcass and meat quality traits were measured and analysed. The offsprings from imported Duroc sire line had significantly lower cold carcass percentage and body fat percentage, but significantly higher bone percentage than those from in-country herd Duroc sire line. There was not significantly difference in meat quality traits between two sire lines. Castrated male pigs had higher marbling score than females.

Keywords: Carcass quality, Meat quality, Duroc sire line, Commercial crossbred pig

Introduction

Crossbreeding system is being used for improving the efficiency and profitability of commercial pigs for production because it combines different pig breeds with different specific characteristics and they display hybrid vigor or also called heterosis (Tang *et al.,* 2013). Heterosis is the improved performance of hybrid offspring compared to the average of their parental purebreds. Rauw *et al*. (2003) stated that crossbreeding system gives the advantage of heterosis and breed complementary. Also, it produces different end-products and satisfies different consumer demands. Jiang *et al*. (2012) stated that it is essential to consider that carcass and meat quality traits depend on the genotypes when selecting animals for crossbreeding scheme. The maternally inherited traits are fertility and litter size whereas the paternally inherited traits are meat productivity and meat quality (Kim *et al.,* 2006; Lee *et al.,* 2011). Purebreeds for crossbreeding systems are maternal line: Large white (LW) and Landrace (LR) because of their good mothering ability. While Duroc is used as a terminal sire line because it expresses an excellent growth rate,

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better feed efficiency, meatier carcass and good meat quality (Sorapukdee *et al*, 2013; Choi *et al.*, 2014; Blasco *et al*., 1994; and Olivier *et al.*, 1994).

The three-way crossbred pigs are being used for pig production in Thailand. Duroc is the breeding line being used widely/commercially as a meat quality sire line and crossed with two-way crossbred females (Large White x Landrace, LWLR) as maternal line. Duroc breed has been imported from various countries to be the terminal sire line to produce the finishing pigs for many years. Furthermore, the pig producers are being used in country herd Duroc which were synthesised, developed and selected from imported Duroc. Recently, new Duroc breed has been imported to be the terminal sire line to improve the economically important traits, especially marbling in finishing pigs. However, the carcass and meat quality of the offsprings from new Duroc sire line have never been determined and compared in country herd Duroc. Therefore, the objectives of the current study were to investigate and compare carcass and meat quality traits of three-way crossbred finishing pigs by using new and old lines of Duroc breed as terminal sire lines.

Materials and methods

All animals were carried out by following the animal welfare standards from the Department of Livestock Development, Ministry of Agriculture and Cooperatives, the Royal Thai Government. There were two sire lines of Duroc pigs used to produce three-way crossbred pigs. New sire line was imported from Canada and old sire line was from Ireland. The dam line was a two-way cross-bred pigs between Large White (LW) and Landrace (LR). The offsprings from both sire lines were raised under the same condition in a commercial pig farm. All experimental pigs were fed twice daily with the same diet, and the pigs had *ad libitum* access to food and water. The pigs were fed with 18 %, 16% and 14% protein diet for starter pigs (20-40 kg body weight), grower pigs (41-60 kg body weight), and finisher pigs (60-100 kg body weight), respectively. A total of 10 pigs from each sire line group consisted of 5 castrated males and 5 famales were selected for slaughtering at the end of finishing period. The measurement of carcass was done after slaughtering and the carcasses were chilled overnight. Cold carcass percentage was calculated from cold carcass weight and final weight. Then, carcass length was measured from the cranial edge of the first rib to the cranial tip of aitch bone. The average backfat thickness was measured from the first rib, last rib, and last lumbar. The marbling score was determined by using NPPC marbling standards (NPPC, 2000). Lean, fat, and bone were seperated from each left side carcass, weighed and calculated as the percentage of cold carcass weight. The *Longissimus dorsi* (LD) was collected from each carcass to measure all meat quality traits.

Measurements of meat qualities were pH, color, drip loss, cooking loss and shear force. The pH at 48 hour post mortem was measured in duplicate directly at *Longissimus dorsi* (LD) using pH meter equipped with a spear glass electrode (Model SG2- ELK Seven Go^{TM}, Mettler Toledo Interantional Inc., China).

The color was measured as the *Longissimus dorsi* muscles were allowed to bloom for 30 min before measuring L* (lightness), a* (redness), and b* (yellowness) color values using a Chroma Meter (CR-400, Minolta Co., Ltd., Suita-shi, Osaka, Japan).

Drip loss was determined as the weight loss during suspension of meat samples in a closed plastic bag filled with air and fastened to avoid evaporation and left at 4 to 6℃ for 48 h according to Honikel (1998). Drip loss was expressed as a percentage relative to the initial weight.

Cooking loss and shear force determination were done as follows: two pieces of approximately 3-cm-thick slices which were obtained from the *Longissimus dorsi* (LD) were weighed, placed into high density polyethylene bag, heat sealed, and then cooked in a water bath set at 80˚C for 30 min or until the internal temperature of the meat sample reached 70˚C. After being cooked, the samples were cooled down in running tap water up to room temperature before weighing. Then, the cooking loss percentage was estimated by calculating the difference between before and after cooking weight. Ten 1x2x1 cm^3 cuts of each cooking loss sample were removed from across the slice parallel to the muscle fiber orientation. Each cut was sheared once perpendicular to the muscle fiber orientation using a Waener-Beatzler shear head attached to a single column material testing machine used Texture Analyser Machine (Model EZSX, Shimadzu, Japan) equipped with a 50 kg load cell using 50 mm/min crosshead speed.

Statistical analysis

A 2x2 factorial experiment in completely randomized design was used to investigate the effect of sire lines and pig genders on all studied traits. There were 4 treatment combinations wherein each treatment consisted of 5 replications. The data were presented as mean ± standard deviation. Differences were tested using F-test. The values $P < 0.05$ were considered statistically significant. Statistical analysis was done using SPSS program.

Results

The carcass quality of the different sire lines and genders are shown in Table 1. There was no interaction between sire lines and genders on studied

traits and no significant difference between sire lines and genders for carcass quality traits, except for the effect of sire line on cold carcass, fat, and bone percentage ($P<0.05$). The offsprings of new Duroc sire had significantly lower cold carcass percentage ($P<0.01$) and fat percentage ($P<0.01$), but significantly higher bone percentage ($P<0.05$) than offsprings from old Duroc sire line. The marbling score of castrated male pig was significantly higher than female ($P<0.05$).

Meat quality of three-way crossbred pigs from different Duroc sire lines and genders are shown in Table 2. The results showed that the effect of sire lines, genders, and interaction between sire lines and genders were not significantly different in all meat quality traits. However, the b* value or the yellowness of meat from the offsprings of old Duroc sire line tended to be higher than that from the new Duroc sire line ($P<0.10$).

For nutrient composition, the fat percentage in meat of the offsprings from old Duroc sire line tended to be lower than that from the new Duroc sire line ($P<0.10$).

Table 1. Carcass characteristics of three-way crossbred pigs from different Duroc sire lines

Traits	Group		Gender		P-value		
	Old line	New line	Castrated Male	Female	Group	Gender	GroupX Gender
Slaughter weight(kg)	108.83±1.95	111.10±2.17	111.83±6.89	108.10±5.64	0.521	0.195	0.517
Cold carcass weight (kg)	81.80±5.76	79.77±4.31	82.35±5.85	79.44±4.10	0.455	0.291	0.465
Cold carcass (%)	74.99±1.36	71.86±1.66	73.65±2.25	73.51±2.19	0.000	0.781	0.744
Carcass length (cm)	79.02±0.60	79.21±0.67	79.37±0.65	78.87±0.63	0.841	0.588	0.252
Back fat (mm)	3.175±0.14	2.81±0.16	3.16±0.14	2.85±1.14	0.111	0.140	0.075
Marbling score[1]	1.67±0.15	2.08±0.16	2.16±0.15	1.63±0.16	0.086	0.029	0.253
Lean[2, 3] (%)	36.58±0.31	36.47±0.34	36.33±0.33	36.72±0.32	0.818	0.412	0.187
Fat[2] (%)	15.48±1.63	12.40±1.93	14.24±3.13	13.51±1.20	0.001	0.366	0.140
Bone[2] (%)	13.81±1.71	15.40±0.74	14.51±1.24	14.70±1.74	0.015	0.764	0.955

[1]NPPC (2000) Subjective marbling score (1=1% intramuscular fat; 10=10% intramuscular fat)
[2]% with cold carcass weight
[3]Lean = loin+tenderloin+shoulder+ham

Table 2. Meat quality and nutrient composition of three-way crossbred pigs from different Duroc sire lines and genders

Traits	Group		Gender		P-value		
	Old line	New line	Castrated Male	Female	Group	Gender	Group X Gender
Meat quality							
L*	57.18 ±1.30	56.73 ±1.44	58.06 ±1.38	55.85 ±1.35	0.817	0.271	0.600
a*	4.93 ±0.27	4.26 ±0.30	4.53 ±0.29	4.66 ±0.28	0.124	0.747	0.162
b*	14.14 ±0.37	13.08 ±0.41	13.89 ±0.40	13.33 ±0.39	0.075	0.336	0.653
pH	5.49 ±0.03	5.51 ±0.35	5.50 ±0.03	5.51 ±0.03	0.748	0.883	0.506
Drip loss (%)	3.42 ±2.37	4.30 ±2.04	3.63 ±2.24	4.09 ±2.29	0.417	0.667	0.641
Cooking loss (%)	21.68 ±2.98	21.09 ±3.78	21.20 ±3.19	21.633.53	0.700	0.779	0.794
Shear force (kg)	5.93 ±1.05	5.37 ±0.48	5.47 ±0.97	5.83 ±0.53	0.173	0.382	0.649
Nutrient composition							
Moisture (%)	73.26 ±0.73	73.77 ±0.88	73.46 ±1.00	73.57 ±0.63	0.190	0.782	0.338
Fat (%)	2.35 ±0.75	3.11 ±0.88	3.00 ±0.91	2.46 ±0.81	0.052	0.151	0.303

Discussion

The present comsumers tend to prefer high eating quality meat especially meat with high marbling. The new sire line pigs have been selected for more intramuscular fat and less backfat to meet the consumers' demand. From the results in this study, there were no differences in carcass and meat quality of the offsprings derived from new Duroc sire line and old Duroc sire lines, except cold carcass, fat, and bone percentage wherein the offsprings from new Duroc sire line had lower cold carcass and fat percentage but higher bone percentage. The offsprings from new Duroc sire line had more intramuscular fat as indicated by the higher fat percentage in meat. It is widely accepted that

marbling and carcass fatness are closely related. Choi *et al.* (2015) reported that the offsprings from Duroc sire lines had thicker backfat in accordance with the higher intramuscular fat. Our results were in agreement with Cilla *et al.* (2006) who found a significant effect of three genetic Duroc pig sire lines on fat, lean, and meat quality which the Duroc sire lines having thicker subcutaneous fat and more body fat percentage with higher intramuscular fat content.

Pigs are selected for lean growth had shown lower meat quality in terms of softer, more exudative, higher shear force value, and less intramuscular fat percentage (Ramiraz and Cava, 2007 and Lonergen *et al.*, 2001). The selected lean Duroc sire line exhibited an increase in lean percentage and decreased backfat thickness (Lonergen *et al.*, 2001). However, the results from this study showed thiner backfat but higher intramuscular fat in the offsprings from new Duroc sire line compared to those from old Duroc sire line. The intensive selection for high marbling and decrease in the backfat thickness in pigs resulted to higher intramuscular fat but thinner backfat in the present study. It is suggested by Wood *et al.* (2004) that the easiest way to optimize the intramuscular fat level was to use special breeds or crosses such as Duroc, whose backfat was relatively thin. The results from this study demonstrated that the new Duroc sire line had the superiority over the old line. Therefore, the high marbling sire line should be used for producing high quality pork production.

In this study, new Duroc sire line gave the offsprings lower fat percentage but higher bone percentage than those from the old sire line. This is in agreement with Soriano *et al.* (2005) who reported that the finishing pigs with thinner backfat had higher lean and bone percentage. There was no effect of gender on any studied traits except on marbling score. The castrated male pigs had higher marbling score than females. This is similar to the results of Latorre *et al.* (2003) who reported that castrates ate more feeds, grew faster, poor feed converters and less lean yield but have thicker backfat and higher intramuscular fat content than gilts. This is in agreement with Soriano *et al.* (2005) who found backfat thickness of castrated pigs was higher than female pigs.

In conclusion, the results suggested that some of carcass and meat quality traits of the new Duroc sire line was different from in-country herd or old Duroc sire line. The use of new imported Duroc sire line has resulted to improved economically important traits in the finishing pigs by increasing intramuscular fat and decreasing backfat thickness and body fat percentage.

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References

Blasco, A., Gou, P., Gispert, M., Estany, J., Soler, Q., Diestre, A. and Tibau, J. (1994). Comparison of five type of pig crosses. I. Growth and carcass traits. Livestock Production Science, 40:171-178.

Cilla, I., Altarriba, J., Guerrero, L., Gispert, M., Martinez, L., Moreno, C., Beltran, J. A., Guardia, M. D., Diestre, A., Arnau, J. and Roncales, P. (2006). Effect of different Duroc line sire on carcass composition, meat quality, and dry-cured ham acceptability. Meat Science, 72:252-260.

Choi, J. S., Lee, H. J., Jin, S. K., Choi, Y. I. and Lee, J. J. (2014). Comparision of Carcass Characteristics and Meat Quality between Duroc and Crossbrad pigs. Journal of Food Science, 34:238-244.

Choi, J. S., Jin, S. K., Choi, Y-II. and Lee, J. J. (2015). Effects of duroc breeding lines on carcass composition and meat quality. Korean Journal of Food Science, 35:80-85.

Honikel, K. O. (1998). Reference methods for the assessment of physical characteristics of meat. Meat Science 49:447-457. doi:https://doi.org/10.1016/S0309-1740(98)00034-5.

Jiang, Y. Z., Zhu, L., Tang, G. Q., Li, M. Z., Jiang, A. A., Cen, W. M., Xing, S. H., Chen, J. N., We,. A. X., He. T., Wang. Q., Zhu G. X., Xie, M. and Li, X. W. (2012). Carcass and meat quality traits of four commercial pig crossbreeds in China. Genetics and Molecular Research, 11:4447-4455.

Kim, I. S., Jin, S. K., Song, Y. M., Park, K. H., Kang, S. M., Ha, J. H., Kim, I. J., Park, Y. S. and Kim, J. H. (2006). Quality characteristics of pork by sex on crossbred pigs. Korean Journal of International Agriculture, 18:34-39.

Latorre, M. A., Lázaro, R., Gracia, M. I., Nieto, M. and Mateos, G. G. (2003). Effect of sex and terminal sire genotype on performance, carcass characterristics, and meat quality of pigs slaughtered at 117 kg body weight. Meat Science, 65:1369-1377.

Lee, Y. H., Kwon, S. G., Park, D. H., Kwon, E. J., Cho, E. S., Bang, W. Y., Park, H. C., Park, B.Y., Choi, J. S. and Kim, C. W. (2011). Development of high meat quality using microsatellite markers in Berkshire pigs. Journal of Animal Science and Technology, 52:89-97.

Lonergen, S. M., Lonergen, E. H., Rowe, L. J., Kuhlers, D. L. and Jungst, S. B. (2001). Selection for lean growth efficiency in Duroc pigs influences pork quality. Journal of Animal Science, 79:2075-2085.

Nationnal Pork Producers Council (NPPC). (2000). Pork Composition and Quality Assessment Procedures. E. P. Brerg, ed. DesMoines, IA.

Olivier, M. A., Guo, P., Gispert, M., Diestre, A., Amau, J., Noguera, J. L. and Blasco, A. (1994). Comparision of five type of pig crosses. II. Fresh meat quality and sensory characteristic of dry cured ham. Livestock Production Science, 40:179-185.

Ramiraz, R. and Cava, R. (2007). Carcass composition and meat quality of three different Iberian x Duroc genotype pigs. Meat Science, 75:388-396.

Rauw, W. M., Varona, L., Gomez, L. and Noguera, J. L. (2003). Meat production using four terminal pig lines. Journal of the Science of Food Agriculture, 83:1504-1510. (online:2003)DOI:10.1002/jsfa.1568.

Sorapukdee, S., Kongtasorn, C., Benjakul, S. and Visessanguan, W. (2013). Influences of muscle composition and structure of pork from different breeds on stability and texturalproperties of cooked meat emulsion. Food Chemistry, 138:1892-1901.

Soriano, A., Quiles, R., Mariscal, C. and Ruiz, G. (2005). Pig sire type and sex effect on carcass traits, meat quality and physicochemical and sensory characteristic of Serrano dry-cured ham. Journal of the Science of Food and Agricuture, 85:1914-1924.

Tang, G., Yang, R., Xue, J., Liu, T., Zeng, Z., Jiang, A., Jiang, Y., Li, M., Li, Z., Bai, L., Shuai, S. and Li, X. (2013). Optimising a crossbreeding production system using three specialised imported swine breeds in south-western China. Animal Production Science, 54:999-1007.

Wood, J. D., Nute, G. R., Richardson, R. I., Whittington, F. M., Southwood, O., Plastow, G., Mansbridge, R., da Costa, N. and Chang, K. C. (2004). Effects of breed, diet and muscle on fat deposition and eating quality in pigs. Meat Science, 67:651-667.

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