GROWTH PERFORMANCE AND SPERM QUALITY OF STRESS NEGATIVE PIÉTRAIN BOARS AND THEIR HYBRIDS WITH DUROC

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ABSTRACT

This study was conducted to evaluate the effects of genetic background and season on growth performance and semen quality of boars. Five genetic groups were evaluated, including stress-negative Piétrain boars with CC (PiCC) or CT (PiCT) halothane genotypes, and Piétrain x Duroc hybrid boars with various compositions (25% PiDu25, 50% (PiDu50) or 75% (PiDu75) of Piétrain origin) The results showed that genetic group has a significant effect on growth performance and semen quality. The hybrid boars PiDu25, PiDu50 and PiDu75 had better growth rate, but lower lean meat in comparison with pure stress-negative Piétrain, except PiDu75 boars PiDu25, PiDu50 and PiCC boars demonstrated high semen quality. A season effect was observed on most of semen quality traits of pure stress-negative Piétrain as well as hybrid boars with different genetic constitution. Sperm concentration was lower in Summer and Autumn, higher in Winter and spring. The Piétrain x Duroc hybrid boars, especially PiDu75 seem to be promising as terminal boars.

Keywords: Growth performance, hybrid boars, semen quality, stress-negative Piétrain, terminal boar.

Sinh trưởng và phẩm chất tinh dịch của lợn đực Piétrain kháng stress thuần và đực lai với Duroc

TÓM TẮT

Nghiên cứu được tiến hành nhằm đánh giá ảnh hưởng của các thành phần di truyền Piétrain kháng stress khác nhau và mùa vụ đến sinh trưởng của lợn đực hậu bị và phẩm chất tinh dịch của chúng. Có 5 nhóm thành phần di truyền được đánh giá, bao gồm: PiDu25, PiDu50, PiDu75, PiCC và PiCT. Kết quả cho thấy, nhóm di truyền ảnh hưởng đến các chỉ tiêu sinh trưởng và phẩm chất tinh dịch. Các nhóm đực lai PiDu25, Pu50 và PiDu75 có tốc độ sinh trưởng cao hơn nhưng tỷ lệ nạc thấp hơn so với Piétrain kháng stress, ngoại trừ PiDu75. PiDu25, PiDu50 và PiCC có phẩm chất tinh dịch tốt. Mùa vụ ảnh hưởng đến hầu hết các tính trạng phẩm chất tinh dịch của đực Piétrain kháng stress thuần chủng cũng như các nhóm đực lai khác. Nồng độ tinh dịch ở mùa Hè và mùa Thu thấp nhất, cao hơn về mùa Đông và mùa Xuân. Nên sử dụng các đực lai giữa Piétrain và Durroc, đặc biệt là PiDu75 làm con đực cuối cùng.

Từ khóa: Đực cuối cùng, đực lai, năng suất sinh trưởng, phẩm chất tinh dịch, Piétrain kháng stress

1. INTRODUCTION

Stress-negative Piétrain line (Piétrain) was developed from classical Piétrain by the Faculty of Veterinary Medicine, University of Liège, Belgium (Hanset et al. 1995; Leroy and Verleyen 1999a, 1999b). Since 2007, such pigs have been raising under tropical conditions in North Vietnam (Luc et al. 2008). Piétrain is used not only as a terminal boar but also as a genetic resource for the production of hybrid boars with Duroc (Luc et al. 2011). The semen quality of purebred Piétrain and Piétrain x Duroc (PiDu) hybrid boars were examined by

Kawecka et al. (2008), Wysokinska *et al.* (2009), Pokrywka and Tereszkiewicz (2011) and Luc et al. (2011; 2013). In Vietnam, most of PiDu boars are provided by private companies and used as terminal boars under industrial conditions (Hao and Chi 2010) as well as household farm conditions (Binh et al. 2008). However, far too little attention has been paid to genetic constitution of PiDu boars. The objectives of this study were to evaluate the growth performance and semen quality of pure Piétrain boar and Piétrain x Duroc hybrid boars with different genetic components.

2. MATERIAL AND METHODS

2.1. Animal

A total of 41 boars, genetically identified at the halothane locus using PCR on samples from tail tissues according to the method of Fujii *et al.* (1991), were divided into 5 different groups according to their genetic constitution and used for the evaluation of the growth performance:

Eight ♀ (Piétrain × Duroc) × ♂ Duroc with CC halothane genotype (PiDu25),

Fourteen ♀Duroc ♂Piétrain with CC halothane genotype (PiDu50),

Eight ♀(Piétrain × Duroc) ♂ Piétrain with CC halothane genotype (PiDu75),

Five Piétrain with CC halothane genotype (PiCC),

Six Piétrain with CT halothane genotype (PiCT).

After completing the growth performance evaluation, 5 boars from each genetic group were selected for semen evaluation. Selected males at an age of 7.5 months were transferred to the artificial insemination building and housed in an individual pen. The training of the young boars was started from 8.5 months of age. The interval between two collections was 4 to 7 days.

Animal husbandry was identically applied to all groups. All pigs were reared in the opening building with curtains at Dong Hiep farm, Hai Phong province, Vietnam. The fans with dripping water were used to reduce heat stress in summer. Animals had free access to water by nipple drinkers and were fed ad libitum until 7.5 months of age. After that period, animals were fed twice per day at 8am and 3pm. All feeds were produced directly on the farm. The feed ingredients were broken rice, rice bran, maize, tapioca, soybean, fish meal, salt, di-calcium phosphate, vitamins and minerals. The feed rations were starter (20% protein, 3250 kcal ME), grower (17.5% protein, 3150 kcal ME), finisher (16.5% protein, 3050 kcal ME), and boar (18% protein, 3150 kcal ME).

2.2. Methods

The growth performances of the 41 mentioned animals were evaluated from February 2009 to April 2011. The growth performance evaluation started at 2 months (60 days) of age and ended on 7.5 months (225 days) of age. The animals were weighted using an electronic balance at starting (BW60) and ending (BW225) dates and the average daily gain (ADG) of the corresponding growth period was computed. On the 225-day of age, backfat thickness (BF) and *longissimus* depth (LD) between the third and fourth last rib were measured by an ultrasound device (AgroScan AL with a linear probe ALAL350, France) at 6 cm from the dorsal midline according to the method described by Youssao et al. (2002b). Lean content (LM) was estimated from BF and LD using the regression equation recommended by the Ministère des classes moyennes et de l'agriculture de Belgique (1999):

$$Y = 59.902386 - 1.060750X_1 + 0.2229324X_2$$

where Y = carcass lean meat percentage estimate (%); X_1 = backfat thickness (including the skin, mm) measured at 6 cm lateral of the carcass midline the 3rd and 4th last ribs; X_2 = longissimus muscle depth (mm) measured at the same time and same place as X_1.

Sperm quality traits were recorded from January 2010 to November 2012. A total of 328 ejaculates were collected from 25 boars, 5 boars

from each genetic group. The sperm quality was assessed on each ejaculate using ejaculation volume (VOL), spermatozoon motility (MO), sperm concentration (CO) and total number of spermatozoon in ejaculate (NT), rate of abnormal spermatozoon (R) and pH of semen (pH). VOL was determined using a graduated cylinder. CO was estimated by using photocolorimetry (Photometer SDM5, Minitube). MO was estimated visually with a microscope. Total number of spermatozoon in ejaculate (NT) was calculated through the product of CO, MO and VOL.

2.3. Statistical analysis

Growth performance (BW and ADG) were analysed using a linear model including the different genetic groups (PiDu25, PiDu50, PiDu75, PiCC and PiCT) considered as a fixed effect. Since the measurements could not be realized exactly at 2 months and 7.5 months of age, actual ages of animals (days) at measurement were added in the model as a covariate. For the sperm quality, the different genetic groups and the seasons (Spring, Summer, Autumn and Winter) were the only effects included in the model.

The data were analyzed using the general linear model (GLM) procedure of SAS software (SAS 1989) in order to identify significant sources of variation. The least-squares means were compared using Tukey HSD tests.

3. RESULTS AND DISCUSSION

3.1. Growth performance

The growth performance is influenced by the genetic group effect ($P<0.01$) except BW60 (Table 1). On the 225-day of age BW, ADG and BF of PiDu50 was higher than PiDu25, PiDu75 and the lowest were PiCC and PiCT (Table 2). In general, in comparison to pure Piétrain, hybrid boars showed an advantageous growth rate. The performances of the PiDu50 boars were better than PiDu25 and PiDu75, although not significant. The data on growth rate reflect the favorable effect of Duroc on growth. The relative performances for the 3 hybrid categories might reflect heterosis, although such conclusion would deserve more investigation. These results are supported by Thao et al. (2009), who identified that ADG of PiDu50 boars were higher in comparison with pure Piétrain boars. Luc et al. (2011) also observed similar result in a report on Piétrain and hybrid boars.

Table 1. Results of the effect of genetic group (PiDu 25, 50 75, PiCC and PiCT) and season on growth performance and semen quality

Variable	Genetic group	Season	R^2
BW60 (kg)	NS		13.77
BW225 (kg)			36.34
ADG (g/day)	***		51.11
BF (mm)			34.97
LD (mm)	***		42.52
LM (%)	***		53.36
VOL (ml)	***	NS	36.79
MO (%)	***	***	18.82
CO ($x10^6$/ml)	***	***	24.82
NT ($x10^9$/ejaculate)	***		23.87
R (%)	***	NS	14.31
pH	***	***	16.32

Note: -: season effect was not tested
*NS = not significant, * = P< 0.05, ** = P<0.01, *** = P< 0.001, R2 = coefficient of determination*

Table 2. Production performance, Least square means (LSM±SE) of PiDu and Piétrain boars

Variable	PiDu25 (n = 8)	PiDu50 (n = 14)	PiDu75 (n = 8)	PiCC (n = 5)	PiCT (n = 6)
BW60 (kg)	16.05 ± 1.03	16.92 ± 0.82	18.08 ± 1.05	17.01 ± 1.31	14.49 ± 1.32
BW225 (kg)	118.27^{a} ± 3.73	119.67^{a} ± 2.87	113.88^{ab} ± 3.70	107.17^{ab} ± 4.73	101.22^{b} ± 4.31
AGD (g/day)	624.09^{ab} ± 18.06	635.07^{a} ± 13.88	577.48^{abc} ± 18.30	552.93^{bc} ± 22.88	516.00^{c} ± 20.88
BF (mm)	11.96^{a} ± 0.68	10.79^{ab} ± 0.51	8.96^{b} ± 0.68	8.72^{b} ± 0.86	8.42^{b} ± 0.78
LD (mm)	51.46^{a} ± 1.33	57.08^{b} ± 1.01	57.44^{b} ± 1.33	57.64^{b} ± 1.68	61.65^{b} ± 1.54
LM (%)	59.02^{a} ± 0.71	61.55^{ab} ± 0.54	63.57^{bc} ± 0.71	63.87^{bc} ± 0.90	65.11^{c} ± 0.82

Note: Least square means with differing letters in each row within an effect differ (P<0.05)
Pi: Piétrain, Du: Duroc, CC and CT: halothane genotypes.

Contrary to growth traits, LD and LM were highest for PiCT and PiCC; PiDu25 was lowest, simultaneously BF was thinnest for PiCT and PiCC; Pi25 was thickest (table 2). This study illustrates that the LD and LM increase while the BF decreases in relation with the Piétrain content: the more Piétrain, the more LM and LD and the lower BF (Table 2).

There was no significant difference in the growth performance between PiCC et PiCT (P>0.05). Luc *et al.* (2008) and Youssao et al. (2002a) did not find out any significant growth difference between the two halothane genotypes in Piétrain. Also, there was no significant difference in lean meat percentage between PiDu75 and pure Piétrain boars (Table 2).

The results of the growth performance suggest a favorable benefit to use PiDu75 as a terminal boar in the pig production in the north provinces to improve a lean meat percentage.

3.2. Semen quality

3.2.1. Influence of genetic group on semen quality

The table 1 shows that semen quality traits are influenced by genetic background (P<0.001). VOL was highest for PiCC, lowest for PiDu75. MO was highest for PiCC and PiDu75, lowest for PiCT. Meanwhile, CO was highest for PiDu25, lowest for PiCC and PiCT. NT of PiCC, PiDu25, and PiDu50 were largely higher than in PiDu75 and PiCT (Table 3). Although the VOL of PiDu75 was lowest, higher MO and CO lead to NT values similar to PiCT.

Table 3. Semen quality, Least square means (LSM ± SE) of Piétrain x Duroc hybrids and Piétrain boars according to genetic group

Variable	PiDu25 (n = 65)	PiDu50 (n = 79)	PiDu75 (n = 31)	PiCC (n = 111)	PiCT (n = 42)
VOL (ml)	217.20^{ab} ± 7.59	241.66^{a} ± 7.06	154.11^{d} ± 11.63	299.46^{c} ± 5.96	201.10^{b} ± 9.55
MO (%)	78.14^{a} ± 0.61	76.53^{ab} ± 0.57	79.20^{bc} ± 0.94	80.49^{c} ± 0.48	75.19^{b} ± 0.77
CO (x10^{9}/ml)	553.44^{a} ± 20.19	502.59^{ab} ± 18.78	425.47^{bc} ± 30.92	400.33^{c} ± 15.85	334.02^{c} ± 25.40
NT (x10^{9}/ej.)	92.45^{a} ± 4.40	93.99^{a} ± 4.09	53.78^{b} ± 6.74	92.27^{a} ± 3.45	49.83^{b} ± 5.54
R (%)	3.92^{a} ± 0.39	5.60^{bc} ± 0.37	1.86^{d} ± 0.62	4.67^{ab} ± 0.31	6.25^{c} ± 0.49
pH	7.49^{a} ± 0.04	7.52^{a} ± 0.03	7.71^{b} ± 0.05	7.44^{a} ± 0.03	7.45^{a} ± 0.04

Note: Least square means with differing letters in each row within an effect differ (P<0.05)
Pi: Piétrain, Du: Duroc, CC and CT: halothane genotypes

Table 4. Semen quality, least square means (LSM ± SE) of Piétrain boars and their hybrids as influenced by season

Variable	Spring (n = 51)	Summer (n = 84)	Autumn (n = 144)	Winter (n = 49)
VOL (ml)	206.25 ± 9.01	221.63 ± 7.01	231.90 ± 5.14	231.04 ± 8.97
MO (%)	80.33^a ± 0.73	76.81^a ± 0.57	77.82^a ± 0.42	76.68^b ± 0.72
CO (x10^6/ml)	467.96^a ± 23.97	392.79^b ± 18.65	394.92^b ± 13.66	517.01^a ± 23.68
NT (x10^6/ej.)	80.45^{ab} ± 5.22	66.87^b ± 4.07	70.06^b ± 2.98	88.49^a ± 5.20
R (%)	3.69 ± 0.45	4.62 ± 0.40	4.72 ± 0.26	4.81 ± 0.45
pH	7.63^a ± 0.04	7.49^b ± 0.03	7.61^a ± 0.02	7.37^b ± 0.04

Note: Least square means with differing letters in each row within an effect differ (P<0.05)

3.2.2. Influence of season on semen quality

Thao et al. (2009) showed that PiDu50 terminal boars had higher NT (from 1 to 8 billion), and especially stronger libido than pure Duroc and Piétrain. According to Kawecka et al. (2008) and Smital et al. (2004), PiDu50 boars have lower VOL but higher CO than pure Piétrain boars. These results are in accordance with the results in the present study.

There were differences in semen quality among PiDu75, PiDu50 and PiDu25 (table 3). The relatively limited number of available PiDu75 ejaculates in this study might be an issue, although standard deviations for this group do not seem to indicate major bias. Although the semen quality of PiDu75 boars was lower than other hybrid boars, it was similar to PiCT.

All semen traits of stress-negative Piétrain boars as well as hybrid boars in this study reached the quality criteria imposed by the Decision 1712/QD-BNN-CN dated 09/6/2008 of the Ministry of Agriculture and Rural Development on technical standards for the radical animal breeds. However, checking semen quality of PiDu75 boars could be a necessary procedure.

The semen traits by season were given in table 4. The season effect was observed on most semen quality traits including CO, MO, NT and pH (table 1). VOL was not affected by season (P>0.05). This result is consistent with the study by Wierzbicki et al. (2010) and Luc et al. (2013) but in contrast to the conclusions of (Wysokinska et al., 2009). CO and NT were low in summer and autumn, high in winter and spring, which were reported by Smital *et al.* (2004). This result may be related to a high temperature of the summer when it can be up to 40-41°C. The studies of Bo *et al.* (2011) and Than *et al.* (2010) showed that the semen quality of pure Piétrain pigs is best in winter, followed by autumn and lowest in summer. Wysokinska et al. (2009) also found reduced CO in May, July and August but higher in November, December and January.

4. CONCLUSION

The production performance and the semen quality are influenced by the genetic background. The Piétrain x Duroc hybrid boars (PiDu25, PiDu50 and PiDu75) have a better growth rate, but lower lean meat percentage in comparison to pure Piétrain, except PiDu75 boars. PiDu25, Pidu50 and PiCC boars show high semen quality traits. The season effect is more important on semen quality traits. Total number of spermatozoon in ejaculate was lower in summer and autumn, higher in winter and spring. This suggests that Piétrain x Duroc hybrid boars, especially PiDu75, should be used as terminal boars to improve lean meat percentage.

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