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POSTER

Animal breeding scheme applied to the quality of pure Iberian *montanera* pigs

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ADDITIONAL KEYWORDS

Selection scheme.
Maternal and production traits.
Carcass.
Meat quality.

SUMMARY

Selection programs are not frequent in the extensive Iberian porcine sector. The traditional company of Iberian pig products located in Jabugo (Sierra de Huelva), Sánchez Romero Carvajal (SRC), with the collaboration and assessment of the Animal Breeding Department of INIA, is making since the year 2012 an unusual effort to develop and implement a breeding selection scheme focused on the Iberian purebred products labelled as Bellota. The animals involved in this program belong to one herd which is placed in two different farms, Montecastilla and Tejarejo (La Granada de Riotinto). 1,205 animals of known pedigree were controlled for selection of growth, body composition, meat and fat quality traits. The main registered traits were average daily gain in montanera, slaughter and carcass weight and weight of premium cuts (ham, shoulders and loins). Besides, backfat fatty acid profile and quality traits as intramuscular fat percentage, color, thawing and cooking water loss and shear force were measured in loin as quality traits. Breeding values for these traits were estimated using an Animal model. Genetic predictions for maternal traits (number of piglets born alive and litter weight at weaning) were performed also using Animal models. Data from 5,134 litters born in 88 batches of 1456 dams and 22 sires were used. This information allowed estimating heritability and genetic correlation as well as to build a combined index for each trait weighting the breeding values by their corresponding economic values. In addition to this, molecular genetic studies on some of the traits cited above are also being implemented. These studies will allow increasing the efficiency of the conventional selection program in the future.

Programa de selección genética enfocada en la calidad de cerdos Ibéricos puros de montanera

PALABRAS CLAVE ADICIONALES

Programa de selección genética.
Caracteres maternos y productivos.
Canal.
Calidad de carne.

RESUMEN

Los programas de selección genética son inusuales en el sector porcino Ibérico de extensivo. La empresa tradicional de productos de cerdo Ibérico, Sánchez Romero Carvajal (SRC), localizada en la Sierra de Huelva, junto con el Departamento de Mejora Genética Animal del INIA, se está esforzando en desarrollar un esquema de selección basado en evaluaciones BLUP-Modelo animal y enfocado a la mejora genética de cerdos Ibéricos puros de montanera. Los animales implicados en este programa pertenecen a una piara distribuida entre las fincas Montecastila y Tejarejo (La Granada de Riotinto). Para la selección de caracteres de crecimiento, composición de canal y calidad de carne y grasa, se dispone de registros de 1.205 animales de genealogía controlada. Los caracteres principales registrados son: ganancia media diaria en montanera, peso de canal y pesos de piezas nobles (jamones, paletas y lomos). Además, como caracteres de calidad se midieron: perfil de ácidos grasos en grasa subcutánea, porcentaje de grasa intramuscular, color, pérdidas de agua después de descongelado y cocinado, así como resistencia del lomo al corte. Las valoraciones genéticas para caracteres maternos (número de lechones nacidos vivos y peso de camada al destete) se han efectuado hasta la fecha usando datos de 5.134 camadas nacidas en 88 lotes de 1.456 cerdas y 22 verracos. Las reproductoras estaban localizadas en un sistema de parideras tradicionales. Esta información permite la obtención de estimas de heredabilidad y correlaciones genéticas, así como de un índice combinado construido con los valores mejorantes ponderados por los pesos económicos respectivos para cada carácter. Las actividades del programa permiten además la realización de diversos estudios de genética molecular. Estos estudios permitirán en el futuro aumentar la eficacia del programa de selección convencional.

INFORMATION

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INTRODUCTION

Selection programs are not frequent in Iberian pig populations despite most of the commercial porcine breeds have implemented these programs for several decades. For instance, Duroc breed, used as paternal line in cross with Iberian pigs, has been subjected to strong breeding programs for growth and lean percentage of carcass and established lines specialized for intramuscular fat percentage (ANPS, 2011). The main objective of the production of Iberian pigs is to obtain heavy pigs destined to be processed as high quality fresh and dry-cured meat products (Silió 2000, p. 511-520). According with the Spanish law, there are three different systems of fattening: 1) *Bellota*: extensive system in which the animals are fattened mainly with acorns and grass from November to late February, named *montanera* period, b) *Cebo de campo*: open-air system in which the animals are fattened with feed and occasionally they take advantage of the natural resources different from acorns and c) *Cebo:* intensive system in which the animals are fattened with commercial feed. (BOE, 2014). Sánchez Romero Carvajal (SRC) is a traditional enterprise of Iberian pig products located in *Sierra de Huelva*. SRC with the collaboration and assessment of the Pig Breeding and Genetics Group of INIA are implementing and developing a breeding selection scheme focused in Iberian purebred pigs fattened in *montanera*. As a first step, a large number of data of different productive, reproductive and meat quality traits are being collected. The final breeding goal of the program consists in combining this information to develop dam and sire lines to obtain purebred Iberian pigs with high premium cuts yield, and high meat and fat quality.

MATERIAL AND METHODS

Data collection

Data from 5,134 litters born in 88 farrowing batches of 1,456 dams and 22 sires were recorded. Sows were allocated on traditional farrowing houses. The traits recorded from these data were the number of piglets born alive (NBA) and litter weight at weaning (LWW). For productive and meat quality traits, data from 1,205 *montanera* pigs slaughtered in 15 batches, coming from 553 dams and 17 sires were used. The main traits recorded were: average daily gain during *montanera* fattening period (ADG), carcass weight and percentage of premium cuts (ham, shoulders and loins) on carcass, and loin intramuscular fat content (%IMF), Minolta color, shear force, compression test and thawing and cooking water losses, measured in loin samples, and backfat composition of the main 12 fatty acids.

Genetic evaluation

Animal models were used to estimate heritability, genetic correlations and breeding values. For reproductive traits the following bivariate model was used:

$$\begin{pmatrix} y_1 \\ y_2 \end{pmatrix} = \begin{pmatrix} X_1 & 0 \\ 0 & X_2 \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \end{pmatrix} + \begin{pmatrix} Z_1 & 0 \\ 0 & Z_2 \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \end{pmatrix} + \begin{pmatrix} W_1 & 0 \\ 0 & W_2 \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \end{pmatrix} + \begin{pmatrix} B_1 & 0 \\ 0 & B_2 \end{pmatrix} \begin{pmatrix} b_1 \\ b_2 \end{pmatrix} + \begin{pmatrix} e_1 \\ e_2 \end{pmatrix}$$

where y_1 and y_2 are the records for NBA and LWW, respectively, the vectors u_1 and u_2 are random additive genetic effects, p_1 and p_2 are the permanent environmental effects of each sow, b_1 and b_2 the farrowing batch effects and e1 and e2 the environmental random effects". The incidence matrices X_1 and X_2 associate y_1 and y_2 with elements of β_1 and β_2 , Z_1 and Z_2 with u_1 and u_2, W_1 and W_2 with p_1 and p_2 and B_1 and B_2 with b_1 and b_2. Farrowing batch was considered as random effect since included 88 levels.

For productive traits the following multitrait model was used:

$$\begin{pmatrix} y_1 \\ \cdot \\ y_5 \end{pmatrix} = \begin{pmatrix} X_1 & 0 & 0 \\ 0 & .. & 0 \\ 0 & 0 & X_5 \end{pmatrix} \begin{pmatrix} \beta_1 \\ \cdot \\ \beta_5 \end{pmatrix} + \begin{pmatrix} Z_1 & 0 & 0 \\ 0 & .. & 0 \\ 0 & 0 & Z_5 \end{pmatrix} \begin{pmatrix} u_1 \\ \cdot \\ u_5 \end{pmatrix} + \begin{pmatrix} e_1 \\ \cdot \\ e_5 \end{pmatrix}$$

where y_1 and to y_5 are the records for ADG, the percentage of ham, shoulders and loins and the percentage of intramuscular fat, respectively. The vectors of fixed effect (β_1 β_2) included the farrowing batch (17 levels) for ADG and the slaughter batch (15) and carcass weight as a covariate for the % of hams, shoulders, loins and IMF. The vectors u_1 and u_2 are random additive genetic effects and e_1 and e_2 the environmental effects. The incidence matrices X_1 to X_5 associate y_1 to y_5 with elements of β_1 and β_2 and Z_1 to Z_5 with u_1 and u_2.

Lastly, an analogous multitrait model which included a litter random effect (*c*) was used to estimate heritability and genetic correlations between % IMF, thawing and cooking losses and shear force. To perform these analyses PEST (Groenveld, 1990) and VCE 5 (Kovac & Groenveld, 2003) software was used.

RESULTS

Table I shows the results for reproductive traits. Heritability values were low for both traits but similar to those reported for other breeds. **Table II** shows the results for productive traits; heritability was low for ADG while for the other traits showed moderate values. There were a positive genetic correlation between body composition traits (% of hams, shoulders and loins) and a negative genetic correlation between body composition traits and IMF. Lastly, **Table III** shows the genetic parameters for meat quality traits. Heritability estimates were moderate for all the traits; in addition to this, IMF was negatively correlated with all the traits and there were high and positive correlations between thawing loss, cooking loss and shear force.

DISCUSSION

According to the results obtained, breeding programs can be implemented in this Iberian purebred population for the traits studied. The genetic correlations observed between body composition traits and IMF point out that selection for body composition

Table I. Heritability estimates (diagonal) and genetic correlation between NBA and LWW (above diagonal) and their corresponding values of permanent environmental effects and standard errors (between brackets) (estimaciones de heredabilidad (diagonal) y correlación genética entre NBA y LWW (sobre la diagonal) y sus valores correspondientes de efectos ambientales permanentes y errores estándar (entre paréntesis).

Trait	NBA	LWW
NBA	0.06 (0.02)	0.12 (0.19)
LWW		0.14 (0.03)
p^2	0.05 (0.02)	0.19 (0.03)

Table II. Heritability estimates (diagonal) and genetic correlation between ADG, % of hams, shoulders and loins and IMF (above diagonal) and standard errors (between brackets) (Estimaciones de heredabilidad (diagonal) y correlación genética entre ADG,% de jamones, hombros y lomos y FMI (por encima de la diagonal) y errores estándar (entre paréntesis).

	ADG	Hams, %	Shoulders, %	Loins, %	IMF, %
ADG	0.09 (0.04)	-0.04 (0.08)	-0.23 (0.12)	-0.01 (0.07)	0.34 (0.07)
Hams , %	-	0.28 (0.04)	0.75 (0.10)	0.84 (0.06)	-0.31 (0.08)
Shoulders, %	-	-	0.10 (0.03)	0.81 (0.09)	-0.10 (0.10)
Loins, %	-	-	-	0.39 (0.06)	-0.40 (0.17)
IMF, %	-	-	-	-	0.27 (0.04)

Table III. Heritability estimates (diagonal) and genetic correlation between IMF, thaw loss, cooked loss and shear force (above diagonal) and standard errors (between brackets) (Estimaciones de heredabilidad (diagonal) y correlación genética entre el FMI, pérdida tras descongelación, pérdida tras cocido y resistencia al corte (sobre la diagonal) y errores estándar (entre paréntesis).

	IMF, %	Thaw loss, %	Cooked loss, %	Shear force, kg	c^2
IMF, %	0.36 (0.13)	-0.84 (0.13)	-0.47 (0.25)	-0.68 (0.17)	0.11 (0.06)
Thaw loss, %	-	0.20 (0.07)	0.87 (0.07)	0.87 (0.19)	0.17 (0.07)
Cooked loss, %	-	-	0.33 (0.09)	0.85 (0.16)	0.10 (0.05)
Shear force, %	-	-	-	0.39 (0.12)	0.06 (0.06)

c^2: litter random effects

traits could decrease the percentage of IMF, leading to a decrease of meat quality. Therefore, a balance between these breeding values should be taken into account in the selection of breeding animals (García-Casco et al. 2014, p. 388-395). In addition to this, breeding values estimation allows to build combined index for each trait weighting the genetic values by their corresponding economic values. Over the last four years, SRC is following these parameters to carry out selection of the breeding animals. IMF was also included in the third model since is the most important trait related with meat quality. It should be noted that the different heritability values of IMF estimated in the two multitrait models are due to the multitrait model used to estimate the genetic components of IMF, thawing loss, cooking loss and shear force includes litter random effects and less phenotypical registers than the one used to estimate genetic parameters of ADG, % of premium cuts and IMF.

It is worth to note the valuable effort made by both SRC and Pig Breeding and Genetics Group to get the animal information, genetic control of the animals, the data recording from pigs fattened in *montanera* and from individual carcasses, individual fat and meat samples in slaughterhouse and the meat and fat quality lab data. Finally, molecular genetic studies on some of the traits cited above are also being implemented. These studies will allow increasing the efficiency of the conventional selection program in the future.

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