Genetic antagonism between intramuscular fat content and primal cuts in Iberian pigs ?

Fernández A., García-Casco J., De Pedro E., Silió L., Rodríguez M.C.

in

Audiot A. (ed.), Casabianca F. (ed.), Monin G. (ed.).
5. International Symposium on the Mediterranean Pig

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 76

2007
pages 43-46

Genetic antagonism between intramuscular fat content and primal cuts in Iberian pigs?

A. Fernández, J. García-Casco, E. de Pedro, L. Silió and M.C. Rodríguez
Departamento de Mejora Genética Animal, INIA,
Carretera de la Coruña Km 7, 28040 Madrid, Spain

SUMMARY – The objective of this work was to estimate the correlations between intramuscular fat content in *M. longissimus*, the percentage of hams, forelegs and loins, and the daily growth over the fattening period. Data analysed came from 3983 castrated males, born in 43 herds since the year 1993. All the animals were fattened under a common extensive management system distributed in 50 batches and slaughtered at approximately 160 kg. Heritability estimates presented high values for all the traits (h^2 = 0.38-0.43) indicating that the selection for these traits could be effective. Genetic correlations between percentages of primal cuts were high and positive (from 0.49 to 0.74). This fact indicates that these traits are partially controlled by the same group of genes. However, genetic correlations between intramuscular fat content in *M. longissimus* and percentages of the main primal cuts showed values close to zero. This result indicates that it is possible to carry out an effective selection scheme focused on the improvement of carcass traits, without affecting the meat suitability for dry-curing in a short-time horizon.

Keywords: Iberian, intramuscular fat, carcass composition, heritability, genetic correlation.

RESUME – *"Antagonisme génétique entre la teneur en gras intramusculaire et les premiers morceaux des porcs Ibériques?". L'objectif de ce travail était l'estimation des corrélations entre la graisse intramusculaire dans le* M. longissimus, *les pourcentages de jambons, palette et longe, et le gain moyen quotidien pendant la période d'engraissement. Les données proviennent de 3983 mâles castrés, nés dans 43 troupeaux depuis 1993. Tous les animaux ont été soumis au même système de production extensive et abattus à 160 kilos, en 50 bandes. Les valeurs estimées d'héritabilité sont élevées pour tous les caractères (h^2 = 0,38-0,43), ce qui démontre que la sélection pour ces caractères peut être efficace. Les corrélations génétiques entre les pourcentages des principales pièces de la carcasse étaient élevées et positives (0,49-0,74), montrant que ces caractères peuvent être contrôlés par le même groupe de gènes. Néanmoins, les corrélations génétiques entre la graisse intramusculaire et les pourcentages des pièces étaient presque nulles. Les résultats montrent qu'il est possible de réaliser un programme de sélection pour améliorer les caractères de carcasse sans détériorer la qualité de la viande.*

Mots-clés : *Ibérique, graisse intramusculaire, composition de la carcasse, héritabilité, corrélation génétique.*

Introduction

Iberian pigs are produced in a range of low, medium and high input production systems, all them focused on obtaining meat and dry-cured products characterized by their high sensorial quality. A breeding programme for the Iberian breed, based on data recorded from pigs fattened on extensive farms, has been developed along the last decade by the Spanish Association of Iberian Pig Breeders (AECERIBER). The breeding goal of this scheme combines traits of carcass conformation (trimmed hams, forelegs and loins, adjusted for carcass weight), identified as the economically most important productive traits in this breed.

The main objective of breeding strategies in cosmopolitan pig breeds has been to increase the lean growth efficiency. As a consequence of the performed intense selection, most of the present day pig lines of these breeds exhibit an increase in lean growth efficiency, decreased backfat, and increased percentage of primal cuts in the carcass. But these advantages may compromise pig meat quality. This selection lead to an increase of protein and water muscle content whereas decreases the intramuscular fat percentage (Lonergan *et al*., 2001).

The design of the Iberian pig breeding program should avoid this risk of diminution of intramuscular fat (IMF) content. A visible high amount of IMF is positively appreciated by consumers of Iberian pig products. Besides its influence on appearance, the IMF level seems to influence meat palatability

characteristics (Hovenier *et al*., 1993). A high IMF content is also required to the effective suitability of meat for the processing industry of dry-cured products, because it is important for favour and to aid slow dehydration during the curing process. In order for any selection program to be successful, (co)variance components and genetic parameters for relevant traits must be estimated. A first estimation of genetic parameters for production and meat and fat quality traits has been previously reported from data recorded in the Iberian pig breeding program (Fernández *et al*., 2003). The aim of this study is to estimate newly genetic parameters for fattening growth, carcass components and IMF content, based on a larger sample of Iberian pigs. These estimates could be used in new selection indices in order to avoid deterioration of meat quality.

Material and methods

Animals

Since 1993 AECERIBER has carried out annual tests of carcass performance based on family groups of animals, sampled at weaning from different herds, and transferred to a common farm. The pigs were fed with a restricted feeding with concentrates up to a live weight of approximately 100 kg. After and until slaughter at an average commercial weight of 160 kg, they were fattened in a free-range system ("Montanera") based on the *ad libitum* intake of acorns and pasture (López-Bote, 1998). Growth and carcass data were collected from 1993 to 2004. Records of IMF content were only available from 1998 onward. Pedigree information came from the herdbook database with all known ancestors of the tested pigs included. Ancestors with unknown parents were defined as the base population. The complete information available for the analysis is shown in Table 1.

Table 1. Size and structure of data and pedigree information

	Total number
Animals with records	3983
Animals of known pedigree / base animals	4214 / 1873
Sires / Average recorded offspring per sire	314 / 3
Herds of origin	43
Slaughter groups	50

Data

Tested animals were weighted the first and the last day of the *ad libitum* fattening period, providing information on the daily growth during the "Montanera" period. They were slaughtered at a commercial abattoir with an average age of 490 days. The weight of the warm carcass and the primal cuts (trimmed hams, forelegs and loins) were individually registered. Samples of *Longissimus dorsi* muscle at the fourth rib level were collected to determinate the content of IMF using reflectance spectroscopy in the near infrared (NIRS). Spectra of muscle samples were obtained using a spectrophotometer Foss-NIRSystems 6500 SY I monochromator equipped with a spinning module (Solís *et al*., 2001).

Statistical analysis

The following multitrait individual animal model was used for a joint analysis of all the traits:

$$\mathbf{Y = X \beta + Z u + e}$$

where: **Y** is a matrix of observations (daily gain, percentage of hams, forelegs and loins, and intramuscular fat content), **β, u** and **e** are matrix of fixed, additive genetic and residual effects respectively, and **X** and **Z** are known incidence matrices. Fixed effects were morphological type (red, chestnut or black hairless), slaughter group (50 levels), herd of origin (43 levels) and the carcass weight as covariate. The REML/VCE 4.2 program (Groeneveld, 1994) was used to estimate (co)variance components, heritabilities and genetic and residual correlations.

Results and discussion

The elementary statistics of the recorded traits are presented in Table 2. Although differences between the analytical methods and the fat distribution may exist, the average IMF content largely exceeds those reported from loins of heavy pigs of other breeds. For example, Corino *et al*. (2002) referred a mean value of 3.74% for the total lipid content of this muscle in castrate male Large White pigs slaughtered at 160 kg.

Table 2. Summary of statistics for the analyzed traits: Number of records (N), average, standard deviation (SD); coefficient of variation (CV), minimum and maximum value

Traits	N	Average	SD	CV (%)	Minimum	Maximum
Growth						
Daily gain, g/d	3910	601.27	142.81	24	82.00	1345.00
Carcass						
Hams, %	3948	15.62	1.44	9	10.27	23.54
Forelegs, %	3948	10.56	0.97	9	6.73	15.31
Loins, %	3639	2.28	0.41	18	0.81	5.18
Meat Quality						
IMF, %	2664	9.99	3.29	33	3.27	29.21
Covariable						
Carcass, kg	3948	131.63	15.20	12	68.00	192.60

The estimated values of heritability (h^2) for all the analyzed traits are presented in the diagonal of Table 3. The h^2 value estimated for the daily growth during the "Montanera" is slightly lower than h^2 values previously estimated for this trait from preliminary data (Fernández *et al*., 2000). The high heritability value of daily gain and the dispersion of this trait, measured by its coefficient of variation (CV = 24%), indicate the easy achievement of genetic changes by selection for growth rate in the fattening period.

Table 3. Heritabilities (on diagonal) and genetic correlations between analyzed traits (above the diagonal) with standard errors (between brackets)

	Daily Gain	Hams	Forelegs	Loins	IMF
Daily Gain	0.43 (0.03)	0.25 (0.05)	0.22 (0.05)	0.11 (0.05)	-0.19 (0.06)
Hams		0.39 (0.03)	0.72 (0.03)	0.68 (0.04)	-0.17 (0.06)
Forelegs			0.43 (0.03)	0.45 (0.04)	0.09 (0.05)
Loins				0.40 (0.03)	-0.10 (0.05)
IMF					0.38 (0.02)

The h^2 values estimated for the percentages of trimmed hams, forelegs and loins (adjusted for carcass weight) are close to 0.40. Johansson *et al*. (1987) reported heritability estimates for ham percentage from 0.28 to 0.43, calculated from European progeny testing programs. A lower value of heritability for the ham weight (h^2 = 0.22) has been estimated in Australian Large White and Landrace pigs (Hermesch *et al*., 2000). There are not available other recent estimates of heritability for these traits. Carcass lean percentage may be considered as a similar trait, although the weights of hams and forelegs include skin, bone and fat. A pooled value of h^2 = 0.54 for carcass lean percentage has been quoted by Ducos (1994), reviewing 77 previous studies of genetic parameters for pig carcass traits. Genetic correlations among the percentages of different primal cuts, estimated in the present study, show great and positive values (from 0.45 to 0.72). It indicates that these traits are partially controlled by the same group of genes, and the selection for carcass components in Iberian pigs could be effective.

The estimated value of heritability for IMF content (h^2 = 0.38) corresponds to the bottom bound of the range of heritabilities for this trait (0.26-0.86), reviewed from 19 previous estimates by Sellier (1998). This lower h^2 value could be attributed to the measurement error of the NIRS method, greater than those of

the correspondent methods of choice. For example, a low value of 0.35 was also estimated in Australian pigs for the heritability of IMF content determined by NIRS (Hermesch *et al*., 2000). Concerning the possible genetic antagonism between IMF percentage and carcass leanness traits, Sellier (1998) reviewed different previous studies in which a negative value of genetic correlations between these traits ($-0.07 \geq g_G \geq -0.55$) was reported, with a pooled average value of $g_G = -0.34$.

In the present study, genetic correlations between IMF content and daily gain or the percentages of hams and loins show negative values, but close to zero. A positive value was estimated for the correlation between IMF and forelegs, but not significantly different from zero. These results indicate that, at least in a short-time horizon, it is possible to carry out an effective selection scheme to increase percentage of primal cuts in the Iberian pig carcasses, without appreciable deterioration of the meat suitability for dry-curing. However, in a medium-time horizon, the objective of the Iberian pig breeding scheme should be modified, incorporating IMF content to the selection goal. It poses some methodological problems, because quality traits are not linearly related to product value, but they present an optimum range, difficulting the definition of the selection index. The use of methods to calculate economic weights for traits with intermediate optimum, or alternative techniques such as restricted-selection or desired-gains indices, should be advisable.

References

Corino, C., Magni, S., Pagliarini, E., Rossi, R., Pastorelli, G. and Chiesa, L.M. (2002). Effects of dietary fats on meat quality and sensory characteristics of heavy pig loins. *Meat Science,* 60: 1-8.

Ducos, A. (1994). Paramètres génétiques des caractères de production chez le porc. Mis au point bibliographique, *Techni-porc,* 17: 35-67.

Fernández, A, Silió L. and Rodríguez, M.C. (2000). Análisis genético del crecimiento en montanera de cerdos ibéricos. *Información Técnica Económica Agraria,* 97 A (1): 77- 89.

Fernández, A., de Pedro, E., Núñez, N., Silió, L., García-Casco, J. and Rodríguez, M.C. (2003). Genetic parameters for meat and fat quality and carcass composition traits in Iberian pigs. *Meat Science*, 64: 405-410.

Groeneveld, E. (1994). VCE – a multivariate multimodel REML (co)variance component estimation package. In: *Proceedings of 5th World Congress on Genetics Applied to Livestock Production,* 22: 47-48, Guelph, Canada.

Hermesch, S., Luxford, B.G. and Graser H.-U. (2000). Genetic parameters for lean meat yield, meat quality, reproduction and feed efficiency traits for Australian pigs. 1. Description of traits and heritability estimates. *Livestock Production Science,* 65: 239-248.

Hovenier, R. (1993). Breeding for pig meat quality in halothane-negative populations. A review. *Pig News Info*, 14: 17N-25N.

Johansson, K., Andersson, K. and Sigvardsson, J. (1987). Evaluation of station testing of pigs III. Genetic parameters for carcass measurements of partially dissected pigs. *Acta. Agric. Scand*., 37: 120-129.

Lonergan, S.M., Huff-Lonergan, E., Rowe, L.J., Kuhlers, D.L. and Jungst, S.B. (2001). Selection for lean growth efficiency in Duroc pigs influences pork quality. *J. Anim. Sci*., 79: 2075-2085.

López-Bote, C. (1998). Sustained utilization of the Iberian pig breed. *Meat Science,* 49 Suppl. 1: S17-S27.

Sellier, P. (1998). Genetics of meat and carcass traits. In: *The genetics of the pig*, Rothschild, M.F., Ruvinsky, A. (eds), CAB International, New York, pp. 463-510.

Solís, M., de Pedro, E., Garrido, A. and García-Olmo, J. (2001). Evaluación de la composición del lomo de cerdo ibérico mediante la tecnología NIRS. *ITEA,* 22: 613-615.