# EFFECT OF SIRE BREED AND REARING METHOD ON QUALITATIVE CHARACTERISTICS OF PORK

**BERGE Ph.**(1), **BOCCARD R.**(1), **GANDEMER G.**(2) and **LEGAULT C.**(3)

(1) I.N.R.A., Station de Recherches sur la Viande, Theix, 63122 Ceyrat, France.
(2) I.N.R.A., Laboratoire d'Etude des Interactions des Molécules Alimentaires, B.P. 527, 44026 Nantes Cedex 03, France.
(3) I.N.R.A., Station de Génétique Quantitative et Appliquée, 78350 Jouy-en-Josas, France.

## INTRODUCTION

Though the concept of meat quality is difficult to define, it is well known that consumer preference depends on factors such as colour, apparent lean:fat ratio, wholesomeness, tenderness and flavour. Meeting the consumer requirements can then be achieved by producing pork of adequate characteristics by means of crossbreeding, diet formulation and suitable further processing.

Various works have demonstrated consistent differences in carcass anatomical composition and meat chemical composition between the main swine breeds. But classification of breeds for each of the main meat components studied somewhat varies between authors.

Diet composition is well known to modify body and meat composition in pigs, mainly through quantity and quality of fat deposited (Monin, 1983; Girard et al., 1988; Bout et Girard, 1988). However, method of rearing including a more or less intensive physical activity has been little studied in pigs. Some experiments indicated that environmental conditions (exercise, confinement, temperature, humidity) could affect meat quality. This causal relationship however remains controversial as reviewed by Monin and Ouali (1989). The respective effects of breed and rearing conditions on meat characteristics then needs to be further investigated.

The present experiment was carried out to study factorially the main effects of sire breed and method of rearing and that of their interaction on meat quality that would provide useful information on conditions required for producing first choice pork from French x Chinese crossbred sows.

## MATERIALS AND METHODS

A total number of 64 experimental pigs (17 males and 47 females) were used according to a 4 x 2 factorial design. Part of the animals were born from Gascon x Meishan sows and sired by one of the three following breeds: Duroc (treatment DU, n = 17), Piétrain (treatment PI, n = 16) and Large White (treatment LW, n = 18). Remaining animals were Large White x French Landrace crossbred and were used as control (treatment C, n = 13), being representative of one of the most common swine breeds reared in France.

Within each sire breed treatment, pigs were allocated by blocks to two rearing methods. Half of the animals were reared indoors, kept in pens at a mean density of 9 $m^2$/animal and fed intensively during the fattening period (*ad libitum* level of feeding from 25 to 100 kg live weight; treatment INT, n = 32). The other half of the animals were reared outside with free access to shelter and exercise area at a mean density of 330 $m^2$/animal and semi-intensively fed during the fattening period. They were first fed *ad libitum* from 25 to 70 kg live weight. Then they were restricted from 70 to 100 kg live weight and fed forages *ad libitum* (treatment EXT, n = 32).

At slaughter at a similar carcass weight, a sample was taken from *M. longissimus dorsi* (from 7th dorsal to 1st lumbar vertebra) and frozen prior to chemical analysis. The dry matter (DM), total crude protein (CP = N x 6.25), collagen (Hydroxyproline x 7.5), intramuscular lipids and myoglobine (haem iron) contents were measured. Furthermore, a subsample was submited to a 2 h heat treatment at 90°C for collagen solubility determination. Data were examined by analysis of variance to evaluate the main effects of sire breed and rearing method as well as that of their interaction.

## RESULTS AND DISCUSSION

At slaughter, carcass weight did not differ significantly between sire breed nor rearing methods (mean value 75 ± 4 kg) but pigs from treatments DU and PI were slaughtered

approximately 13 days later than their counterparts from treatments C and LW (significant difference, $P<0.05$). Results are presented in Table 1.

Effect of rearing method

Rearing method had no significant effect on meat characteristics except on collagen content and solubility. In treatment EXT collagen content was lower and collagen heat solubility was greater than in treatment INT (7 % and 14 % difference respectively, $P<0.05$). However the effect of rearing method varied among sire breeds (significant interaction between the two factors, $P<0.001$). While a greater solubility was indeed observed in EXT pigs from treatments C, DU and LW (25 to 35 % difference), the pigs from treatment PI showed the opposite trend: the collagen solubility of INT animals was 25 % greater than that of EXT animals within this sire breed (Table 2).

Though not significant, there was a tendency of INT pigs to have a greater iron pigment content than that of the EXT pigs. Biedermann and Bader (1972) and Warriss et al. (1983) also reported a paler meat in outdoors-reared pigs compared to confined pigs. These findings however contradict those of Goutefongea et al. (1983) who found higher dry matter and iron pigment contents in meat of outdoors-reared pigs compared to indoors-reared pigs, or those of Shuler et al. (1970) and Galloway et al. (1973) who found no effect of degree of confinement on meat colour.

Effect of sire breed

Sire breed affected significantly all the parameters studied except pigmentation. Pigs from treatments DU and PI showed higher meat DM content than pigs from C and LW treatments. Other workers also found that meat from heavy-muscled breeds such as hypertrophied Belgian Landrace and Piétrain had a higher dry matter content than that of Large White and French Landrace animals (Touraille et Monin, 1984; Barton-Gate, 1988; Bout et Girard, 1988).

The intramuscular lipid content varied to an even greater extent among breeds, being greater in pigs from treatment DU than in pigs from treatment PI and LW. Duroc and Hampshire purebred pigs are known for their high intramuscular lipid content (Monin et al., 1986; Wood et al., 1987; Barton-Gade, 1987 et 1988). In the present experiment the lipid content in meat of control pigs was lower than those of pigs from treatments DU, PI and LW. This result confirms the conclusion of Touraille et al. (1989) that the introduction of Genes from Chinese breeds leads to an increased intramuscular fat deposition that might have enhanced this breed effect.

Meat from treatment PI had a significantly higher protein content than those of the other sire breed treatments ($P<0.01$). It also had a lower collagen content, treatments DU and LW being highest and treatment C intermediate. This classification of breeds confirms the results of Boccard (1968), Touraille et Monin (1984), Monin et al. (1986) and Baland and Monin (1987) indicating a lower meat collagen content in heavy-muscled breeds (Piétrain, Belgian Landrace) compared to other breeds such as Large White and Hampshire.

Mean collagen heat solubility was lowest in treatment PI but differences between sire breeds did not reach significance ($P>0.10$). Because of the interaction between sire breed and rearing method (Table 2), collagen solubility in PI pigs was actually lowest in EXT treatments only (see above). This finding however corroborates previous observations that meat from Piétrain breed is generally given a lower tenderness score than Large White and French Landrace breeds when submitted to sensory evaluation (Dumont, 1974; Touraille et Monin, 1984). Such a discrepancy between a lower collagen content and a lower tenderness score in Piétrain pigs could then be attributed to differences in the nature of collagen deposited combined with the higher stress-sensitivity of breeds selected for heavy muscularity (Touraille et Monin, 1982).

Pigs from treatment LW tended to have a darker meat than those from other breed treatments. Though the difference between mean values was noticeable (+13 to +22 %) it did not reach significance.

It may then be concluded from this experiment that both factors affected the qualitative characteristics of meat. There was a significant response in terms of quantity and quality of intramuscular collagen deposited to the rearing method that might be explained by the combined effects of intensity of physical activity and feeding strategy. A sensory eva-

luation by taste panel under course will provide further information on the final implication of such structural modifications on meat acceptability by consumer.

The differences recorded between sire breed treatments confirmed the importance of genetics as a mean of manipulating the quality traits of meat from crossbred pigs. The introduction of Genes from Chinese breeds improved the intramuscular fat content and thus could favourably affect the quality of pork as it was previously reported by Touraille et al. (1989). The present work also suggests that the response of Pietrain pigs to variations in rearing conditions should be further investigated in comparison with those of the other continental porcine breeds.

## REFERENCES


Baland, A. and Monin, G. (1987):
Relation between muscular development and muscle collagen in pigs. Meat Sci. 21: 295-299.

Barton-Gade, P.A. (1987):
Meat and fat quality in boars, castrates and gilts. Livest. Prod. Sci. 16: 187-196.

Barton-Gade, P.A. (1988):
The effect of breed on meat quality characteristics in pigs. Proc. 34th International Congress on Meat Science and Technology, 29/8-2/9 1988, Brisbane. Part B, pp. 568-570.

Biedermann, G. and Bader, J. (1972):
Realtionships between carcass quality traits and their dependance on different environmental factors in German Landrace pigs. 1-Influence of different environmental factors on carcass quality with special reference to meat colour (Göfo). Züchtungskunde 44: 98.

Boccard, R. (1968):
Variation de la teneur en hydroxyproline de muscles de porcs Large White et Piétrain. Ann. Zootech. 17: 71-75.

Bout, J., Girard, J.P. (1988)
Lipides et qualités des tissus adipeux et musculaires de porc. Facteurs de variation. 2° partie: Lipides et qualités du tissu musculaire. Facteurs de variation. Journées Rech. Porcine en France, 20: 271-278.

Dumont, B.L. (1974):
Propriétés sensorielles et qualités technologiques de la viande de trois races (Landrace Belge, Landrace Français et Piétrain). Journées Rech. Porcine en France, 6: 233-238.

Galloway, D.E., Dalrymple, R.H., Cassens, R.G. and Briskey, E.J. (1973):
Effect of heat stress on pigs reared under various degrees of confinement. J. Anim. Sci. 36: 29-31.

Girard, J.P., Bout, J. and Salort, D. (1988):
Lipides et qualités des tissus adipeux et musculaires de porc. Facteurs de variation. 1° partie: Lipides et qualités du tissu adipeux. Facteurs de variation. Journées Rech. Porcine en France, 20: 255-270.

Goutefongea, R., Girard, J.P., Labadie, J.L., Renerre, M. and Touraille, C. (1983):
Utilisation d'aliments grossiers pour la production de porcs lourds. Interactions entre type génétique, sexe et mode de conduite. 2-Qualité de la viande et aptitude à la transformation. Journées Rech. Porcine en France, 15: 193-200.

Monin, G. (1983):
Influence des conditions de production et d'abattage sur les qualités technologiques et organoleptiques de la viande de porc. Journées Rech. Porcine en France, 15: 151-176.

Monin, G. and Ouali, A. (1989):
Muscle differentiation and meat quality. *in* Development in Meat Science Vol.5, R. Lawrie ed., Elsevier Applied Science publ. [submitted to publication].

Monin, G., Talmant, A., Laborde, D. and Zabari, M. (1986):
Compositional and enzymatic characteristics of the *Longissimus Dorsi* muscle from Large White, halothane-positive and halothane-negative Pietrain and Hampshire pigs. Meat Sci. 16: 307-316.

Shuler, R.O., Pate, T.D., Mandigo, R.W. and Lucas, L.E. (1970):
Influence of confinement, floor structure and slaughter weight on pork carcass characteristics. J. Anim. Sci. 31: 31-35.

Touraille, C. and Monin, G. (1982):
Qualités organoleptiques de la viande de porc en relation avec la sensibilité à l'halothane. Journées Rech. Porcine en France, 14: 33-36.

Touraille, C. and Monin, G. (1984):
Comparaison des qualités organoleptiques de la viande de porcs de trois races: Large White, Landrace Français et Landrace Belge. Journées Rech. Porcine en France, 16: 75-80.

Touraille, C., Monin, G. and Legault, C. (1989):
Eating quality of meat from european x chinese crossbred pigs.Meat Sci. [in press].

Warriss, P.D., Kestin, S.C. and Robinson, J.M. (1983):
A note on the influence of rearing environment on meat quality in pigs. Meat Sci. 9: 271-279.

Wood, J.D., Kempster, A.J., David, P.J. and Bovey, M. (1987):
Observations on carcass and meat quality in Duroc, Landrace and Duroc x Landrace pigs. Anim. Prod. 44: 488 (Abstract).

Table 1. Qualitative characteristics of pork (*M. longissimus dorsi*) as affected by sire breed and rearing method (mean values[1]).

| | Sire breed[2] | | | | Rearing method[2] | |
|---|---|---|---|---|---|---|
| | C | DU | PI | LW | INT | EXT |
| Carcass weight (kg) | 75 (3) | 76 (3) | 73 (4) | 74 (4) | 74 (3) | 75 (4) |
| Age at slaughter (days) | 186$^{a}$ (13) | 198$^{b}$ (11) | 198$^{b}$ (7) | 184$^{a}$ (13) | 193 (13) | 190 (12) |
| DM (g/kg fresh) | 260$^{a}$ (10) | 274$^{b}$ (12) | 269$^{bc}$ (5) | 264$^{ac}$ (7) | 267 (10) | 267 (9) |
| Lipids (mg/g fresh) | 21.0$^{a}$ (10.8) | 37.1$^{c}$ (10.5) | 24.9$^{ab}$ (6.3) | 30.9$^{b}$ (10.6) | 30.1 (11.2) | 27.9 (9.7) |
| CP (mg/g fresh) | 235$^{a}$ (7) | 235$^{a}$ (11) | 242$^{b}$ (7) | 233$^{a}$ (8) | 236 (8) | 237 (9) |
| Collagen (mg/g fresh) | 3.88$^{a}$ (0.6) | 4.36$^{b}$ (0.6) | 3.40$^{c}$ (0.3) | 4.20$^{ab}$ (0.6) | 4.12$^{a}$ (0.6) | 3.83$^{b}$ (0.6) |
| Collagen (% of CP) | 1.65$^{a}$ (0.27) | 1.86$^{b}$ (0.27) | 1.40$^{c}$ (0.12) | 1.81$^{ab}$ (0.28) | 1.75$^{a}$ (0.28) | 1.62$^{b}$ (0.27) |
| Collagen heat solubility (%) | 27.3 (5.5) | 28.9 (6.2) | 25.6 (6.0) | 28.2 (7.2) | 25.6$^{a}$ (5.5) | 29.5$^{b}$ (6.2) |
| Myoglobine (µg/g fresh) | 765 (309) | 760 (121) | 729 (218) | 874 (454) | 815 (337) | 756 (210) |

(1) Within-treatment mean values on the same line and followed by different superscripts differ significantly ($P<0.05$). Corresponding standard deviation is mentionned in parentheses.
(2) Legend: C control (Large White x French Landrace), DU Duroc, PI Piétrain, LW Large White, INT indoors and intensive rearing, EXT outdoors and semi-intensive rearing.

Table 2. Interaction between sire breed and rearing method on collagen heat solubility of *M. longissimus dorsi* in pigs (mean values[1], %).

| Rearing method[2] | Sire breed[2] C | DU | PI | LW |
|---|---|---|---|---|
| INT | 24.0 (3.1) | 25.3 (5.9) | 29.1 (5.1) | 23.9 (6.0) |
| EXT | 30.2 (3.3) | 33.0 (3.3) | 22.1 (4.8) | 32.5 (5.6) |

(1) Corresponding standard deviation is mentionned in parentheses.
(2) Legend: see Table 1.