INFLUENCE OF PIG HOUSING CONDITIONS ON MUSCULAR AND ADIPOSE TISSUE TRAITS, AND TECHNNOLOGICAL AND SENSORY QUALITY OF DRY-CURED HAMS

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BACKGROUND

Increased public interest in production methods of meat animals has led to a development of rearing methods that are alternative to the classical intensive system, for example outdoor rearing. The main factor limiting outdoor pig rearing is thermal environment. Indeed, ambiant temperature has been shown to greatly influence carcass, muscle and adipose tissue traits (Le Dividich et al., 1987; Lefaucheur et al., 1991). Others factors such as nycthemeral and day to day variations in temperature, feeding level or physical activity that are modified by outdoor system, might also influence tissue traits and meat quality.

OBJECTIVES

The objective of this study was to investigate the influence of outdoor *vs* indoor pig rearing, and the effect of indoor ambient temperature (17°C *vs* 24°C) on muscular and adipose tissue traits, and technological and sensory quality of dry-cured hams.

METHODS

Animals. The experiment included three groups of 48 P76 x (Large White x Landrace) pigs (24 females and 24 castrated males). During the growing-finishing period, two groups of pigs were reared indoor at an ambient temperature of 24°C (24) or 17°C (17), the former being considered as control, whereas another group was reared outdoor (O) with free access to a shed. All animals were fed *ad libitum* until slaughter at a live weight of approximately 105 kg. The present experiment was conducted in the southern part of France, from October 1995 to January 1996.
Muscular and adipose tissue traits. Ultimate pH of Semimembranosus (SM) muscle was measured, and lipid content of SM and backfat were determined according to Folch et al. (1957). Fatty acid composition of backfat lipids was determined by gaz chromatography. Firmness of ham fat was assessed using a fat firmness penetrometer (FFP). Myofiber typing of Longissimus dorsi (LD) muscle was performed on 10 pigs per group. Fibers were classified as βR (slow red), αR (fast red) or αW (fast white) according to Ashmore and Doerr (1971). Percentages of fiber types were determined using a projection microscope, and area and relative area of fiber types were measured using a computerized image analysis system (Lefaucheur et al., 1992).
Technological and sensory quality of dry-cured hams. Thirty hams (10 per group) were processed into dry-cured hams (11 months drying). Processing yield was measured by the variation of ham weight during processing. Sensory evaluation of dry-cured hams was performed by a trained panel to characterize aspect, texture and flavor.
Statistical analyses. Data were examined by analysis of variance using the SAS GLM procedure (SAS, 1989), to evaluate the main effect of rearing group.

RESULTS AND DISCUSSION

Environmental conditions of outdoor-reared pigs. During the experimental period, average outdoor temperature reached approximately the level of low indoor temperature (17°C), but with large day to day variations (about 6°C between minimal and maximal daily means).
Growth performances and carcass traits. Daily gain was higher for group 17 than for the two others groups, which had similar daily gain (912, 863 and 835 g/day for group 17, 24 and O, respectively, $p<.05$). Muscle percentage was similar (around 58%) between the three groups.
Muscle traits. Pig housing conditions influenced some histological traits of LD (Table 1). Compared to group 24, pigs from group O exhibited a higher percentage of αR fibers ($p<.001$) and a slightly lower percentage of αW fibers ($p<.10$), thus leading to a higher oxidative capacity. Fiber type percentages of group 17 were intermediate (ns) between the two other ones. Fiber type areas (not shown) and mean area were not affected by housing conditions. Despite the variations observed on fiber percentages, relative areas of fibers were similar in the three groups. This may be explained by the higher area of αW fibers compared to αR or βR, whatever the group of pigs. The lack of influence of ambient temperature on LD myofiber typing is in accordance with Lefaucheur et al. (1991) who did not report any effect of the ambient temperature (12°C *vs* 28°C) on LD histological traits. The higher percentage of oxidative fibers observed for outdoor-reared pigs may be explained by a higher physical activity of pigs, which has been reported to increase the ratio of αR to αW fibers (Petersen, 1997). Intramuscular fat (IMF) content was not affected by ambient temperature or rearing method, in accordance with Lefaucheur et al. (1991) and Berge et al. (1989), respectively, while Enfält et al. (1997) reported a tendancy to a lower IMF for outdoor-reared pigs.
Adipose tissue traits. Housing conditions did not influence lipid content of backfat, but greatly modified its characteristics. Compared to group 24, group 17 exhibited quite similar saturated fatty acid (SFA) content, lower polyunsaturated (PUFA) and higher monounsaturated (MUFA) contents, in agreement with Le Dividich et al. (1987) and Lefaucheur et al. (1991). Group O showed lower SFA and higher MUFA, but similar level of PUFA content than group 24. Group 17 presented the higher backfat firmness and group O the lower, as expected from the well known influence of fatty acid composition on this trait (Enser, 1983; Wood, 1984).
Technological and sensory quality of dry-cured hams. Ultimate pH was not affected by pig housing conditions, contrarily to Enfält et al. (1997) who reported a lower pHu in outdoor-reared pigs. However, the differences observed between the swedish study and the present one may be attributed to differences in the environmental conditions. Weight losses during processing were lower for group 17 than for the two other ones. This can be explained by the slightly higher backfat depth reported in group 17 (not shown), which would limit water evaporation during processing (Buscailhon and Monin, 1994). Sensory analyses showed that aspect of dry-cured ham was modified by pig housing conditions.

Homogeneity and intensity of lean meat color were lower in group 17 and also, to a lower extent, in group O, than in group 24. Flavour (of lean and fat) and tenderness were similar in the three groups.

CONCLUSION

Pig housing conditions influenced muscular and adipose tissue traits, and quality of dry-cured hams. Low ambient temperature decreased polyunsaturated fatty acid level in backfat and tended to increase fat firmness, thus leading to a better technological quality of this tissue. Outdoor rearing increased the percentage of rapid red fibers, and tended to decrease fat firmness. Processing yields of dry-cured hams were higher at lower ambient temperature, whereas outdoor rearing had no influence on technological quality of ham. The low ambient temperature, as it can occur in outdoor rearing, influenced dry-cured ham apperance, but seemed to have no effect on the evaluation of flavour or tenderness by the test panel.

LITERATURE

Ashmore C.R., Doerr L., 1971. Comparative ascpects of muscle fiber types in different species. Exp. Neurol., 31, 408-418.

Berge P., Boccard R., Gandemer G., Legault C., 1989. Effect of sire breed and rearing method on qualitative characteristics of pork. In: Proc. 35th Int. Cong. Meat Sci. Technol., Copenhagen, Denmark. 3, 987-992.

Buscailhon S., Monin G., 1994. Déterminisme des qualités sensorielles du jambon sec. VPC, 15, 23-48.

Enser M., 1983. Fat quality in lean pig. Workshop in the CEC, Büssels, 53-57.

Enfält A.C., Lundström K., Hansson I., Lundeheim N., Nyström P.E., 1997. Effects of outdoor rearing and sire breed (Duroc or Yorkshire) on carcass composition and sensory and technological meat quality. Meat Sci., 45, 1-15.

Folch J., Lee M., Sloane Stanley G.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem., 226, 497-509.

Le Dividich J., Noblet J., Bikawa T., 1987. Effect of environmental temperature and dietary energy concentration on the performance and carcass characteristics of growing-finishing pigs fed to equal rate of gain. Livest Prod. Sci., 17, 235-246.

Lefaucheur L., Le Dividich J., Mourot J., Monin G., Ecolan P., Krauss D., 1991.Influence of environmental temperature on growth, muscle and adipose tissue metabolism, and meat quality in swine. J. Anim. Sci., 69, 2844-2854.

Lefaucheur L., Buche P., Ecolan P., and Lemoing M., 1992. Classification of pig myofibers and assessment of post-mortem glycogen depletion according to fiber type by computerized image analysis. Meat Sci., 32, 267-278.

Petersen J.S., 1997. Muscle structure and meat quality in physically active pigs. Pig News Inf., 18, 79N-82N.

SAS (1989) Sas User's Guide, Statistics SAS Institute Inc, Cary, NC.

Wood J.D., 1984. Fats deposition and the quality of fat tissue in meat animals. In : Fats in animal nutrition, J. Wiseman (Ed), Butterworths, London. 407-435.

Table1. Influence of pig housing conditions on muscle and adipose tissue traits, and technological and sensory quality of dry-cured hams.

	Indoor, 17°C	Indoor, 24°C	Outdoor	RSD	Sign.[a]
Muscle traits					
Myofiber typing (LD)					
Proportion (%) βR	9.8	10.9	10.1	3.31	ns
αR	17.5 ab	14.9 a	19.6 b	3.08	**
αw	72.7	74.2	70.3	3.77	†
Fiber mean area (μm^2)	3235	3440	3607	982	ns
Relative area (%) βR	7.4	8.1	6.8	2.41	ns
αR	12.5	11.3	14.2	3.93	ns
αw	80.1	80.6	79.0	4.91	ns
Intramuscular fat (SM) (%)	1.53	1.46	1.55	0.52	ns
Adipose tissue traits					
Lipid content (%)	67.9	67.4	68.5	5.73	ns
% SFA	36.0 ab	36.8 a	35.2 b	2.21	**
% PUFA	14.1 a	16.4 b	16.0 b	1.95	***
Firmness (FFP)	649 a	616 ab	578 b	123.5	*
Ham quality					
Technological properties					
Ultimate pH	5.62	5.65	5.60	0.20	ns
Weight losses (%)	31.3 a	34.1 b	33.4 b	2.46	*
Sensory properties					
Aspect					
Meat color homogeneity	4.9 a	5.8 b	5.1 ab	1.96	*
Meat color intensity	4.6 a	5.6 b	4.8 a	1.71	**
Flavour	5.4	5.5	5.7	1.85	ns
Tenderness	5.4	4.9	5.4	2.05	ns

[a] *** : p<.001; ** : p<.01; * : p<.05; † : p<.10; ns : p>.10.

Means within row affected different letters differ significantly (p<.05).