INFLUENCE OF REARING CONDITIONS (INDOOR vs. OUTDOOR WITH PASTURE) ON CARCASS, BACK FAT AND MUSCLE TRAITS OF CULL SOWS

B. Lebret[1], A.S. Guillard[2], F. Berger[3]
[1]INRA, Unité Mixte de Recherches sur le Veau et le Porc, 35590 Saint-Gilles, France; [2]CTSCCV, 7, Avenue du Général de Gaulle, 94700 Maisons Alfort, France; [3]Chambre d'Agriculture de la Mayenne, 19, rue de l'Ancien Evêché, BP 1229 53012 Laval Cédex, France

Background

Outdoor rearing of sows is an alternative method of production that influences the image of pig production for consumers, especially from welfare and environmental points of view. In such systems, sows exhibit a pasture behaviour, in particular during the gestation when they are submitted to feed restrictions. Indeed, it has been shown that grass consumption highly increases the n-3 fatty acid content in muscles of free range reared pigs, without decreasing the oxidative stability of the meat because of the high content in antioxidative agents in the grass (Nilzen *et al* 2001). Apart from this, many factors are modified by outdoor rearing compared to indoor, such as the level of physical activity and the climatic variations, that may influence carcass and muscle traits and, consequently, pork meat quality (Enfält *et al* 1997; Lebret *et al* 1998). Nevertheless, the influence of outdoor rearing on carcass and meat traits of cull sows remains very little documented.

Objectives

The aim of this study was to provide some information on the influence of rearing conditions : outdoor with pasture *vs.* indoor, on carcass and meat quality of cull sows. Carcass traits and composition of back fat and muscles are presented in this paper. Influence of rearing conditions on meat quality and sensorial traits of cured bacon are presented in this conference in an other paper (Guillard *et al*).

Methods

Animals. The experiment involved a total of 12 Large White X Landrace sows from the same breeding unit, 6 reared indoors (I) on totally slatted floor and 6 reared outdoors (O) with pasture (650 m²/sow during gestation and 500 m²/sow during lactation). The two groups had similar level of parity (mean 5.3, 4 to 7 litters in each group). Eleven days after the last weaning, sows were transported to the slaughterhouse of INRA, weighed, kept all night in individual cases in the lairage, and slaughtered after low voltage electrical stunning and exsanguination.
Carcass traits. Carcass weight and linear measurements were measured on the day of slaughter, and weights of fresh carcass and wholesale cuts of the left side were recorded on 2 days after slaughter.
Muscle and back fat traits. Thirty minutes after slaughter, samples of *Longissimus* (L) (last rib level) and *Triceps brachii caput longum* (TB) were taken and frozen in liquid nitrogen for determinations of lactate dehydrogenase (LDH), β-hydroxyacyl coenzyme A dehydrogenase (HAD) and citrate synthase (CS) activities as described by Lefaucheur *et al* (1991), in order to characterize the glycolytic capacity, lipid β-oxidation and Krebs cycle activity, respectively. Two days after slaughter, transversal sections of L and TB were taken, trimmed of external fat and epimysium and freeze-dried before lipid (Folch *et al* 1957), collagen (=7.14 * hydroxyproline (Bergman & Loxley, 1963)) and collagen heat-solubility determinations (Hill, 1966). A sample of back fat (last rib level) was taken for lipid determination. Contents in vitamin E (Schüep & Steiner, 1988) and fatty acids (FA) (Morrisson & Smith, 1964) were determined from back fat and muscle lipids.
Statistical analysis. Data were submitted to an analysis of variance (GM procedure, SAS, 1989) to evaluate the effect of rearing conditions. When applicable, Tukey's test was used for mean comparisons.

Results and discussions

Carcass traits were influenced by rearing system (Table 1) : O sows exhibited heavier carcasses than I, whereas differences in carcass weights were lower, due to higher weights of internal organs such as perirenal fat in the formers. Back fat (+40%) and muscle (+15%) depths were increased, giving rise to slightly fatter carcasses in O than I sows. Outdoor rearing did not modify lipid content of back fat, but strongly influenced its composition (Table 2). Vitamin E appeared to be higher (+ 35%) and contents in SFA and PUFA were increased in O compared with I sows, in particular the n-3 fatty acids C18:3 (α-linolenic) and C22:6, leading to a high decrease in the n-6/n-3 ratio. In muscles, lipid and vitamin E contents were similar between groups (Table 3). C18:3 level was highly increased in the L muscle of O sows, thus reducing the n-6/n-3 ratio, whereas in TB, fatty acid composition was similar between the two groups. Results on back fat and L muscle are in agreement with observations of Nilzen *et al* (2001) in pigs, and are explained by the very high level of C18:3 in the grass (61% of the FA in this study, in accordance with Rey *et al* (1997)). The benefit effect of n-3 fatty acids on human health is now clearly established (a n-6/n-3 ratio less than 4 being recommended (Enser, 2000)). Thereby, present results indicate an improvement in nutritional quality of meat with outdoor rearing of sows. Concerning TB, the similar lipid composition between groups may be explained by the higher muscle potential for lipid β-oxidation (HAD) in O sows, suggesting a higher lipid turn-over and a lower level of exogenous FA in these muscles at slaughter. In both muscles, collagen content was lower in 0 than I sows (- 15 %), without influence on solubility, and may be related to the relatively higher muscle depth of the formers. Muscle metabolic traits were influenced by rearing system : in the L muscle, LDH activity was increased and LDH/CS ratio was decreased in O sows, indicating a higher muscle glycolitic capacity. In the TB of outdoor sows, CS and HAD activities were increased, and LDH/CS ratio was reduced, giving rise to a higher oxidative capacity. Thus, it seems that outdoor rearing influences muscle metabolism towards an increase in the predominating metabolic way, *i.e.* the glycolitic one in the white L, and the oxidative one in the red TB. Outdoors, the lower ambient temperature and higher physical activity of animals may influence muscle metabolism. Indeed, Lefaucheur *et al* (1991) reported higher activities of LDH in L muscle, and of CS and HAD in the red *Semispinalis capitis* of pigs reared at low (12°C) compared with high (28°C) temperatures. Moreover, physical activity has been shown to increase the oxidative capacity of muscles implied in movement, such as TB, but not in the *Longissimus* (Petersen, 1997). However, our results are not in agreement with previous work (Lebret *et al* 1998) showing an increase in the relative area of αR fibers, without effect on LDH and CS activities, in the L muscle of pigs offered a small outdoor area during their growing-finishing period.

Conclusions

This study shows that outdoor rearing of cull sows led to fatter and heavier carcasses, and strongly modified the lipid composition of back fat and *Longissimus* muscle towards higher levels of n-3 fatty acids, thus improving the nutritional quality of the meat, and thereby confirming previous results on pork meat. Vitamin E tended to be higher in the back fat of outdoor reared sows, suggesting a limited oxidation rate of this tissue despite its high PUFA level. Muscle metabolism was also influenced by rearing system. In the whole, the differences in tissue traits reported here between rearing systems of cull sows may influence the technological and eating quality traits of the meat.

Pertinent literature

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Table 1. Influence of rearing conditions on carcass traits

	Indoor	Outdoor	SEM	*P*
Live weight at slaughter (kg)	257.0	296.0	30.4	***0.050***
Hot carcass weight (kg)	190.6	215.3	24.7	*0.115*
Dressing (%)	74.0	72.7	1.8	*0.246*
Linear measurements				
Fat depth (last rib), mm	18.7	26.3	6.3	*0.061*
Fat depth (10-11 dors.v.), mm	27.0	36.8	6.8	***0.031***
Muscle depth (last rib), mm	113	130	15	*0.083*
Carcass composition (%)				
Ham	24.3	23.0	1.0	***0.047***
Loin	27.1	26.5	0.9	*0.255*
Shoulder	25.5	25.4	0.5	*0.773*
Belly	14.3	15.9	1.2	***0.043***
Back fat	8.1	8.6	1.5	*0.531*

Table 2. Influence of rearing conditions on back fat traits

	Indoor	Outdoor	SEM	*P*
Lipid content (%)	73.6	74.4	3.8	*0.787*
Vitamin E (µg/g)	34.1	46.3	12.6	*0.132*
Fatty acids (mg/g)				
C14:0	7.3	8.7	0.8	***0.015***
C16:0	137	152	12	***0.049***
C18:0	67	84	11	***0.025***
C18:1	322	298	19	*0.051*
C18:2	78	78	11	*0.996*
C18:3	7.9	13.1	1.7	***<0.001***
C20:1	13.9	9.5	2.3	***0.008***
C22:6	0.8	1.7	0.6	***0.039***
n-6/n-3 ratio	5.8	4.0	0.5	***<0.001***

Table 3. Influence of rearing conditions on *Longissimus* and *Triceps brachii* muscle traits

	Longissimus				*Triceps brachii*			
	Indoor	Outdoor	SEM	*P*	Indoor	Outdoor	SEM	*P*
Chemical composition								
Lipid, %	1.69	1.60	0.46	*0.744*	2.15	2.32	0.48	*0.558*
Vitamin E, µg/g	1.98	1.35	0.86	*0.235*	1.81	2.25	0.83	*0.377*
Fatty acids, mg/g								
C14:0	0.13	0.14	0.06	*0.766*	0.15	0.21	0.07	*0.201*
C16:0	2.46	2.44	0.92	*0.974*	2.75	3.53	0.83	*0.134*
C18:0	1.16	1.21	0.43	*0.838*	1.30	1.72	0.38	*0.083*
C18:1	5.03	4.84	2.18	*0.886*	5.98	6.42	2.41	*0.755*
C18:2	1.30	1.36	0.21	*0.626*	1.97	2.33	0.30	*0.057*
C18:3	0.05	0.13	0.03	***0.002***	0.11	0.17	0.07	*0.140*
C20:1	0.12	0.10	0.03	***0.002***	0.14	0.13	0.04	*0.643*
C22:6	0.01	0.02	0.01	*0.613*	0.03	0.05	0.04	*0.436*
n-6/n-3 ratio	10.1	5.64	3.77	*0.068*	3.83	3.83	0.51	*0.999*
Collagen, %	0.42	0.37	0.05	*0.080*	0.54	0.46	0.05	***0.013***
Solubility (% of total coll.)	4.2	5.3	1.7	*0.265*	6.0	5.1	1.8	*0.433*
Metabolic traits								
LDH	2 126	2 485	124	***<0.001***	1080	848	294	*0.202*
HAD	3.1	2.8	0.4	*0.152*	8.5	12.2	2.3	***0.020***
CS	5.3	4.7	0.7	*0.200*	12.9	17.5	2.9	***0.020***
LDH / CS	410	542	82	***0.020***	93	52	37	*0.086*