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THE EFFECTS OF FATTENING PIGS IN INDOOR OR OUTDOOR PENS ON LIVE PERFORMANCE, CARCASS COMPOSITION AND MEAT QUALITY

S.D.M. JONES, A.L. SCHAEFER, R. DYCK and J. COLYN

Agriculture Canada, Research Station, Lacombe, Alberta, Canada

INTRODUCTION

There has been increasing interest in North America and Europe in swine production systems that use outdoor, or `natural', conditions rather than intensive feeding in enclosed barns. For example, Van Der Wal (1993) reported that a little less than 1% of Dutch swine production came from free range, or `scharrel', pigs. In Canada, no attempt has been made to market free range pigs since the costs of production would likely be higher leading to lower financial returns unless a marketing plan was developed to market this product as a premium item.

Relatively little work has been completed on the effects of the rearing environment and its possible implications on carcass composition and meat quality. Warriss *et al.* (1983) reported in a small study that rearing environment (indoor vs outdoor) of pigs had no effect on indicators of stress (blood cortisol levels and adrenal gland ascorbic acid levels) but made some general comments based on observations that outdoor reared pigs had different behaviour compared to indoor reared pigs. These observations collectively indicated that indoor reared pigs were more easily startled and much more difficult to load into trucks than outdoor reared pigs. Barton-Gade and Blaabjerg (1989) found that free range pigs also had a different behaviour to commercially reared pigs and considered them to be calmer and more easily handled in the abattoir although no actual behaviourial measurements were recorded. Grandin (1989) considered that environmental enrichment (access to toys, outdoor rearing, etc.) reduced excitability in hogs which, in turn, allowed easier handling and less stress prior to slaughter. While there appears to be several reports indicating that rearing environment (indoor vs outdoor) can influence swine behaviour, there is little information to support if this rearing will reduce the stress of marketing and slaughter and so reduce the occurrence of pale, soft and exudative (PSE) meat.

Rearing pigs outdoors has been reported to result in less backfat and darker meat colour (Warriss *et al.*, 1983). However, Barton-Gade and Blaabjerg (1989) found that free range pigs had lower pH^{24} measurements and a tendency to produce higher levels of PSE meat than indoor reared pigs. Van Der Wal (1991) found no significant differences in carcass composition and meat quality in free range compared to commercially reared pigs. Thus, conclusions over the effects of rearing environment on carcass composition are somewhat different depending largely on the nature of the study. In Canada, there is also the extremes of weather in summer and winter that may also impact on swine behaviour and muscle quality.

The hypothesis to be tested in the present study is that outdoor fattening results in a lower incidence of PSE meat and a leaner carcass than indoor fattening of pigs.

MATERIALS AND METHODS

Two experiments were conducted to evaluate the effects of feeding pigs in indoor pens or outdoor lots using Lacombe pigs of the H++ genotype. Experiment 1 was completed during the winter period (November to February) while experiment 2 was conducted during the summer months (June to September). Groups of pigs were allocated to test as close to 50kg live weight as possible on a random basis to three indoor pens each containing 12 pigs and three outdoor lots also containing 12 pigs (total number=72 pigs) balanced by sex. The indoor pens were 7.3x2.4m with a concrete floor and the pigs were bedded in wood shavings. The outdoor pens were 10.4x25.9m with a dirt floor and cabin

(6x3.0m) that had straw as bedding to provide for protection against extremes in temperature. The same procedure was repeated in both experiments except that in experiment 2, the total number of pigs fed in indoor pens was 35 and those in outdoor lots was 32 pigs. All pigs were fed a fattening diet designed to meet or exceed the requirements laid out by the National Research Council. The diet had an average protein content of 15.5% and an energy content of 2880 Cal.

All pigs were weighed every 28 days and feed consumption recorded weekly. Pigs were slaughtered as close to 100kg as possible and shipped to the research abattoir on the morning of slaughter a distance of approximately 200m. Pigs were held in lairage for a maximum of four hours, stunned by electricity (head to back stunner at 400V, 1.7A) for three to four seconds, stuck, scalded and dressed following commercial procedures. The carcasses were shackled by alternate legs to reduce the possibility of side to side variations in meat quality. Warm split sides were weighed approximately 40 to 45 minutes post-slaughter and pH was recorded in the centre of the longissimus thoracis (LT) between the 10^{th} and 11^{th} ribs and to a depth of 3cm on the medial surface of the *semimembranosus* (SM). The left carcass sides were probed for fatness and muscle depth at the $3/4^{th}$ last rib using a Hennessy Grading Probe. Kidney fat and liver weight was recorded on the slaughter floor. All carcasses were chilled at 1 °C with an air velocity of 1m s^{-1} for an average time of 24 hours and reweighed to determine shrinkage losses. A pH 24 hours measurement was also recorded.

The left carcass sides were fabricated into the major primal cuts (shoulder, loin, ham and belly) and the four lean cuts (butt, picnic, loin and ham) were completely defatted and deboned. The weight of lean tissue in the four lean cuts was expressed as a proportion of the combined primal weights. The LT from the 3^{rd} to the 13^{th} ribs and the SM were removed and used for the evaluation of muscle quality. The LT only was assessed for colour (5-point scale with 1=extremely pale and 5=extremely dark) and structure (5-point scale with 1=extremely soft with dough like appearance and 5=extremely firm). A 25mm steak was obtained from both muscle for the determination of objective muscle colour and shear force. Protein solubility was determined as described by Murray *et al.* (1989).

The data was analyzed using a least squares analysis of variance with treatment and pen as main effects for the live performance variables. For the carcass data, the sex of the animal was also included in the model. Means were separated at a probability of $P<0.05$ using linear contrasts.

RESULTS AND DISCUSSION

The live performance of the pigs fattened indoor or outdoor pens in the winter or summer months is shown in Table 1. Pigs in indoor pens grew faster in both seasons than those in outdoor lots. On average, pigs in indoor pens grew 15% faster than pigs fed in outdoor pens. Feed intake was higher for indoor fed pigs in both seasons than outdoor fed pigs but the average feed conversion was similar for both environments. The net implications of feeding pigs in outdoor pens from 50-100kg was a 10 day longer feeding period to reach slaughter weight than their counterparts fed indoors. When the data was reanalyzed on an individual basis for average daily gain a significant treatment x sex interaction was found. Combined over the two seasons, barrows grew faster than gilts in indoor pens (0.91 vs 0.75kg d^{-1}), but there was no difference in growth performance between the two genders for pigs fed in outside pens.

Plant weight of pigs was similar for both treatments (Table 2) but pigs fed indoors in the Winter season had a higher dressing proportion than those fed outdoors. The same effect was not observed in the Summer season. Warriss *et al.* (1983) found that rearing environment had no significant effect on dressing proportion. A similar result was found for liver proportion which was higher for outdoor fed pigs in the Winter season compared to indoor fed pigs but this difference was not observed in the Summer season. Although trends for less kidney fat, less fat at the $3/4^{th}$ last rib and greater muscle thickness as measured by the Hennessy Grading Probe were observed there were no significant differences found (Table 2). Warriss *et al.* (1983) found that backfat thickness was reduced in a stress resistant genotype that was outdoor fattened, but the same effect was not apparent in a stress susceptible genotype. Also Van Der Wal (1991) reported that free range pigs had similar fat and muscle thickness to indoor reared pigs when compared at the same carcass weight, but that estimated carcass lean percentage tended to be higher for free range compared to indoor fattened pigs. In a subsequent study (Van Der Wal 1993), the indoor fattened pigs tended to be leaner than the outdoor fed pigs. However, despite not finding any differences in linear measures that reflect carcass composition in the present study, the carcass dissection results showed that outdoor reared pigs had a higher proportion of lean and a lower proportion of fat in the lean cuts for pigs slaughtered during the Winter season only. These results collectively suggest

that pigs reared outdoors tend to produce leaner carcasses than indoor reared pigs but the effect is not large and probably of limited commercial value. The lower growth rate of outdoor fattened pigs is likely to be the main factor influencing carcass composition.

The were few significant effects of fattening environment on the standard measurement of muscle quality. For the pigs slaughtered during the Winter season, pH values at 45 minutes and 24 hours, muscle colour, shear value, intramuscular fat and soluble protein for the LT muscle were not different (data not shown). Similar results were found for the SM muscle except that soluble protein was lower (148 vs 170mg g^{-1}) for outdoor compared to indoor fattened pigs. The meat quality results for the Summer season for both the LT and SM muscles is shown in Table 3. Again, apart from a lower intramuscular LT fat content for the outdoor pigs, the meat quality results were similar for both fattening environments. With regard to PSE status, the genotype used in this study precluded a high incidence of pale, soft and exudative meat. Fattening environment had no significant effect on the incidence of PSE meat and outdoor reared pigs tended to have poorer scores for meat quality (higher incidence of PSE meat). Warriss *et al.* (1983) observed slightly darker meat colour as a consequence of outdoor fattening, but Van Der Wal (1991) could find no differences in meat quality that could be attributed to feeding pigs indoors or outdoors. In a subsequent study (Van Der Wal 1993) which included sensory evaluation of free range and indoor fattened pigs, no differences were found in any of the parameters studied. A preliminary study reported by Barton-Gade and Blaabjerg (1989) suggested that free range pigs had a different behaviour pattern to indoor reared pigs and settled down quickly in the lairage pens after delivery to the abattoir. This resulted in high muscle energy reserves and a higher incidence of PSE meat in outdoor compared to indoor fattened pigs. To support these observations, the same authors reported that outdoor fattened pigs showed very little DFD meat when compared to indoor fattened pigs. The original hypothesis developed for the present study suggesting that outdoor rearing would produce a pig more resistant to the stressors encountered during marketing and so produce less PSE meat was not supported by the results of the present experiments. Behaviour data was collected in the present study but has not yet been subject to statistical analysis, but casual observation of behaviour indicated that outdoor pigs had a calmer disposition and were more easily moved to the restrainer for stunning. Further work might be appropriate to examine a different pre-slaughter management regime for outdoor compared to indoor fattened pigs.

CONCLUSION

The present study has shown that outdoor reared pigs had a lower average daily gain than indoor reared pigs which amounted to a difference of about 15%. While feed conversion was similar on both systems, outdoor fattened pigs would take about 10 days longer to reach market weight than indoor fattened pigs. Grading data indicated that rearing environment only had a small effect on carcass lean percentage which tended to be higher for outdoor compared to indoor reared pigs. On a carcass dissection basis, indoor fattened pigs were fatter than outdoor reared pigs during the Winter season. In the same way, meat quality was not influenced by fattening environment, but there was a trend towards higher PSE scores for outdoor compared to indoor fattened pigs.

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Table 1. Growth performance of indoor and outdoor fattened pigs.

	Season					
	Winter			Summer		
	Indoor	Outdoor	P	Indoor	Outdoor	P
start weight, kg	49.4	48.0	0.387	50.8	49.4	0.457
final weight, kg	98.5	98.9	0.849	98.6	101.2	0.163
ADG, kg d^{-1}	0.82	0.71	0.005	0.83	0.72	0.025
Feed intake, kg d^{-1}	2.95	2.33	0.019	2.69	2.35	0.029
Feed conversion, kg d^{-1}	3.59	3.28	0.170	3.24	3.25	0.915

Table 2. Carcass characteristics and composition of indoor and outdoor fattened pigs.

	Season					
	Winter			Summer		
	Indoor	Outdoor	P	Indoor	Outdoor	P
Warm carcass wt, g kg^{-1}	835	821	0.001	825	821	0.261
Kidney fat, g kg^{-1}	16.4	14.9	0.154	15.4	14.4	0.285
Liver, g kg^{-1}	17.1	18.2	0.008	17.9	18.4	0.288
Probe fat, mm	24.3	22.1	0.131	22.6	21.3	0.204
Probe lean, mm	48.7	49.9	0.179	49.8	52.8	0.086
Lean, %	55.9	59.7	0.006	58.6	59.7	0.298
Fat, %	35.2	30.9	0.003	32.7	30.9	0.103

Carcass weight, kidney fat and liver weight expressed as proportion of final live weight.

Table 3. Meat quality for the *longissimus thoracis* and *semimembranosus* fattened indoors or outdoors in the summer season.

	Longissimus thoracis			Semimembranosus		
	Indoor	Outdoor	P	Indoor	Outdoor	P
pH45	5.57	5.57	0.968	5.79	5.78	0.889
pH24	5.51	5.49	0.490	5.58	5.57	0.720
Shear, kg	7.49	8.02	0.116	9.07	8.91	0.669
Fat, %	1.99	1.62	0.001	1.05	0.98	0.242
Sol.protein, mg g^{-1}	122	125	0.620	155	154	0.832
Colour score	1.93	1.79	0.399			
Structure score	1.94	1.77	0.174			
Minolta L*	62.5	62.7	0.748	55.9	55.5	0.713