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Effect of stocking density on average daily gain and welfare of grow finish pigs

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Introduction

Efficient utilization of pen space is important for pork production. Increasing stocking density may improve pen space utilization and profitability, however, there should be a balance between animal well-being and financially efficient pen space utilization (Gonyou and Stricklin, 1998). Often performance indicators such as average daily gain (ADG), average daily feed intake or feed to gain ratio are used to assess the welfare of grow-finish pigs. While it is true that compromised welfare may be reflected in production performance, the converse may not be correct. Despite no adverse effect on performance, a higher stocking density may have negative effect on well-being of grow-finish pigs in terms of behavior, physiology and health.

The space requirement of a pig in a group includes static space determined by its body dimensions and space needed to perform normal functions such as feeding, drinking, elimination, resting and interacting with other pigs and stockpersons. Petherick and Baxter (1981) related space requirement of a pig using a mathematically defined biological (allometric) relationship, considering size and shape of the pig and its behavior relative to the manner in which the space is utilized. This in turn was used to calculate the total static space occupied by a group of pigs. Based on allometric relationships, Petherick (1983) calculated the area (A) using a formula $A\ (m^2) = k \times W^{0.667}$, where 'k' is a constant and W is the body weight of the pig in kg. Accordingly, space allowance recommendations have been made for pigs (Baxter, 1984). However, these studies have also used only production performance in the evaluation, and not other welfare indicators. The space available within a group is shared so that when a fixed total space is provided per pig, the amount of free space available depends on group (McGlone and Newby, 1994). However, the extent of reduction in space that can be permitted without adversely affecting well-being and production has not yet been well understood. Similarly, when space need for a group of pigs is calculated allometrically, based on average body weight of the pigs in the group, a group with heavier and lighter pigs may get more available space than a group with uniform sized pigs. Thus, the objective of the present study was to evaluate welfare and performance of grow-finisher pigs at space allowances based on four 'k' values and in two body weight composition groups.

Materials and methods

The trial was conducted following a 4 x 2 factorial design across 32 pens in 2 environmentally controlled barns at an eastern Minnesota farm. Each pen had fully slatted flooring, a 5-place dry wean to finish feeder and 2 cup waterers. Nineteen barrows (Yorkshire X Landrace X Hampshire X Duroc commercial crosses) of 30 kg (30.56 +0.15) were randomly allocated to each of 4 floor space allowance treatments based on four 'k' values (0.037, 0.034, 0.031 and 0.027), calculated for the final anticipated weight of 116 kg. The corresponding space allowances were 0.88, 0.81, 0.74 and 0.64 m^2 per pig respectively. The group composition treatments included pigs of uniform or varying body weights. The experiment was replicated four times using 608 individually identified (ear-tagged) pigs. All pigs had ad libitum access to feed and water. Five focal pigs were randomly identified from each pen at the start of the trial for assessing injury levels, salivary cortisol concentration and behavior and the same focal pigs were followed through out the trial.

Saliva collection started when pigs reached a body weight of 75 kg (at 8th week after beginning of the experiment) in any one of the pen and at weekly intervals thereafter. Cortisol concentrations were assessed using solid phase cortisol radioimmunoassy (Coat-A-Count TKCO, Diagnostic Products Corporation, Los Angels, U.S.A). Injuries of all pigs were assessed based on frequency and severity of wounds on different body locations such as head, limbs, thorax, flank, top of the back, rump, udder, vulva and tail (ranging from 0 to 3; no injury, mild, obvious and severe respectively) and the scores were added together to get the total injury scores (TIS)

Behavior of the focal pigs was recorded using a time-lapse video recorder and high resolution cameras, for 8 hours from 8 am to 4 pm. Behavior recording started when pigs reached a body weight of 75 kg in any one of the pen and continued at bi-weekly intervals thereafter. The frequency of behaviors of pigs for was analyzed using a software ('The Observer', version 4.1. Noldus Information Technology Inc, Leesburg, USA). All pigs were individu-

ally weighed at the start, bi-weekly up to 6 weeks and weekly thereafter up to 14th week of the trial. Average daily gain was determined from body weights and pen efficiency was determined by calculating daily gain per square meter of floor space.

The pen was considered as the experimental unit for analysis. The number of occurrences of behavior during the observation time was expressed as frequency of behavior. Repeated-measures of ANOVA was performed for ADG, pen efficiency, injury levels, cortisol concentrations and behavior. Means were compared using Tukeys pairwise comparison.

Results

The pigs in 0.027 had lower ($P<0.05$) ADG (0.859kg/day) than those in 0.037 (0.936kg/day) and 0.34 (0.916kg/day) whereas pigs in 0.027 and 0.031 (0.905kg/day) did not differ in ADG. Weight group composition had no ($P>0.05$) effect on ADG.

Pigs in 0.027 had higher overall pen efficiency (g daily gain/m^2) than in other space allowance treatments. Weight group compositions had no effect on pen efficiency. Pigs in 0.027 had higher ($P<0.05$) injury scores than those in 0.037 and 0.034. Weight group composition had no effect on injury levels. Salivary cortisol concentrations did not differ with space allowance treatments or with weight group compositions.

Average number of aggressions were higher ($P<0.05$) in 0.027 compared to that in 0.037 and 0.034. Weight group composition had no effect on average number of aggressions. Average number of non-agonistic social interactions was not different ($P>0.05$) among the four space allowance treatments or in different weight group compositions.

Discussion

A lower ADG at lower space allowance per pig as observed in this study agrees with a previous report (NCR-89 Committee on confinement management of swine, 1993). However, in most of the previous studies, group size has been confounded with space allowance. Studies without confounding of space and group size and using k values for space allocation (Pearce and Paterson, 1993, 'k' 0.048 vs. 0.025; Meunier-Salaun et al., 1987, 'k' 0.032 vs. 0.047) have also indicated lower ADGs when 'k' value was small. The present trial indicated that 0.034k and 0.037k ensured higher ADG which are comparable to the range of 'k' (0.032- 0.038) suggested by Brumm et al., (1996).

Sorting according to body weight to minimize dominance related variation in production may be useful only if resources are limited and easily defendable and therefore, grow-finish pigs fed ad-libitum may not be benefited from sorting by weight (Gonyou, 2003). A lack of difference in performance among pigs grouped with varying degrees of weight variation as in the present study has been reported by McGlone et al., (1987) also. Higher pen efficiencies at lower space allowance as observed in the present study has also been reported previously (Powell and Brumm, 1992).

Basal cortisol concentrations were not elevated by space restriction in studies reported by Pearce and Paterson (1993) and Meunier-Salaun et al., (1987), which agrees with the present result of no difference in cortisol concentrations among pigs in various space allowance treatments.

The increase in injury levels at lower space allowance observed may be due to increase in agonostic behavior at lower space allowance (Meunier-Salaun et al. 1987). Though a reduction in space may inhibit initial aggression, it may increase aggression in longer term in stable groups (Weng et al., 1998). The present result of higher injury scores at lower 'k' values of 0.027 and 0.031 agrees with these reports. Although overall injury levels decreased with increase in space allowance, an increase in space allowance from 0.027 to 0.031 did not result in significant reduction in injury. There may be increased competition for resting place causing aggression and injuries when space is less. Also, when animals grow in size there may be difficulty for all pigs to simultaneously occupy the feeder, though the number of feeder space remains same. Competition to gain access to feeder and maintain it may also cause aggression. Even if feeding is ad-libitum, social facilitation may motivate pigs to eat simultaneously resulting in competition and aggression. This may explain the higher number of aggressive interactions in lower space allowance observed in this study.

Conclusion

The ADG was lower at 0.027 compared to that at 0.034 and 0.037. Pen efficiency was higher at lower space allowances. Results also suggested welfare benefits in terms of lower injuries and aggression associated with higher space allowance. Allotting grow-finish pigs according to uniformity or variation in body weight may not provide any differential benefit in ADG or overall welfare. Although, a beneficial effect was observed in terms of ADG, injury scores and aggression by increasing space allowance, an increase in space allowance from 0.027 to 0.031 did not result in significant benefit. Similarly, reducing space allowance from 0.034 to 0.031 also did not cause further disadvantages in terms of ADG, injuries and aggression, suggesting that 'k' value of 0.031 was intermediate to higher (0.037 and 0.34) and lower (0.027) 'k' values. It may be concluded that in fully slatted floor, space allowances considering the final market weight of

barrows, corresponding to 'k' values of 0.037 and 0.034 appear to be acceptable when compared to a 'k' value of 0.27, in production and welfare terms. Further studies are needed to evaluate intermediate k values.

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