Different roughages to organic growing/finishing pigs — Influence on activity behaviour and social interactions

M. Høøk Presto a,⁎, B. Algers b, E. Persson b, H.K. Andersson a

a Dept. of Animal Nutrition and Management, Swedish University of Agricultural Sciences (SLU), PO Box 7024, SE-750 07 Uppsala, Sweden
b Dept. of Animal Environment and Health, Swedish University of Agricultural Sciences (SLU), PO Box 234, SE-532 23 Skara, Sweden

A R T I C L E   I N F O

Article history:
Received 4 June 2008
Received in revised form 8 October 2008
Accepted 11 October 2008

Keywords:
Activity
Behaviour
Aggression
Growing pigs
Organic production
Roughage

A B S T R A C T

The effect of roughage on pigs' activity behaviour and social interactions was investigated at four observation occasions in this study, which was performed during two years and included two experiments of organic growing/finishing pigs. In experiment 1, 377 pigs were allocated randomly to either a control treatment (C) or one of three treatments with access to additional roughages; hay (H), grass silage (GS) or whole crop barley silage (BS). In experiment 2, 138 pigs were randomly allocated to the C or the GS treatment. Pigs were housed indoors with straw in the lying area and with access to a concrete outdoor run, where H, GS and BS pigs were given roughages ad libitum in hedges. Pigs given roughage were staying outdoors significantly more frequently than control pigs (p = 0.031 in experiment 1 and p = 0.002 in experiment 2) and were more active (p = 0.034 and p = 0.006, respectively). C pigs were rooting in straw more often than GS pigs and tended to root more often than BS pigs, which suggests that pigs with additional roughage are motivated to use it to explore and forage. However, no difference in time spent on eating the different roughages was found. Indoors, the frequency of aggressive behaviour in the lying area was lower for pigs with access to roughage than for pigs in the control treatment in experiment 1 (p = 0.009) and was lower, though not significantly, in experiment 2 (p = 0.121). Our results confirm that access to additional roughage in the outdoor area significantly influences the pigs to go outdoors more frequently and to be more active, and reduces the aggressive behaviour among the pigs.

© 2008 Elsevier B.V. All rights reserved.

1. Introduction

Pigs in organic production should be able to express their natural behaviour for rooting and grazing. Larger areas and outdoor runs occupy pigs giving them more possibilities to be active. Roughages such as grass (fresh or dried), silage or straw should be offered in unlimited amounts (EC, 1999). According to Swedish standards (KRAV, 2007), high quality hay or silage should be included in the diet. Pigs have a capacity to digest forage fibres in the hindgut (Andersson and Lindberg, 1997) and roughages might, due to high fibre content, be a way to improve the well-being of pigs because they positively affect the development of the micro flora and epithelium in the gut (Fernandez and Danielsen, 2002). Roughages also positively affect pigs by increasing their motivation to explore and forage (Roberts et al., 1993; Vestergaard, 1996). It has been shown that roughage can be included in the total diet up to 18–19% of dry matter without refusals (Carlsson et al., 1999) and that pigs with a live weight of 60 kg or more, are able to consume 10% of the energy from roughage (Jensen and Andersen, 2002). Danielsen et al. (1998) showed that when an amount of feed was replaced with roughage, higher meat content and better feed efficiency but slower growth rate was obtained. All aspects of animal production relate to the animals' behaviour (Broom et al., 2007) and the environment influences the well-being and the behaviour of pigs. Pigs are curious and have a well-developed exploratory behaviour (Wood-Gush and Vestergaard, 1991). Exploring, foraging and rooting behaviours are expressed largely in the pigs' general
activity and are performed to search for possible locations of food and to gather general information on the surroundings (Studnitz et al., 2007). Inglis and Ferguson (1986) suggested that the animal is motivated to work for information as well as to find food. Pigs that were born and kept in a semi-natural environment (including grass and woodland) spent 20% of the daylight period rooting and 30% grazing (Stolba and Wood-Gush, 1989). Roughage is an important resource in organic production systems, which can influence the pigs' activity pattern and social interactions. By increasing the time spent eating, roughage can occupy the pigs and most likely reduce stress and aggression between individuals. Several studies have shown a reduction in aggressive and harmful behaviours when enrichments such as roughage or straw were supplied (Petersen et al., 1995; Beattie et al., 2000; Persson et al., 2004). The same results were obtained with barley-pea and whole crop silage roughages, which were also concluded to be appropriate rooting substrates for pigs (Olsen, 2001).

The objective of the present study was to evaluate the effects of roughage on organic growing/finishing pigs' activity behaviour and social interactions. The hypothesis was that access to additional roughage in the outdoor area would make the pigs use this area more frequently and change their activity pattern. Further, access to roughage would reduce aggressive behaviour and stress among the pigs.

2. Materials and methods

2.1. Animals and experimental design

A total of 515 organic female and castrated male pigs were included in this two-year field study, comprising two experiments, performed during 2002/03 and 2004/05. Experiment 1 included 377 pigs in three different herds (I, II, III) and experiment 2 included 138 pigs in herd III. Four pens per herd within experiment were included in the study. All pigs were of (Landrace * Yorkshire) * Hampshire breed. The pigs were bought from two organic piglet-producing herds at Hampshire breed. The pigs were bought from two organic piglet-producing herds at Hampshire breed. The pigs were bought from two organic piglet-producing herds at Hampshire breed. All pigs were born and kept in a semi-natural environment (including grass and woodland) spent 20% of the daylight period rooting and 30% grazing (Stolba and Wood-Gush, 1989).

The two experiments were carried out during the winter period (November–February) when the pigs were housed indoors with access to an outdoor run. The average outdoor temperature was 0.7 °C (min. –10.0° and max. 10.5 °C) in experiment 1 and 5.0 °C (min. –7.1° and max. 11.4 °C) in experiment 2. Pigs in herd I were housed in a barn, which was un-insulated, with 29, 31, 36 and 49 pigs per pen, respectively. Each pen contained a lying area on a deep straw bed and an eating area with water cups and feeding troughs, which allowed all pigs to eat simultaneously. The total indoor area was 1.52 m²/pig. The pigs had access to a concrete outdoor run without roof, with an area of 1.0 m²/pig. The openings between the pen and the outdoor run were provided with a transparent plastic curtain and there was a ramp leading down to the concrete. The deep straw bed was cleaned once before arrival of new piglets and provided with a large bale of straw once a week during the growing/finishing period and the outdoor run was cleaned once a week. Pigs in herd II were housed in an insulated rebuilt stable with 22, 22, 32, and 32 pigs in each pen, respectively. Pigs in herd III were housed in an un-insulated barn and each pen enclosed 31 pigs in experiment 1 and 32, 35, 35 and 36 pigs, respectively in experiment 2. The pigs in herd II and III consisted of a lying area with slatted floor. The lying area was provided with cut straw (herd II) and a small bale of straw (herd III) everyday, and the pens were cleaned daily. Each pen had an eating area with feeding troughs to allow all pigs to eat simultaneously. The total indoor area was not less than 1.59 m²/pig. The pens also allowed admittance to a concrete outdoor run without roof and the area was not less than 1.03 m²/pig. The openings between the pen and the outdoor run were provided with a transparent plastic curtain and in herd II and III there was a step leading down to the concrete.

2.2. Housing

The two experiments were carried out during the winter period (November–February) when the pigs were housed indoors with access to an outdoor run. The average outdoor temperature was 0.7 °C (min. –10.0° and max. 10.5 °C) in experiment 1 and 5.0 °C (min. –7.1° and max. 11.4 °C) in experiment 2. Pigs in herd I were housed in a barn, which was un-insulated, with 29, 31, 36 and 49 pigs per pen, respectively. Each pen contained a lying area on a deep straw bed and an eating area with water cups and feeding troughs, which allowed all pigs to eat simultaneously. The total indoor area was 1.52 m²/pig. The pigs had access to a concrete outdoor run without roof, with an area of 1.0 m²/pig. The openings between the pen and the outdoor run were provided with a transparent plastic curtain and there was a ramp leading down to the concrete. The deep straw bed was cleaned once before arrival of new piglets and provided with a large bale of straw once a week during the growing/finishing period and the outdoor run was cleaned once a week. Pigs in herd II were housed in an insulated rebuilt stable with 22, 22, 32, and 32 pigs in each pen, respectively. Pigs in herd III were housed in an un-insulated barn and each pen enclosed 31 pigs in experiment 1 and 32, 35, 35 and 36 pigs, respectively in experiment 2. The pigs in herd II and III consisted of a lying area with slatted floor. The lying area was provided with cut straw (herd II) and a small bale of straw (herd III) everyday, and the pens were cleaned daily. Each pen had an eating area with feeding troughs to allow all pigs to eat simultaneously. The total indoor area was not less than 1.59 m²/pig. The pens also allowed admittance to a concrete outdoor run without roof and the area was not less than 1.03 m²/pig. The openings between the pen and the outdoor run were provided with a transparent plastic curtain and in herd II and III there was a step leading down to the concrete.

2.3. Diets and feeding

All pigs were fed liquid diets based on organic raw materials (cereal grains and protein concentrates). In experiment 1 the diets were complemented with cream and whey (herd I) or starch-by products (herds II and III). Correspondingly, the diets in experiment 2 were complemented with distiller's grain. The pigs were fed three times daily according to the standard feeding regime for growing/finishing pigs in Sweden (Andersson et al., 1997). All pigs received straw in the lying area and H, GS and BS pigs were given additional roughages ad libitum in feeding hedges in the outdoor area. Roughage was replenished every morning and if needed in the afternoon.

2.4. Behaviour observations

Behaviour observations were performed in all pens at four occasions continuously; at arrival and later every four weeks throughout the growing/finishing period. In experiment 1, two observers, one in herd I and one in herd II and III, recorded the observations, whereas in experiment 2, one observer recorded all observations. The observers were standing outside the pen viewing both indoor and outdoor areas and the observation did not start until the pigs were accustomed and paid no attention to the observer. In experiment 1, each observation occasion lasted two days and the pigs were observed twice daily, one session at 9.00 and one at 13.00. In experiment 2, all pigs changed alternately
between the treatments; one week in treatment C and one in GS. Each observation occasion lasted two days per week and the pigs were observed three times a day (sessions at 8.30, 12.00 and 15.00), due to higher expected activity in the afternoon according to a previous study (Olsen et al., 2000). The sessions included sets of direct observations of the pigs’ general behaviour and their location, and continuous sampling of the pigs’ social interactions. One set of direct observations (by scanning the whole pen) was performed in one pen and followed by 1 min of continuous sampling. After that, the observer repeated the same procedure in the other pens. Each session lasted 120 min (including 12 sets of direct observations and 12 min of continuous sampling) in experiment 1 and 90 min (including 9 sets of direct observations and 9 min of continuous sampling) in experiment 2. This led to in total 48 direct observations and 48 min of continuous sampling per pen and occasion in experiment 1 and 54 direct observations 54 min of continuous sampling per pen and occasion in experiment 2. The behaviours recorded are shown in an ethogram in Table 1.

2.5. Statistical analyses

The statistical analyses were performed with the SAS package, version 9.1 (SAS Institute, 2008). The variables rooting in straw and rooting in other environment were added together and named rooting in straw or other. Two additional variables were created; exploring (rooting in straw or other added with eating roughage) and being active (standing added with eating roughage). All dependent variables were examined for normal distribution using Proc Univariate, considering skewness, kurtosis, Shapiro–Wilks test for normality and a normal probability plot. Inactivity in deep straw in experiment 1 and exploring in experiment 2 were the only variables that showed normal distribution and therefore original data were used in the analysis for these variables. All other variables showed non-normality and activity behaviour variables were therefore arcsin-transformed and social interaction variables were square root-transformed to improve the normality of the distribution before the statistical analysis.

The statistical analyses of activity behaviour and social interactions were performed in Proc Mixed and in experiment 1, the model included treatment (C/H/GS/BS), observation occasion (1/2/3/4), session time (9.00/13.00) and herd (I/II/III) as fixed effects. Pen within herd was treated as the statistical unit. In experiment 2, the model included treatment (C/GS), observation occasion (1/2/3/4) and session time (8.30/12.00/15.00) as fixed effects and pen was the statistical unit. In the analysis of all social interactions, number of pigs per pen within session was included as a covariate. Because behaviour observations were performed repeatedly, time was analysed with repeated statement with Compound Symmetric as the covariance structure. Two-way interactions between treatment and observation occasion were tested in the model, but without any significance and were therefore excluded. The analyses were based on the average total number of direct observations per pen and session for activity behaviours (n = 192), and the average frequency of each behaviour performed per pen and session for social interactions (n = 192). After analysis, the values for activity behaviours were transformed back to proportions and were presented as least square means of percent of the observations. For social interactions, the transformed values were presented as least square means of number of times per hour that each behaviour occurred. Social interaction behaviours that were performed less than one time per hour were not included in the statistical analysis (outdoor nibbling in experiment 1, and ear biting, tail biting and outdoor belly massaging in both experiments).

3. Results

In general, the pigs’ daily weight gain in experiment 1 did not differ between treatments and was on average 740 g (SD 13.0 g). The consumption of roughage was slight and the average amount recorded was 0.25, 0.62 and 0.40 kg roughage/day and pig in treatment H, GS and BS, respectively, which correspond to 1.07, 1.65 and 1.29 MJ ME.

3.1. Activity behaviour

Pigs with access to roughage in feeding hedges in the outdoor area were staying outdoors more frequently than pigs without roughage (p = 0.031 in experiment 1, and p = 0.002 in experiment 2; Table 2). In experiment 1, pigs in treatment H, GS and BS stayed outdoors on average 9.6, 12.5 and 10.9%, respectively of the observations compared to 3.8% for pigs in treatment C. In experiment 2, the corresponding values for GS

Table 1

<table>
<thead>
<tr>
<th>Behaviour variables</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity behaviours</td>
<td>Lying, Lying/sitting, Standing, Walking/running</td>
</tr>
<tr>
<td></td>
<td>Eating feed/trying to eat feed from feeding trough</td>
</tr>
<tr>
<td></td>
<td>Eating/manipulating roughages from hedges in outdoor area</td>
</tr>
<tr>
<td></td>
<td>Eating/rooting in straw indoors</td>
</tr>
<tr>
<td></td>
<td>Rooting on floor, ground or other environment (except for straw or roughage)</td>
</tr>
<tr>
<td></td>
<td>Manipulating or rubbing the environment in pen or outdoor area</td>
</tr>
<tr>
<td></td>
<td>Social behaviour (unspecified)</td>
</tr>
<tr>
<td>Social interactions</td>
<td>Aggression</td>
</tr>
<tr>
<td></td>
<td>Two or more pigs are fighting</td>
</tr>
<tr>
<td></td>
<td>A pig is mounting another pig</td>
</tr>
<tr>
<td></td>
<td>A pig nibbles (almost bites) another pig</td>
</tr>
<tr>
<td></td>
<td>A pig is massaging another pig’s belly</td>
</tr>
<tr>
<td></td>
<td>A pig is biting or touching another pig’s tail with its snout</td>
</tr>
<tr>
<td></td>
<td>A pig is biting or touching another pig’s ear with its snout</td>
</tr>
</tbody>
</table>

M. Høøk Presto et al. / Livestock Science 123 (2009) 55–62
pigs was 15.3% and for C pigs 5.5%. Exploring (rooting in straw or other and eating roughage) did not differ between treatments in experiment 1, whereas GS pigs explored more than C pigs in experiment 2 ($p = 0.036$). Rooting in straw or other differed between treatments in both experiment 1 and 2 ($p = 0.045$ and $p = 0.018$, respectively; Table 2). More rooting was found among C pigs than among GS pigs. Compared to BS pigs there was a tendency of more rooting among C pigs ($p = 0.084$), whereas there was no difference between H and C pigs ($p = 0.151$). Percent of observed pigs that were eating roughage did not differ significantly between H, GS and BS treatments. In experiment 1, standing indoors and outdoors did not differ between treatments. However, in experiment 2 pigs in treatment C were standing outdoors significantly more often and tended to stand indoors more often than pigs in treatment GS ($p = 0.004$ and $p = 0.061$, respectively). When analysing the behaviour variable being active (standing and eating roughage), pigs in roughage treatments were significantly more active than control pigs ($p = 0.034$ in experiment 1, and $p = 0.006$ in experiment 2). Lying indoors in the lying area occurred frequently in all treatments (on average 62.5% of the observations in experiment 1 and 48.9% in experiment 2), but did not differ significantly between treatments. However, numerically more pigs were lying in treatment GS than in H and BS ($p = 0.046$ and $p = 0.050$, respectively). Eating feed occurred on average 6.5% of the observations in experiment 1 and 3.5% in experiment 2. Lying outdoors, other social behaviour indoors and outdoors, and manipulating environment indoors and outdoors occurred rarely in both experiments, and did not differ significantly between treatments (data not presented).

More pigs stayed outdoors and tended to be eating roughage more frequently during observation occasions 3 and 4 compared with 1 and 2 in experiment 1 ($p = 0.003$ and $p = 0.078$, respectively). In experiment 2, there was a time effect but without any consistent trend ($p < 0.001$). In general, pigs were standing indoors less over time ($p = 0.001$ for experiment 1 and $p = 0.005$ for experiment 2).

Pigs were exploring more and lying in the lying area less frequently in the noon session than in the morning session in experiment 1 ($p = 0.007$ and $p = 0.001$, respectively; Fig. 1). In experiment 2 however, pigs were exploring more in the morning session than in the noon and afternoon session ($p = 0.003$), and more pigs were staying outdoors, were active and were eating roughage in the afternoon session than in earlier sessions ($p = 0.001$ for all; Fig. 1).

A herd effect was found for staying outdoors, exploring, rooting in straw or other, standing and lying indoors, being active, manipulating outdoor environment and eating feed from the feeding troughs ($p \leq 0.05$ for all).

### 3.2. Social interactions

Indoors, the frequency of aggressive behaviour in the lying area was lower for pigs with access to roughage than for pigs in the control treatment in experiment 1 ($p = 0.009$; Fig. 2) and lower, though not significantly, in experiment 2 ($p = 0.121$; Fig. 3). Outdoors, the frequency of aggressive behaviour did not differ in experiment 1 ($p = 0.802$), but was higher among pigs in treatment GS than in C in experiment 2 (1.9 vs. 0 times per hour, respectively, $p = 0.013$). However, the frequency of aggressive behaviour outdoors was in general low in both experiments (on average 2.8 and 1.0 times per hour for experiments 1 and 2, respectively). The other social interaction variables were not influenced by access of roughage and did not differ between treatments.
Aggressive behaviour indoors decreased over time until the third observation occasion and then it stayed on the same level in experiment 1 \((p = 0.035; \text{Fig. } 4)\). The average values for each occasion were 48.8, 39.2, 25.4 and 26.0 times per hour, respectively. Riding indoors were most frequent at the first occasion and then decreased considerably at the later occasions \((p = 0.017; \text{Fig. } 4)\). No significant time effect was found in experiment 2. Aggressive behaviour indoors occurred significantly more often in the noon session than in the morning session in both experiments \((p = 0.008 \text{ and } p = 0.027)\) but decreased in the afternoon session to the same level as in the morning session in experiment 2. Herd significantly affected riding, outdoor aggression, and indoor belly massaging and nibbling \((p \leq 0.05 \text{ for all})\).

4. Discussion

4.1. Activity behaviour

In the present study, pigs that received additional roughages (hay, grass silage or whole crop barley silage) in the outdoor area stayed outdoors to a larger extent than pigs that received straw only in the deep straw area indoors. This is in accordance with Olsen et al. (2002), who found that pigs with access to roughage in the outdoor area stayed outdoors more frequently than pigs without roughage. Exploring was on average performed 20.0\% of the time in experiment 1, and 30.1\% in experiment 2. This is lower than found by Stolba and Wood-Gush (1989), who reported that pigs examined the environment, manipulated and collected feed up to 75\% of time. However, that study was carried out under semi-natural conditions with large areas, whereas our study was performed indoors in enriched systems with access to an outdoor run on concrete. Several studies have concluded that various rooting materials increase exploratory behaviour directed towards the rooting materials (Beattie et al., 1996; Olsen et al., 2000; Guy et al., 2002a,b; Long, 2002; Olsen et al., 2002). The relatively small difference in exploring (rooting in straw or other and eating roughage) between the different treatments in our study, might be because C pigs were rooting straw in the lying area in the absence of additional roughage and this was recorded as exploring behaviour. All pigs in our study had access to straw in the lying area and the fact that C pigs were rooting in straw significantly more often than GS pigs and tended to root more often than BS pigs, suggests that pigs with additional roughage are motivated to use it to explore and forage. However, we found no significant difference in time spent on eating the different types of roughages. In contrast, Olsen et al. (2000) found that whole crop silage of oats, vetch and lupine was manipulated more often than six other types of roughages including straw. In a study by Jensen and Pedersen (2007), maize silage was preferred to seed grass

![Fig. 1. Effect of session time (morning = black bars, noon = white bars and afternoon = grey bars) on activity behaviour in experiments 1 and 2. Least square means of percent of the observations that each activity occurred per pen, \(n = 192\) (see Table 2). \(*p \leq 0.05; \*\*p \leq 0.01; \*\*\*p \leq 0.001\).](image1)

![Fig. 2. Effect of treatment (C, H, GS and BS) on aggressive behaviour indoors in experiment 1. Least square means of frequency of aggressive behaviour per pen and hour, \(n = 192\) (see Table 2). \(*p \leq 0.05; \*\*p \leq 0.01; \*\*\*p \leq 0.001\).](image2)

![Fig. 3. Effect of treatment (C = black bars, GS = white bars) on aggressive behaviour indoors and outdoors in experiment 2. Least square means of frequency of aggressive behaviour per pen and hour, \(n = 192\) (see Table 2).](image3)
hay and straw. The authors stated that straw might still be a good rooting material but other materials are better. The enrichment substrates should be complex, changeable and destructible and when edible, foraging behaviour will be stimulated (Studnitz et al., 2007). Bracke et al. (2006, 2007) concluded that straw and whole straw with chopped beet roots, maize silage, a bale of straw or long straw with fir branches are valued highest as enrichment substrates for pigs, and that roughage might be sufficient. It has also been concluded that pigs not only require environmental enrichment but also space for proper exploratory behaviour (Beattie et al., 1996). Outdoor rearing often offers a more complex environment as well as more space than indoor rearing, and pigs in outdoor systems have been found to explore more than pigs in barren indoor systems without any enrichment materials (Cox and Cooper, 2001; Hötzel et al., 2004).

Control pigs were significantly less active (standing and eating roughage) outdoors than pigs with additional roughage, which indicates that the roughage encouraged pigs to go outdoors and to be more active. However, when analysing standing outdoors in particular, C pigs in experiment 2 were standing more. This could be because C pigs were recorded as standing (if they were standing), whereas GS pigs might have been recorded as eating roughage. Even if GS pigs were actually standing and eating roughage, eating was given priority. Morrison et al. (2003, 2007) confirmed more activity (standing and locomotion) in pigs in deep litter-systems than in conventional pens. On the other hand, Lyons et al. (1995) found that pigs with straw enrichment were standing less than pigs on bare-concrete and slats. In a recent study by Høøk Presto et al. (2008), it was found that outdoor pigs on pasture were walking and standing more often than indoor pigs in conventional pens, which was probably due to larger areas. Cox and Cooper (2001) suggested that the difference between indoor and outdoor piglets is not how much time piglets are active but rather what they do while they are active.

Lying indoors in the lying area occurred on average 62.5% of the time in experiment 1 and 48.9% in experiment 2. Similarly, lying and sitting behaviour was performed about 58% of time and with no difference between weaned pigs in either confined or outdoor systems (Hötzel et al., 2004). Interestingly, lying tended to be more frequent among pigs that received grass silage than among those that received hay and whole crop barley silage in experiment 1 in our study. This was probably due to more satisfied and calmer pigs, and was one underlying observation when deciding which type of roughage to be included in experiment 2.

More time was spent outdoors later in the rearing period in experiment 1. Consequently, pigs also tended to perform the behaviour eating roughage more frequently at that time. This may be because the pigs were stimulated to continue exploring and eating the substrate. Correspondingly, pigs were rooting in straw or other significantly less during the later observation occasions compared with the first. This may indicate that roughage has a higher value as feeding and rooting substrate than straw as mentioned earlier in this paper. As expected, more pigs were staying outdoors, were active and were eating roughage in the afternoon session compared with the earlier sessions, while exploring occurred more in the morning session than in the noon and afternoon session in experiment 2. This is in accordance with Olsen et al. (2000) who found that the greatest activity level was seen in the afternoon between 12.00 and 16.00, but also in the morning between 07.00 and 09.00. Consequently, replenish of roughage in the morning seems to have had a minimal effect on the pigs’ activity behaviour.

4.2. Social interactions

The results from our study showed that access to additional roughage outdoors reduced the frequency of aggressive behaviour in the lying area. This agrees with the results of others, who found positive effects such as reduced abnormal behaviours directed to pen-mates and less aggressive behaviour in pigs given different types of enrichments (Beattie et al., 2000; Kelly et al., 2000; Beattie et al., 2001; Olsen, 2001; Guy et al., 2002b; Long, 2002; Olsen et al., 2002; Bolhuis et al., 2005). However, because straw was only offered in the lying area in the control group, this might have led to a higher number of aggressions when the pigs wanted to lie and root in the same area. If straw had been offered in feeding hedges in the outdoor run, it might have influenced the aggressive behaviour and equalised the situation. The higher frequency of aggressive behaviour outdoors in the roughage treatment compared with the control treatment in experiment 2, could be because roughage was served in feeding hedges that gave insufficient

---

**Fig. 4.** Effect of observation occasion on indoor aggression (–x–) and riding (–□–) in experiment 1. Least square means of the frequency of each behaviour performed per pen and hour, n = 192 (see Table 2). p = 0.035 for aggression and p = 0.017 for riding.
space around the hedge. Similarly, Madsen (2001) and Olsen et al. (2002) also concluded this. However, no difference in aggression was found in experiment 1, although the same feeding hedges were used. The feeding hedges might have affected the frequency of aggression outdoors, but still, they do not seem to have been inappropriate. Nevertheless, aggression outdoors was in general low (2.8 times per hour for experiment 1 and 0.7 for experiment 2). The level of outdoor aggressiveness found by Olsen et al. (2002) was lower (on average 0.1 events per hour) than those found in our study.

Aggression decreased with increasing age of pigs in experiment 1. This is in agreement with Lyons et al. (1995), who found that more pigs were biting pen-mates at the beginning than in the middle and in the end of their experiment. Aggressive behaviours of sows and piglets under semi-natural conditions occurred more often earlier than later in the observation period (Newberry and Wood-Gush, 1988; Wood-Gush et al., 1990). The higher aggression level indoors in the noon session than in the morning session could be explained by the lower activity during this session. The fact that aggressive behaviour decreased in the afternoon session in experiment 2, supports the higher occurrence of more pigs staying outdoors and higher activity during the afternoon session.

4.3. Herd effect on activity behaviour and social interactions

Many activity behaviours and social interactions were performed differently in the three herds in our study, most probably because the environment affects the pigs’ behaviour. The production systems were similar in the three herds, but the design of the pens and outdoor areas differed, which might have influenced the activity behaviour of the pigs. In a recent study by Munsterhjelm et al. (2006), it was found that the social activity and the exploratory behaviour of growing pigs was affected by their early experience with enrichment as piglets. There was a small deviance in outdoor temperature between the two experiments in our study, which also might have affected the pigs’ behaviour. Such factors have to be considered to generalise the results from our study.

5. Conclusion

Our results confirm that access to additional roughage in the outdoor run encourages pigs to go outdoors more frequently and suggests that pigs might be motivated to use the roughage to explore and forage. Although straw was provided indoors, access to additional roughage outdoors affected the pigs to be more active and reduced the aggressive behaviour among the pigs. This indicates that roughage is an important resource that might influence the well-being and the behaviour of pigs.

Acknowledgements

Formas (Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning) supported this study. The authors would like to thank the managers and staff at the pig herds for letting us perform our study, for taking excellent care of the pigs and for good cooperation. The authors also would like to thank Sylvia Persson and Karin Wallin for experimental and practical help at the pig herds, and Ulla Schmidt for entering data into the database.

References


Forskning i økologisk svineproduktion. FØJO-rapport nr.1, pp. 19–42.
