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Effect of toys on behaviour and body weight of weaned pigs after mixing

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Abstract: This study was conducted to evaluate the effects of a toy on the behaviour and body weight of weaned pigs after mixing. Two groups (192 pigs in total, control: without toy; treatment: with toy placed on the floor) of weaned pigs housed in pens (1.8 m × 1.4 m, 4 pigs/pen) were observed with the aid of video technology for nine consecutive hours in the early (days 1 and 2) and late (days 38 and 39) period after mixing. Body weight of pigs at the end of the study (Mann-Whitney *U*-test, $Z = -2.46$, $P = 0.01$) and the average daily gain ($Z = -2.75$, $P < 0.01$) were 10% higher in the treatment group than in the control group. The presence of the toy in the pen influenced the pig behaviours. In pens enriched with toys there was an increase of feeding behaviour and a decrease of agonistic and belly nosing behaviours. Toy supply reduced negative social behaviours and thereby improved body weight of weaned pigs. The results of this study suggest that toys used as environmental enrichment are useful for enhancing the pig welfare and effective for farmers.

Keywords: average daily gain; environmental enrichment; pig; toy; welfare

Animal welfare is one of the most important issues in the modern pig industry (Benson and Rollin 2004). Welfare conditions could be especially important in critical stages, such as weaning of pigs when their performance may be influenced by behavioural, nutritional, and physiological changes (Oliveira et al. 2016). Pigs of similar age and body weight are bred in intensive pig production systems (Gracner et al. 2013). Weaned pigs are mixed into groups with other litters, and are often reared in restricted and barren housing conditions. These breeding and housing conditions may be detrimental for animal welfare (Faucitano and Schaefer 2008; Torralladona and Roura 2009).

Weaning and mixing of pigs are common in the pig industry; however, these are stressful experiences for the animals (Hayne and Gonyou 2006). Pigs are separated from the sow and brood, and their feeding and environment are changed. Moreover, pigs are mixed with unfamiliar pigs from other litters (D'Eath 2002). Mixing and weaning are critical periods for pigs because of their immature digestive and immune functions, and potential aggressive behaviour between pen mates (Melotti et al. 2011). They are susceptible to diseases in this period (Turner et al. 2009). All these components may lead to a reduction in the growth performance and welfare of the pigs (Verdon et al. 2016).

To reduce stress caused by mixing, environmental enrichment for the pen could be used. Especially, environmental enrichment is an obligatory requirement in the EU defined by Directive

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2008/120 and Recommendation 336/2016 (Godyn et al. 2019). This enrichment may improve the barren conditions and appease behavioural needs (Newberry 1995). It is widely accepted that environmental enrichment that facilitates the natural behaviour of pigs may improve their welfare (Beattie et al. 2000; Ismayilova et al. 2013). Most commercially raised pigs are housed in concrete pens without bedding such as straw, wood, hay, or sawdust. It is impossible to use these materials as environmental enrichments on the solid floor of the housing systems. In these systems, single point enrichment would be more useful as an alternative (Docking et al. 2008).

Environmental enrichment could have positive effects on a reduction of aggressive behaviour by developing their social skills and changing behavioural priorities (Beattie et al. 2000; Bolhuis et al. 2006; Melotti et al. 2011; Nannoni et al. 2016). Toy supplying would be an effective environmental enrichment for the pens. Moreover, a cheap and easy manageable toy may be useful in the pig industry. We hypothesized that supplying toys with the aim of improving the welfare of pigs would positively influence their behaviour and body weight. Therefore, this study was conducted to evaluate the effects of toy on the behaviour and body weight of weaned pigs after mixing.

MATERIAL AND METHODS

The experimental protocols describing the management and care of the animals were reviewed and approved according to the Guide for the Care and Use of Laboratory Animals (Institutional Animal Care and Use Committee of National Institute of Animal Science, NIAS 2014-289).

The experiment was carried out at the experimental farm of the National Institute of Animal Science in Cheonan (Chungnam Province, South Korea), using 192 weaned pigs (Landrace × Yorkshire × Duroc). The weaned pigs were reared in 1.8 × 1.4 m pens with solid plastic flooring and a heat lamp. Pigs were weaned at 27 (± 1.5) days of age and mixed in different groups: control (four individuals per pen without toy) and treatment (four individuals per pen with toy). Final body weight was measured on day 42 after weaning. For control and treatment groups, the pigs were randomly selected from litters and mixed in pens. The sex ratio was 1 : 1.

The environmental control systems were the same in all the housing facilities. The temperature in each pen was controlled by ventilation fans and heaters and was maintained at approximately 28 ± 1 °C. Each pen was provided with a stainless-steel feeder and a nipple drinker that allowed the pigs *ad libitum* access to food and water throughout the experiment (Kelly et al. 2000). In the treatment group, one toy was supplied in each pen. The toy was made of silicon rubber (24 × 14 × 10 cm, width × length × height; white colour; 2 kg). It was placed on the floor. Moreover, there were no differences in animal care conditions between the two groups, excluding the toy. The toy cannot be used alone in the EU because they are not in agreement with requirements mentioned in EU Recommendation 336/2016.

In total forty-eight replicate pens were evaluated in the control (n = 24) and treatment (n = 24) groups. A wide-angle video camera was installed at the centre of the ceiling, so that all the areas of the pens could be observed. The behaviours of the pigs were video-recorded continuously for 9 h per day for the early (days 1 and 2) and late (days 38 and 39) periods after mixing. All behavioural data were obtained from video images that were digitally recorded from 09:00 to 18:00. Instantaneous scan sampling was carried out at 10 min intervals. All video recordings were viewed by a trained observer who was blinded to which groups are experimental or control to eliminate subjective bias and interindividual discrepancy (Li and Wang 2011; Rhim 2012).

The following self-maintenance and social behaviours were recorded: drinking, feeding, inactive, locomotion, pen exploration, excretion, play, other, agonistic, belly nosing, tail biting and other social behaviours (Table 1). The frequency of the individual performing the behaviour, as well as the individual receiving the behaviour, was noted. The behavioural time values presented are the means and standard errors of the relative frequencies of each behaviour, calculated from the results obtained from the observation of each group (Rhim et al. 2015; Hwang et al. 2016).

Data analysis was performed using SAS/STAT® software, v9.4 (SAS Institute, Cary, NC, USA), with the pen serving as the experimental unit. The residual data sets were tested for normality using the Univariate Procedure of SAS (Rhim et al. 2015). The data were not normally distributed, so the behavioural data and body weight were

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Table 1. Ethogram of behavioural categories and their respective definitions

Behaviour	Description
Self-maintenance	
Drinking	Drinking water or manipulating the drinker with or without ingestion of water
Feeding	Head positioned in the feeder or chewing food displaced from the feeder
Inactive	Motionless and sleeping
Locomotion	Any movement including walking, running, scampering, and rolling
Pen exploration	Sniffing, touching, sucking or chewing any object that is part of the pen
Elimination	Defecating or urinating
Play	Playing with toy and other piglets
Other	All other self-maintenance behaviors not listed above
Social	
Agonistic	Biting, head-thrusting, ramming, or pushing another piglet
Belly nosing	Repeated thrusting of snout into the belly of another piglet
Interaction between individuals of adjacent pen	Social interaction including threatening, ramming, or head-thrusting gestures with another piglet in adjacent pen
Tail biting	Having the tail of another piglet in its mouth and biting or pulling hard enough to cause a reation in the other piglet
Other social	All other social interactions including mounting, head rubbing and nosing parts of the body other than the belly

analysed by the Mann-Whitney *U*-test between the control and treatment groups, and *P*-values were calculated. Values were considered statistically significant at $P < 0.05$.

RESULTS

The average initial (day 1 after weaning) body weight of the pigs when placed in a pen was 8.99 ± 0.30 kg. The body condition and weights of weaned pigs did not differ at the start time of the study in the control and treatment groups. There was no difference in the body weight of weaned pigs on day 1 after mixing between the control and treatment group (Mann-Whitney *U*-test, $Z = -1.77$, $P = 0.77$). However, the mean body weight at the end of the study (day 42 after mixing) was 32.20 kg in the control and 35.28 kg in the treatment group. The body weights of pigs at the end of the study were significantly different between the two groups ($Z = -2.46$, $P = 0.01$). Moreover, average daily body weight gain was significantly higher in the treatment than in the control group ($Z = -2.75$, $P < 0.01$) (Table 2).

During the early period after mixing, the frequencies of pen exploration ($Z = -2.40$, $P = 0.02$), excretion ($Z = -1.99$, $P = 0.04$), other ($Z = -2.48$, $P = 0.01$), agonistic ($Z = -2.81$, $P = 0.01$), and belly nosing ($Z = -2.48$, $P = 0.01$) behaviours were higher in the control than in the treatment group. Frequencies of those behaviours, feeding ($Z = -2.53$, $P = 0.01$) and play ($Z = -6.70$, $P < 0.01$) were higher in the treatment group than in the control group (Table 3). However, the frequencies of all self-maintenance and social behaviours except feeding ($Z = -1.93$, $P = 0.05$), play ($Z = -6.93$, $P < 0.01$), and agonistic ($Z = -2.72$, $P = 0.01$), and

Table 2. Initial (day 1 after weaning) and final (day 42 after weaning) body weight, and average daily gain of weaned piglets in the control (four piglets/pen without toy) and treatment (four piglets/pen with toy) group

	Control ($n = 24$)	Treatment ($n = 24$)	Z	P
Initial body weight on day 1 (kg)	8.95 ± 0.25	9.05 ± 0.35	–1.77	0.77
Final body weight on day 42 (kg)	32.20 ± 0.61	35.28 ± 0.93	–2.46	0.01
Average daily gain (g/day)	564.75 ± 11.18	625.49 ± 15.31	–2.75	< 0.01

Comparisons between the control and treatment group are based on the Mann-Whitney *U*-test

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Table 3. Time spent (%) on self-maintenance and social behaviours of weaned piglets in the control (four piglets/pen without toy) and treatment (four piglets/pen with toy) group in the early period after mixing

	Control (n = 24)	Treatment (n = 24)	Z	P
Self-maintenance				
Drinking	6.70 ± 0.71	6.14 ± 0.68	–0.70	0.48
Feeding	5.96 ± 0.78	8.95 ± 0.73	–2.53	0.01
Inactive	62.04 ± 2.33	62.13 ± 2.35	–0.09	0.92
Locomotion	15.15 ± 1.25	18.58 ± 1.34	–0.05	0.96
Pen exploration	1.88 ± 0.36	1.17 ± 0.30	–2.40	0.02
Excretion	0.42 ± 0.14	0.10 ± 0.02	–1.99	0.04
Play	0.00 ± 0.00	2.58 ± 0.41	–6.70	< 0.01
Other	0.27 ± 0.12	0.00 ± 0.00	–2.48	0.01
Social				
Agonistic	3.95 ± 0.28	0.81 ± 0.05	–2.81	0.01
Belly nosing	0.24 ± 0.10	0.00 ± 0.00	–2.48	0.01
Tail biting	0.05 ± 0.04	0.00 ± 0.00	–1.43	0.15
Other social	1.19 ± 0.27	1.23 ± 0.33	–0.95	0.34

Comparisons between the control and treatment group are based on the Mann-Whitney U-test

Table 4. Time spent (%) on self-maintenance and social behaviours of weaned piglets in the control (four piglets/pen without toy) and treatment (four piglets/pen with toy) group in the late period after mixing

	Control (n = 24)	Treatment (n = 24)	Z	P
Self-maintenance				
Drinking	4.27 ± 0.47	4.31 ± 0.48	–0.06	0.95
Feeding	7.01 ± 0.69	12.36 ± 0.74	–1.93	0.05
Inactive	68.12 ± 1.62	66.74 ± 1.63	–0.69	0.48
Locomotion	14.76 ± 0.89	12.60 ± 0.82	–1.63	0.10
Pen exploration	0.49 ± 0.09	0.08 ± 0.04	–1.55	0.12
Excretion	1.38 ± 0.26	1.38 ± 0.26	–0.14	0.89
Play	0.00 ± 0.00	2.25 ± 0.36	–6.93	< 0.01
Other	0.04 ± 0.04	0.32 ± 0.17	–1.34	0.18
Social				
Agonistic	1.54 ± 0.12	0.21 ± 0.03	–2.72	0.01
Belly nosing	0.12 ± 0.01	0.59 ± 0.09	–2.59	0.01
Tail biting	0.00 ± 0.00	0.01 ± 0.01	–0.99	0.32
Other social	1.45 ± 0.25	1.62 ± 0.31	–0.03	0.98

Comparisons between the control and treatment group are based on the Mann-Whitney U-test

belly nosing (Z = –2.59, P = 0.01) were not different between the control and treatment group during the late period after mixing (Table 4).

In self-maintenance behaviour, inactive (Z = –2.28, P = 0.02) and excretion (Z = –6.31, P = 0.03) behaviours were higher during the late than during the early period. The frequencies of drinking, locomotion, pen exploration, and other behaviours were higher during the early period. Among social behaviours, agonistic behaviour (Z = –3.81, P < 0.01) was higher during the early period (Table 5).

The frequencies of drinking (Z = –3.10, P < 0.01), locomotion (Z = –3.50, P < 0.01), pen exploration (Z = –4.82, P < 0.01) and agonistic (Z = –6.25, P < 0.01) behaviours were higher during the early period. Moreover, feeding (Z = –2.10, P = 0.04), excretion (Z = –3.74, P < 0.01), and belly nosing (Z = –2.81, P < 0.01) behaviours were higher during

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Table 5. Time spent (%) on self-maintenance and social behaviours of weaned piglets in the early and late periods after mixing in the control (four piglets/pen without toy) group

	Early	Late	*Z*	*P*
Self-maintenance				
Drinking	6.70 ± 0.71	4.27 ± 0.17	−3.82	< 0.01
Feeding	6.96 ± 0.48	8.01 ± 0.69	−0.01	0.93
Inactive	62.04 ± 2.33	68.12 ± 1.62	−2.28	0.02
Locomotion	18.15 ± 1.25	14.96 ± 0.89	−2.24	0.03
Pen exploration	1.88 ± 0.36	0.49 ± 0.08	−6.22	< 0.01
Excretion	0.42 ± 0.07	1.38 ± 0.26	−6.31	0.03
Play	0.00 ± 0.00	0.00 ± 0.00	–	–
Other	0.27 ± 0.01	0.04 ± 0.01	−2.64	< 0.01
Social				
Agonistic	1.39 ± 0.28	0.74 ± 0.09	−3.81	< 0.01
Belly nosing	0.24 ± 0.05	0.56 ± 0.08	−0.89	0.37
Tail biting	0.05 ± 0.01	0.00 ± 0.00	−1.84	0.07
Other social	1.19 ± 0.27	1.45 ± 0.25	−0.26	0.80

Comparisons between the early and late period after mixing are based on the Mann-Whitney *U*-test

the late period. The frequencies of inactive, play, other, tail biting, and other social behaviours did not differ between the two groups (Table 6).

DISCUSSION

Wild boars seek their food in the soil. Despite selection by humans, pigs still retain vestiges of their natural exploration tendencies (Fraser et al. 1991). The pig's intrinsic tendency to explore and dig is particularly evident in poor environmental conditions. In poor environments, the tendency is directed at other pigs in the same pen, and can be shown as aggression, tail biting, or cannibalism (Keeling and Gonyou 2001; Van de Weerd et al. 2005). Toys can be a "novelty aspect" which allows pigs to express exploratory behaviour (Nowicki et al. 2015).

Table 6. Time spent (%) on self-maintenance and social behaviours of weaned piglets in the early and late periods after mixing in the treatment (four piglets/pen with toy) group

	Early	Late	*Z*	*P*
Self-maintenance				
Drinking	6.14 ± 0.48	4.31 ± 0.38	−3.10	< 0.01
Feeding	5.95 ± 0.73	9.36 ± 0.74	−2.10	0.04
Inactive	62.13 ± 2.35	61.74 ± 1.58	−1.52	0.13
Locomotion	18.58 ± 1.34	12.60 ± 0.78	−3.50	< 0.01
Pen exploration	1.17 ± 0.06	0.08 ± 0.01	−4.82	< 0.01
Excretion	0.10 ± 0.02	1.41 ± 0.18	−3.74	< 0.01
Play	2.58 ± 0.41	2.25 ± 0.36	−1.95	0.05
Other	0.00 ± 0.00	0.32 ± 0.12	−1.55	0.12
Social				
Agonistic	2.00 ± 0.37	0.46 ± 0.02	−6.25	< 0.01
Belly nosing	0.00 ± 0.00	0.54 ± 0.01	−2.81	< 0.01
Tail biting	0.00 ± 0.00	0.01 ± 0.01	−0.77	0.44
Other social	1.24 ± 0.14	1.62 ± 0.31	−0.74	0.46

Comparisons between the early and late period after mixing are based on the Mann-Whitney *U*-test

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Toys also seem to be able to keep attention of pigs (Moinard et al. 2003). However, the interest in toys decreases within a few days (Ernst et al. 2018). It is the reason why they should be replaced or more attractive than plastic and rubber toys.

The results of this study showed that the presence of the toy in the pen influenced the pig behaviours. In pens enriched with toys, the pigs remained for a long time close to the toys during the study period. This can be explained by the increased play and decreased social behaviour (such as agonistic) of the pigs in toy enriched pens. This may suggest that the social hierarchy of weaned pigs was more quickly established in the treatment group, and that the presence of a toy made the adjustment to mixing easier (Nowicki et al. 2007).

Environmental enrichment can be defined as an increase in the physical and emotional functioning of captive animals, resulting from changes in their environment (Newberry 1995). Moreover, it should improve animal welfare by decreasing social stress and increasing animals' ability to cope with behavioural and physiological challenges (Docking et al. 2008; Trickett et al. 2009; Gracner et al. 2013). There were higher agonistic and belly nosing behaviours in the control group. It demonstrated that changes in the environment resulted in improved welfare. Provision of a toy may reduce the interaction with other pigs and reinforce manipulative activities involving the mouth and snout (Van de Weerd et al. 2003). It may also result in a decrease in adverse behaviours, such as agonistic and belly nosing (Petersen et al. 1995). Moreover, providing environmental enrichment after weaning can provide distraction for pigs, and may induce growth performance by an increase of feeding behaviour (Moncek et al. 2004; Dudink et al. 2006).

The weaning and mixing of pigs often are practiced for economic reasons. Pigs being mixed with strange pen mates can cause agonistic behaviour for a social position within the group (Keeling and Gonyou 2001; Nowicki and Klocek 2012); this behaviour is especially visible after mixing, which is a very stressful event. Mixing is often associated with vigorous agonistic behaviour which is necessary for the establishment of social hierarchy, and it is associated with growth check (Keeling and Gonyou 2001). Moreover, increased salivary cortisol concentrations can be found in pigs after mixing (Merlot et al. 2004). Most of the aggressive behaviour occurs during the first hours after mixing, and it steadily decreases for several days after mixing (Keeling and Gonyou 2001). In this study, the weaned pigs showed higher agonistic, locomotion, and pen exploration behaviours, and lower inactivity during the early period after mixing; this was probably because of increased pig nervousness due to their unstable social status.

Environmental enrichment facilitates the reduction of social pressure, which leads to a decrease in aggressive activity (Newberry 1995). Also, agonistic behaviour was decreased in toy supplied pens in the present study. A decrease in the frequency of agonistic behaviour and an increase of feeding frequency are connected with redirecting the weaned pig activity towards the toy and may cause improvements in productivity (Beattie et al. 2000; Melotti et al. 2011; Nowicki and Klocek 2012). There was higher play behaviour of weaned pigs in the treatment group during the early and late periods. Moreover, the lower proportion of agonistic and belly nosing behaviour had a positive influence on body weight gain of the animals assigned to the toy supplied group (Oliveira et al. 2016). In spite of the fact that the rubber toy use in this study has very few traits mentioned in the EU Recommendation, it is still effective for the welfare of weaned pigs. The Recommendation in the EU may be too strict. Therefore, there is a need to revise and implement materials of environmental enrichment.

CONCLUSION

Toy supply reduced negative social behaviours and thereby improved the welfare of weaned pigs. Moreover, body weight was higher in the pens of toy supply. The results of this study suggest that toys used as environmental enrichment are useful and effective for farmers. In addition, more investigations on toys should be carried out to confirm their effects on the growth performance and animal welfare in pigs.

Conflict of interest

The authors declare no conflict of interest.

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