Welfare impact of social breeding value and straw for growing-finishing pigs

Välfärdseffekter av socialt avelsvärde och halm på växande slaktsvin

Leonie Jacobs

Sveriges lantbruksuniversitet
Institutionen för husdjurens miljö och hälsa
Avdelningen för etologi och djurskydd

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Leonie Jacobs

Studentarbete 391, Skara 2012

Advanced E, 30 ECTS, Animal Science program, Exam work in Animal Science EX 0567, SLU and Wageningen University (WUR)

Supervisor: Harry Blokhuis
Co-supervisor: Liesbeth Bolhuis (WUR)
Examinator: Lena Lidfors

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Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Avdelningen för etologi och djurskydd
Box 234, 532 23 SKARA
E-post: hmh@slu.se, **Hemsida:** www.slu.se/husdjurmiljohalsa

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Summary

Animal welfare is of increasing concern in present society. In commercial pig farming, animal welfare problems are common. One of the causes for these problems is the barren environment in which pigs are housed, which can cause oral manipulation of pen mates. Providing straw might be one solution to this problem. Another solution could be reached through genetic selection. Present breeding schemes are only focused on direct production characteristics of the individual, like growth performance. Welfare, as well as production, might be improved by including the effect an animal has on its pen mates in the selection criteria. However, effects on welfare of selection for the so called Social Breeding Value (SBV), which is based on growth, are largely unknown. This study investigated the direct welfare effects induced by straw as well as SBV and the possible interaction between both. In a one generation selection experiment, 192 finishing pigs with either a high or low SBV, were housed in barren or straw pens. In this 2x2 experimental design, pigs were studied from weaning until slaughter. Welfare status was assessed using a protocol that was partly based on the Welfare Quality® protocol. Results show that straw had a positive welfare effect regarding tail biting and exploration. Straw housed pigs had less infections and greater body weight at slaughter age than barren housed pigs. Pigs in enriched pens did show more lesions than barren housed pigs, probably due to raised overall activity in enriched pens. No welfare effect was found due to SBV, besides an effect on the occurrence of a rough hair coat. No interactions were found. It can be concluded that the welfare impact of SBV for growing-finishing pigs is not yet proven.

Sammanfattning

Det finns ett ökat intresse för djurvälfärd i samhället. I kommersiell grisuppfödning är problem relaterat till djurvälfärd vanligt förekommande. En av anledningarna till detta är den karga miljön i vilken grisarna föds upp i, vilket kan orsaka orala beteendeproblem riktade mot andra individer. Att ge djuren tillgång till halm skulle kunna vara en lösning på problemet, ett annat sätt är genom genetisk selektion. Nuvarande selektion för avel är främst inriktad på produktionsparametrar hos individen till exempel tillväxthastighet. Både välfärden och produktionsegenskaper skulle kunna förbättras genom att inkludera effekten en individ har på en annan individ i selektionskriterierna. Effekten på välfärd vid selektering på det så kallade ”Social Breeding Value” (SBV), vilket är baserat på tillväxt, är till stor del okänt. I denna studie undersöktes de direkta välfärdseffekterna av tillgång till halm, SBV, samt möjliga interaktioner mellan parametrarna. I detta experiment baserat på selektion under en generation, användes 192 grisar med högt och lågt SBV, vilka inhystes i grupper utan berikning eller i grupper med halm som berikning. I experimentet studerades grisar från avvänjning till slakt. Välfärdsstatus bedömdes enligt ett protokoll som delvis är baserat på Welfare Quality® protokollet. Resultaten visar att halm har en positiv effekt på välfärden, särskilt med avseende på svansbitning och undersökande beteende. Grisar som fötts upp med halm som berikning hade färre infektioner och högre slaktvikt än de som fötts upp utan berikning. Grisar i de berikade grupperna påvisade fler skador än grisar från icke berikade grupper, detta beror troligen på den generellt ökade aktiviteten i grupperna med halm. SBV gav ingen effekt på välfärden, dock fann man att SBV gav upphov till en strävare päls hos djuren. Inga signifikanta interaktioner upptäcktes. Välfärdseffekten av SBV på slaktgrisar har ännu ej bevisats.

Introduction

The Eurobarometer survey (European Commission, 2006), shows that European citizens are concerned about the welfare of farm animals. However, most consumers still base their purchases on price or other factors rather than animal welfare (Terragni and Torjusen, 2007).

Even though the term 'animal welfare' is widely used, there is no generally agreed definition and agreed measuring method (Barnard, 2007). Animal welfare could be defined as: "The ability of an animal to cope physiologically, behaviourally, cognitively and emotionally with its physiochemical and social life environment" (Sejian *et al*., 2010). Consumers' idea of food quality is not only determined by its overall nature and safety, but also by the animal welfare status from which it was produced (Blokhuis, 2008). Measuring animal welfare includes several factors, so constructing a measuring tool is a complex process (Courboulay *et al*., 2009). Some monitoring systems base the evaluation on the environment of the animals (Bartussek, 1999) (input-based measurement). However, the relation between specific resource measures and an animal's welfare status is not always clearly understood (Blokhuis, 2008). It could be better to evaluate the response of the animals (Capdeville and Veissier, 2001) as opposed to an analysis of the environment. Measuring the response of the animals (output-based parameters) is easier to translate into animal welfare than input-based factors (Blokhuis *et al*., 2010). An example of a welfare measuring tool with this output-based approach is the Welfare Quality® protocol. The main aim of the Welfare Quality® project was to develop a standardised on-farm welfare monitoring system (Welfare Quality®, 2009). The system consists of primarily animal-based welfare measures that address aspects of feeding, health, housing and behaviour (Welfare Quality®, 2009).

Current pig management often does not take the animals' biological needs into account (Baxter *et al*., 2011), which can result in welfare problems. An example of a welfare problem in the pig sector is oral manipulation directed at pen mates. Pigs are highly motivated to show foraging and exploratory behaviours even when plenty of food is available (Wood-Gush and Vestergaard, 1991). It has been shown that barren environments prevent pigs to show motivated exploratory behaviour, which can cause the development of adverse redirected behaviours such as tail biting (Arey, 1993; Morgan *et al*., 1998; Lyons *et al*., 1995; Guy *et al*., 2002). So, the intensive housing systems offer a stimulus-poor environment that imposes restrictions on the development and expression of species-specific behaviour (Wemelsfelder *et al*., 2000). A study by Bolhuis *et al*. (2005) showed that pigs housed in barren conditions

express more manipulative oral behaviours directed at pen mates than pigs housed in a stimulus-rich environment. Another study (Beattie *et al*., 1995) showed that extra straw resulted in less tail-biting, aggression and antisocial behaviour and the pigs showed more play behaviour, indicating enhanced welfare. Straw housing is generally considered to improve the comfort and welfare of pigs (Arey, 1993).

Another approach to improve welfare of finishing pigs may be through genetic selection. Commercially kept finishing pigs are selected on individual production traits, not including their social behaviour and possible effects on group members (Muir, 2005). A side-effect of the current genetic selection method could be an increase in negative social behaviours (Rodenburg *et al*., 2010) and so a decrease in welfare. However, it is difficult to measure behaviour quickly and on a large scale.

Including social genetic effects, i.e. the heritable effects of individuals on their group members, for production traits (e.g. growth) in the selection of pigs could be a way to indirectly select for behaviour. Individuals can influence traits of pen mates, which can be defined as social or associative genetic effects. The social genetic effect an animal has on the growth of its pen mates can be expressed in Social Breeding Value (SBV) (for growth). It has been shown that social genetic effects explain a large part of the genetic variation in growth of finishing pigs (Bergsma *et al.*, 2008). However, the mechanism behind this effect is still unknown. It has been hypothesized that the effect occurs due to a difference in social behaviour between pigs with high or low SBV. Two hypotheses exist; pigs with a high SBV show more positive social behaviour and less negative social behaviour, or pigs with a high SBV show less overall activity. Including a SBV in genetic estimates could result in an increase of average daily gain (ADG) in finishing pigs at group level. De Vries (in Rodenburg *et al*., 2010) and Canario *et al*. (2010) found that SBV had an effect on lesion scores of pigs shortly after mixing and in a steady situation. This suggests that in pigs, SBV might have an effect on aggressive and manipulative behaviours. Studies have shown that manipulative behaviour, due to local infections (Wallgren and Lindahl, 1996), and aggression (Hansen *et al*., 1982) can influence ADG. It could be that pigs with high SBV have a reduced occurrence of manipulative and aggressive behaviours, and so, promoted growth of conspecifics. A selection experiment including effects of SBV could give more insight in the changes that may occur in social behaviour of SBV selected pigs.

So both adding straw bedding to the pen, as this makes highly motivated behaviours possible, and genetic selection that takes into account social genetic effects, could potentially affect welfare of growing-finishing pigs.

Aim

The aim of this study was to gain insight in the effect of selection for SBV on animal welfare and to compare this to the welfare effect of straw. To that aim, the effects of straw and SBV on pig welfare and the interaction between these two components were investigated. This resulted in the following research question:

- What is the difference in welfare between pigs with high and low social breeding values in barren or straw housing?

Hypotheses

- A high SBV has a positive effect on growth at finishing age
- A high SBV will increase welfare of finishing pigs
- Straw supply has a positive welfare effect
- High SBV has a similar welfare effect when compared to straw in finishing pigs

Materials and methods

Animals and housing

The Animal Care and Use Committee of Wageningen University approved the experiment. It was carried out in two successive batches. Offspring from in total 28 multiparous TOPIGS20 sows (F1 based on the TOPIGS Z-line (Large White type) and the N-line (Landrace type)) and Tempo boars were used. Sows with a relatively high vs. low SBV were inseminated with semen from boars with a relatively high vs. low SBV, respectively, to create offspring diverging in SBV. Pigs with a high SBV (on average +2.72 g ADG) were housed in separated pens from pigs with a low SBV (on average -1.50 g ADG) throughout the experiment. A total of 192 crossbred pigs were studied from weaning until slaughter in week 23. Piglets were weaned at 3 weeks of age.

At on average three and a half weeks of age, piglets were weaned and transported to the experimental facilities of Wageningen University, the Netherlands. After weaning, the experiment was set up with a 2x2 arrangement, with SBV (high or low) and housing conditions (barren or enriched) as factors. Per batch, 16 pens (four per treatment combination) contained six pigs each. These six pigs were grouped together until slaughter. Each pen contained three barrows and three gilts. Space allowance was a bit over $1m^2$ per pig. Pens contained a single space dry pellet feeder with ad libitum feed and one drink nipple. The barren pens consisted of 1/3 slatted floor. The enriched deep litter pens had a solid floor with straw and sawdust bedding. The enriched pens received a handful of straw on a daily basis and soiled straw was removed weekly. A light regime of 12:12 was used. All animals got an ear label at weaning and received back numbers with blue marking spray for identification purposes. In the first week after weaning, all pens were equipped with a heath lamp. Environmental temperature was kept at 24°C in the first week after weaning, and at 20°C until slaughter.

Experiment

Measuring animal welfare

For the welfare measurement of the finishing pigs an assessment was done on a weekly basis from weaning until slaughter (the measurements and description in appendix I). In total, three observers conducted this assessment. On forehand, all observers were trained to prevent observer bias. Animal welfare was determined through an assessment based on the Welfare Quality® protocol (Welfare Quality®, 2009). This study is part of the PhD project ‘Seeking

sociable swine conducted at Wageningen University and Research Centre. Due to the experimental setup of this research, adaptations to the welfare assessment tool of Welfare Quality® were made. The assessment consisted of most output based welfare measures from the Welfare Quality® protocol, supplemented with measures from other studies (Biovar and ASG, 2002, Fix *et al*., 2010, Hart, 1988, Scott *et al*., 2009), see Table 1. Also the number and type of received treatments against health problems were scored. Besides this, additional lesion scores were taken into account and behavioural observations were used.

Table 1. Indicators and measurements used for the welfare measurement

Indicators	**Welfare Quality®, 2009**	**Scott *et al*., 2009**	**Biovar & ASG, 2002**	**Fix *et al*., 2010 and Hart, 1988**
Feeding	Body condition score	Body condition score		
Housing	Bursitis, absence of manure on body Shivering, panting, huddling			
Health	Lameness, wounds, tail biting, mortality, coughing, sneezing, pumping, twisted snouts, rectal prolapse, scouring, skin condition, ruptures, hernias, castration		Rough hair coat Lameness Diarrhoea	Rough hair coat
Behaviour	Social behaviour Exploratory behaviour			

The welfare measurement was visually determined. The animals remained in their home pen and were not picked up during the assessments. After determining the thermal comfort of animals, by observing the number of animals huddling, shivering or panting, all animals needed to stand up (and were stimulated to do so) to ensure reliable observations of health parameters like lameness. Animals were scored as 1 when a welfare issue was present, and 0 when nothing was wrong. During the welfare measurement, tail condition was scored, according to the protocol from Zonderland *et al*. (2009) (see Table 2). Tail damage and blood freshness were scored per individual on a scale from 1 to 4.

Table 2. Tail damage scores and blood freshness scores with definitions

Class	Damage	Definition	Class	Freshness	Definition
1	No	No tail damage visible	1	No	No blood visible
2	Hair removed	The tail lacks its hair partially or completely	2	Dried	Old dried black blood in the form of a scab
3	Bite marks	Small bite marks are visible	3	Sticky	Sticky dark red blood, mainly a half day to day old
4	Wound	Clearly visible wound	4	Fresh	Fresh bleeding wound

Home pen observations of behaviour

During this study, live behavioural observations were conducted to establish whether the animals showed social and exploratory behaviours, using instantaneous scan sampling with a two-minute interval. This way, frequency of behaviours was recorded. These home pen observations were part of the welfare measurement. The observed behaviours with accompanying codes are shown in appendix II. All pigs of each batch were observed two times at steady stages in their life (assumed that the six pigs in each pen formed a stable hierarchy and no changes in housing or group composition occurred) as evaluating the welfare of pigs is more reliable when social stability in the groups is achieved, compared to when the hierarchy is being set up (Courboulay *et al*., 2009). Observations were done at 8 and 21 weeks of age, five days a week. In total, eight observers conducted the home pen observations. Observers were trained to minimise observer bias.

Observations were done during the active period of the pigs, from 8.00 until 17.30h. Because pigs are less active at midday, a break from 11.30 until 14.00h was scheduled. Observations were conducted for six hours per day, with a fifteen-minute break between two observations of one hour. This resulted in 180 observations per animal per day. Observations were done with PSION handheld computers with Observer software (Noldus Information Tech. B.V., Wageningen, The Netherlands).

For the analysis of the home pen observations the behaviours were categorised, adapted from Temple *et al*. (2011). Table 3 shows the behaviours included in each category.

Table 3. Behavioural categories and behaviours included

Behavioural category	Behaviours
Exploration	Nose, nose object, root, root object, chew, chew object, chew toy, substrate play
Active	Eat, drink, locomotion, defecate/urinate, comfort behaviour, individual play
Passive	Sleep, lie, sit, stand
Social positive	Nose body, nose contact, gambolling
Social negative	Tail bite, fight, fight at feeder, mount, bite, ear bite, belly nose, manipulate, head knock

To get an estimate of time spent (or percentage of observations) on a certain behavioural category, all behaviours in the category were summed and divided by the total number of observations of that individual.

Lesion scores

Besides the wounds on the body, which were checked during the welfare measurement, lesions were counted as a measurement of aggression. This was done according to the method of Turner *et al*. (2006), where number and location of fresh lesions were recorded. The location of each lesion was noted according to whether they occurred on the anterior third (head, neck, shoulders and front legs), central third (flanks and back) or caudal third (rump, hind legs and tail) of the body. The number of lesions may indicate the amount of aggressive interactions an individual has had. Lesions were measured six weeks after weaning (at week 10 of age), and six weeks after regrouping (at week 17 of age). For analysis, a total lesion score was the sum of lesions of the three areas.

Statistical analysis

Results were analysed with SAS 9.2 (SAS Inst. Inc., Cary, North Carolina, USA). Residuals were checked for a normal distribution before analysis and variables with skewed distributions were square root transformed before analysis. For the welfare measurement and tail bite scores, mean scores per pig for all observations were used for analysis. Normally distributed data were analysed with a mixed model, with batch, sex, sow, coping, housing and SBV as fixed effects. Also sex*SBV and SBV*housing were tested. Pen nested within SBV,

housing and batch was included as a random effect. The experimental unit for analysis of SBV and housing effects was pen (N=32). When transformation did not result in a normal distribution of residuals, effects were analysed with a generalised linear mixed model (glimmix) with a normal distribution. The fixed and random effects were the same as the mixed model. Besides this, correlations between body condition score (BCS) and rough hair coat were tested with Spearman rank correlations test for variables with skewed distributions, to check for a possible association. Correlations between tail blood score and tail damage score was tested with Pearson correlations for normally distributed data. Data are presented as means ± SD.

The mixed model used for the home pen observations contained fixed effects for SBV, coping, batch, housing and sex, age at observations, and pen (nested within SBV, housing and batch) and pig (nested within pen, sex, SBV, housing, batch) as random effects. For the analysis of the lesion scores, a mixed model was used with batch, sex, housing and SBV as class variables. Random effects were pen (nested within SBV, housing and batch) and batch.

Results

Welfare measurement

Welfare was scored according to the form in appendix I. Pigs received a score of 1 or 0, resulting in the mean overall scores shown in Figure 1. Barren housed pigs had a rough hair coat more often than pigs in enriched pens ($P<0.05$, Fig.1). Besides this, pigs in barren housing received treatments significantly more often, mainly for tail biting, than pigs in enriched pens ($P<0.001$). Barren housed pigs were treated for tail biting a total of 217 times in 19 weeks, and pigs in enriched pens were treated for tail biting 26 times in total. However, pigs on straw received 19 treatments for other problems, whilst barren housed pigs received 8 treatments.

Barren housed pigs had a significantly higher score for manure on body than pigs housed in enriched pens (P<0.001), which may be an indicator for discomfort around resting. Pigs in barren housing showed more huddling than pigs in enriched pens (P=0.0004, Fig.1). Barren housed pigs tended to show more shivering than pigs in enriched housing (P=0.085, Fig.1) and also tended to show more local infections (P=0.083, Fig.1). Housing did not affect BCS, lesions, ruptures, respiratory diseases, diarrhoea occurrence and lameness.

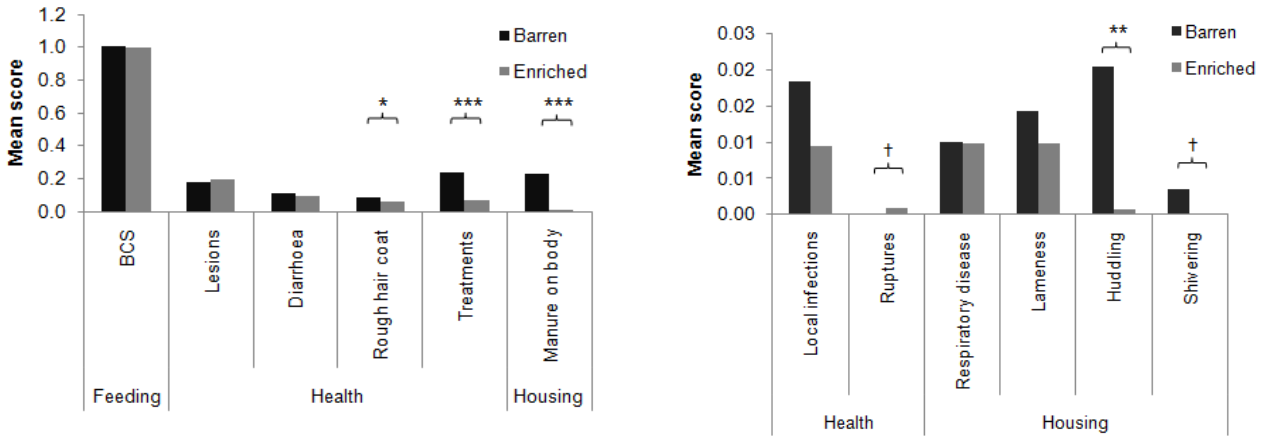

Figure 1. Mean score of welfare aspects measured per housing condition. Pigs either received a score of 1 when a welfare problem was present or 0 when it did not occur. For BSC (body condition score), a mean score is on a scale from 0 to 2. 0=obese, 1=good, 2=lean. † P<0.10; *P<0.05; **P<0.01; ***P<0.001(N=32)

Pigs with a low SBV had respiratory diseases more often than pigs with high SBV (P<0.05) (25 pigs versus 12 pigs respectively, Fig.2). Pigs with a low SBV had a higher fraction of rough hair coat than pigs with a high SBV (P<0.05, Fig.2). BCS was normal for both treatment groups. SBV had no significant effect on BCS, lesions ruptures, local infections, diarrhoea, number of treatments, manure on body, lameness, huddling and shivering.

No interactions between SBV and housing were found for the welfare measurement. Also, no correlation was found between thermal comfort (shivering) and BCS. Ten animals were lost to follow-up due to diverse causes, e.g. lameness, pneumonia, heart or lung disease. This can also be seen as an aspect of welfare according to the Welfare Quality® protocol.

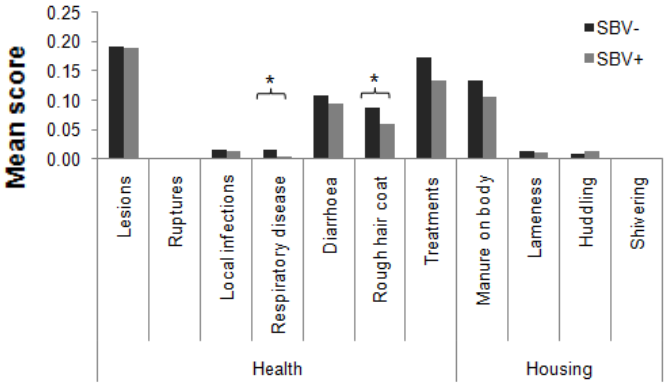

Figure 2. Mean score of pigs for the welfare aspects measured per SBV category. Pigs either received a score of 1 when a welfare problem was present or 0 when it did not occur.*P<0.05 (N=32)

Tail bite scores

Both tail damage and tail blood scores were significantly higher in pigs housed in barren pens than pigs housed in enriched pens (P<0.001, Fig.3). Besides this, a strong positive correlation (R^2=0.90) existed between tail damage score and tail blood score (P<0.0001, Fig.3). SBV did not significantly affect tail damage and tail blood scores (Fig.3). Also, no interaction or other effects were found on these scores.

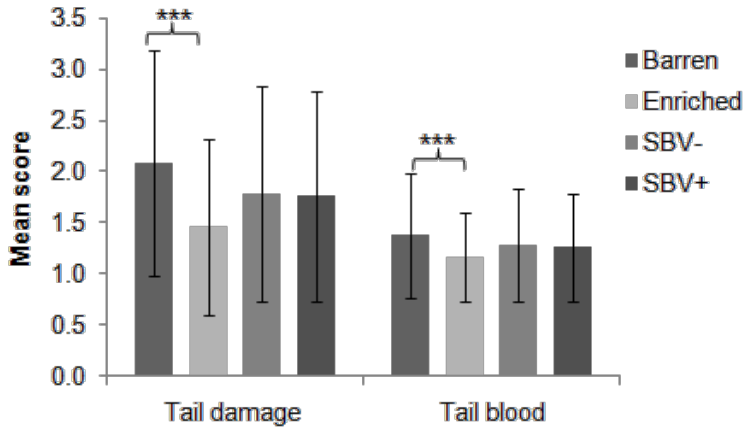

Figure 3. Mean tail damage (with SD) and mean tail blood score due to tail biting per housing condition (barren versus enriched) and per SBV category (low vs. high). Tail damage scores range from 1 until 4; 1=no damage, 2=hair removed, 3=bite mark and 4=wound. Tail blood scores range from 1 until 4; 1=no blood, 2=dried blood, 3=sticky blood and 4=fresh blood. *** P<0.001 (N=32)

Home pen observations

Figure 4 illustrates the effect of housing conditions on behaviours shown by the pigs. Pigs in barren housing showed more passive behaviours than pigs in enriched housing (P<0.05), more negative social behaviours (P<0.001) (tail biting) and less exploratory behaviours (P<0.001). No significant effect was found of SBV on any of the behavioural categories.

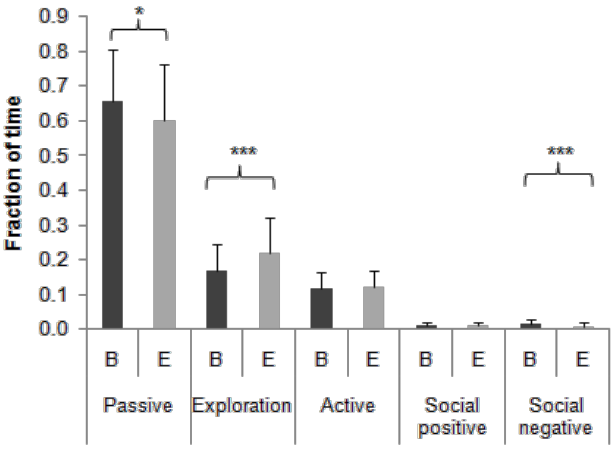

Figure 4. Mean fraction of observations spent per behavioural category divided per housing condition. B= barren housed and E= enriched with straw. *P<0.05; ***P<0.001 (N=32)

Sex had a significant effect on the amount of exploration showed by the pigs (P<0.01). Gilts showed more exploratory behaviour than barrows (20.6% of the time versus 18.2% of the time respectively). Gilts also showed 1.1% more active behaviours than barrows (P<0.01).

Lesion scores

Pigs in straw enriched pens had significantly more lesions than pigs in barren housing in both weeks (wk10: P<0.0001 and wk17: P<0.001, Fig.5). No significant effect was found of SBV or its interaction with housing on the occurrence of lesions (Table 4).

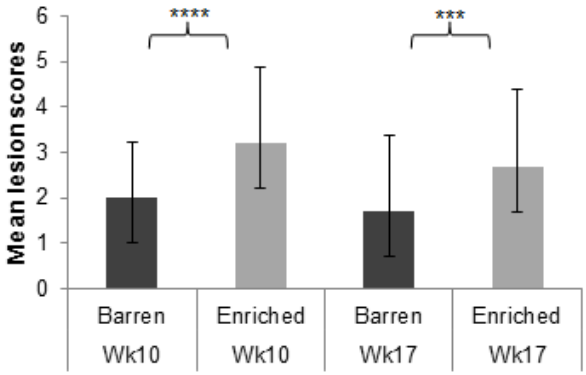

Figure 5. Mean lesion scores per housing type (enriched with straw or barren) during steady stages in the pigs' life. ***P<0.001; ****P<0.0001(N=32)

Table 4. Mean lesions per SBV category at two measuring moments (week 10 and week 17 of age) at the steady stages of the pigs' lives (N=32)

	W10	**W17**
SBV+	2.63±1.66	2.41±1.56
SBV-	2.58±1.49	1.99±1.90

Discussion

The aim of this study was to gain insight in the welfare effect of selection for SBV and to compare this to the welfare effect of straw. Welfare was measured with a welfare assessment protocol supplemented with additional tail bite scores, home pen observations and lesion scores.

Results from the current study show that straw could have a positive welfare effect on growing-finishing pigs, due to the positive effect on behaviour. Pigs in enriched pens showed more activity, more exploratory behaviour and less time on oral manipulation, like tail biting, than pigs in barren pens. This is in line with other studies (Bolhuis *et al*., 2006; Beattie *et al*., 1996). Bolhuis *et al*. (2006) mentioned that in barren pens, the performance of explorative activities cannot be performed, leading to frustration. These exploratory behaviours are considered important elements in the behavioural repertoire of pigs (Fraser and Broom, 1997; Wood-Gush and Vestergaard, 1989) and so, behavioural needs are not completely met in barren housing conditions.

Straw provision had a large welfare impact when looking at tail biting occurrence. A significant effect was found of housing on tail damage score and tail blood score due to tail biting. This is in line with the findings of Hunter *et al*. (2001). Researchers agree that the occurrence of tail biting indicates that pigs in a pen are experiencing reduced welfare (Schrøder-Petersen and Simonsen, 2001; Widowski, 2002). This could lead to the conclusion that barren housing results in reduced welfare. However, tail biting does not only occur in barren housing. The pigs in enriched pens showed tail damage and blood as well. Other studies mention that tail biting is even recorded in outdoor herds (Walker and Bilkei, 2006) and with pigs kept in organic conditions (Hansson *et al*., 2000). In this study, piglets were housed in a barren pen before weaning where they already performed tail biting and the

results may be affected by this. In addition, early weaning can cause tail biting (as redirected suckling behaviour) (Schrøder-Petersen and Simonsen, 2001).

Straw also increases comfort for growing-finishing pigs. Barren housed pigs had more often a rough hair coat than pigs in enriched pens. In a study by Wilson (1977) a similar result was found. In the current study, it was found that there was a positive correlation between the occurrence of a rough hair coat and lean animals as compared to pigs with a normal or heavier body weight (personal communication). Besides a rough hair coat, pigs in barren pens showed more shivering in the week after weaning and received more treatments. These observations all relate to each other since low body weight, a rough hair coat and shivering all indicate that the animal is experiencing illness, stress or thermal discomfort. After weaning the piglets face a stressful situation. Furthermore, the nursery pens had a slightly lower environmental temperature then the farrowing pens, but were provided with a heat lamp. It might be that the enriched pens, as compared to the barren pens, reduced the impact of this stressful moment by having straw as distraction material and straw offering more comfort by warmer bedding material.

Lying comfort, which is measured by the number of pigs with manure on their body (Welfare Quality®, 2009), is improved with the addition of straw. Size of the pens was above legal requirements and the temperature was within a pig's comfort zone. However, the lying area of $1m^2$ per pig requires the animals to lay down in the defecating area (at 100kg body weight). Because barren pens stay wet longer than straw enriched pens it is easier for manure to stick to the body.

Barren housed pigs tended to show more infections than enriched pigs (1.78% of observations versus 0.92% of the observations respectively). Other authors contradict this finding. The use of straw has been identified as a risk factor for infections with Y. enterocolitica and Oesophagostomum (Skjerve and Lium, 1998; Roepstorff and Jorsal, 1990). The fact that enriched housed pigs showed a higher growth between 5 and 10 weeks of life does not point to a higher infection incidence due to straw, because infections are known to reduce ADG (Regula *et al.*, 2000). Hayne *et al.* (2000) found a higher growth in pigs housed with straw bedding as well. In piglets, more infections in barren pens could be due to stress inflicted by the low stimulus environment or by decreased gut health (Oostindjer *et al*., 2010) and thus an enhanced risk of intestinal inflammation and diarrhoea (Soderholm and Perdue,

2001;Moeser *et al*., 2007). With piglets in the enriched pens, straw could have stimulated gut health (Oostindjer *et al*., 2010).

Even though welfare increases greatly with the addition of substrate to the pen, it could also cause a decrease in some welfare aspects. Pigs in enriched pens had more superficial body lesions than pigs in barren housing, which is in accordance with the results from Munsterhjelm *et al*. (2009). They found more lesions as a possible consequence of scratches caused by the substrate or due to overall raised activity of the enriched pigs compared to the barren housed pigs (Munsterhjelm *et al*., 2009). Raised activity can result in more exploration but also in more aggression, which is reflected in the number of lesions. Expressing natural behaviour is seen as an important part of biological fitness (Hamilton, 1964a; Hamilton, 1964b) and welfare (Baxter *et al.*, 2011). Therefore, the small increase of superficial skin lesions in the enriched pens does not weigh up to the welfare increase due to straw bedding.

Even though it was hypothesized that SBV would have an effect on social behaviour and so, on welfare, no effect was found in the current study. Also, no proof was found for an effect of SBV on tail bite incidence or the number of skin lesions. In Japanese quail SBV seemed to influence the aggressive behaviour of the animals (Muir, 2005). In laying hens, selection lines showed a reduction in feather pecking behaviour (Ellen *et al*, 2007) which in pigs might be comparable to the motivation to perform oral manipulation. Canario *et al*. (2010) and De Vries (in Rodenburg *et al*., 2010) found effects of SBV on the number of skin lesions in fattening pigs, suggesting a difference in aggression. The hypotheses around SBV made in these earlier studies were integrated in the present study. That no differences in SBV are found at this moment could be due to the number of animals used. Only two batches were used in the analysis till now, whilst the significant effects on social behaviour are calculated for five batches of 96 pigs each. Positive results towards SBV may be expected when data on all pigs have been gathered. It could also be the case that the difference between high and low SBV was not large enough to show a significant difference, even though a significant effect on respiratory diseases was found.

Social behaviour can influence growth in several ways. By oral manipulation or aggression pigs can cause wounds to their pen mates. Via these wounds infections can arise, leading to illness and reduced feed intake. This will result in reduced growth (Regula *et al*., 2000). Social behaviour can also influence growth by the hierarchical structure of group housed

pigs. When only one feeding space is present, competition for feed or time at feeder may occur. In this study animals were immediately treated for their wounds and animals were removed from the experiment when tail bite wounds lead to a shortened tail. Pens contained a single space feeder but pigs were fed unrestricted.

It could be possible that high SBV results in low levels of anxiety, instead of a difference in behaviour, as seen in hens (Bolhuis *et al.*, 2009). Pigs with low SBV could be more anxious and so, more stressed. This could be proven by measuring corticosteroids in the blood, which is known as a stress parameter. Stress can reduce immune response and so, increase number of infections and reduce ADG. Anxiety levels were not established during this study.

Overall welfare

Straw as a substrate results in many welfare improvements (exploratory behaviour, less tail biting), but Beattie *et al*. (1998) mention that peat, mushroom compost and sawdust as substrate are preferred by pigs over straw. This could increase their welfare even more.

Little effect has been found of SBV on finishing pig welfare. Although, using breeding techniques to improve welfare has been discussed before and could improve animal welfare on a large scale. Genetic selection should be seen as an opportunity to equip the animal with better abilities to cope with the human-made environment (Kanis *et al*., 2004). Selection for increased welfare will result in robust pigs with better social skills and an improved immune system (Kanis *et al*., 2004). Selection including SBV in pigs is only possible since recently. This research is the first testing for effects of this new selection method. Calculated estimates for SBVs may change with the availability of new offspring data. Therefore, differences between the high and low group may be small or even undetectable in this first generation selection experiment. To gain sufficient statistical power a sample size of 480 pigs is used. However, the results described here are based on 192 animals. The fact that no significant differences between the high and low SBV group were found in this assessment does not exclude the possibility of welfare related differences due to SBV.

Conclusion

The research question was: What is the difference in welfare between pigs with high and low social breeding values in barren or straw housing? It can be concluded that straw enrichment causes a welfare increase for finishing pigs, as it improves behaviour (exploration increase, tail bite decrease), growth and health. No welfare effect is found from SBV. Yet, more research should be done to be sure of the possible welfare effect of SBV.

Animal welfare implications

The outcome of this study might be applicable in future farming practices as knowledge on SBV could improve welfare of production animals in the long term. Straw bedding has been shown to be a great welfare improvement, and methods of easy appliance should be formed, so that more farmers add straw to the pens. SBV should be studied more, before application in practise can be realised.

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I. Measures to assess welfare

CODE	Vitality aspect	Measurement	Protocol
1A	Thermal comfort	Lying widely and scattered	Pig lies down on a side with all legs stretched and not in contact with other pigs
1B		Huddling	Pig lies down with >50%* of its body on top of another pig (not side by side)
1C		Panting	Breathing rapidly in short gasps, breathing through the mouth
1D		Shivering	Pig is vibrating its body
2A	Absence of prolonged hunger	Body Condition Score	Score 0 – 2** 0= Obese (1= Good) 2= Lean Visually scored, score 1 is not necessary to record
3A	Comfort around resting	Manure on body	Manure covers ≥30%* of animal's body
3B		Bursitis	A sac that contains fluid (pressure injury). ≥1bursa are present
4A	Locomotion comfort	Lameness	Pig limps with ≥1 or more legs
5A	Absence of wounds	Lesions	Pig has >1 severe lesions (open lesion, not just a scratch) or a large number of lesions (≥10) on: - ears - front - middle - hind - legs - tail
5B		Ruptures	Lump under the skin due to protrusion of bodily structure or organ - umbilical - scrotum
5C		Local infections	- swellings - abscesses
6A	Absence of disease	Respiratory tract	- Coughing - Sneezing - Pumping
6B		Diarrhea	Liquid manure present around anus or it is observed that pig defecates liquid manure
6C		Rough hair coat	Hair coat of the pig is thicker and longer (compared to littermates)
6D		Bad skin condition	≥10%* of skin has abnormal color or texture
7A	Notes logbook	Disease	Disease of a pig mentioned in the logbook (e.g. pneumonia)
7B		Treatment	Treatment of a pig mentioned in the logbook (e.g. antibiotics)
7C		Other notes	…
8	None	None	Vitality of the pig is okay

II. Ethogram for behavioral observations in homepen

Behaviour	Recipient	Description
INACTIVE		
Sleeping		Lying without performing any other described behaviour, eyes closed.
Lying inactive		Lying without performing any other described behaviour, eyes opened.
ACTIVE		
Standing		Standing without performing any other described behaviour
Locomotion		Walking or running without performing any other described behaviour
Sitting		Sitting or kneeling without performing any other described behaviour
Comfort behaviour		Rubbing body against objects or pen mate, scratching body with hind leg or stretching (part of) body.
Urinate/defecate		Piglets urinates or defecates
Feeding		
Eating feeder		Eating at feeder
Drinking		Drinking from drinking nipple
Pen directed		
Nosing floor		Sniffing, touching or scraping floor
Nosing object		Nosing above floor level (e.g. walls)
Rooting		Rooting pen floor or in straw
Rooting object		Rooting above floor level (e.g. walls) or object
Chewing		Non-feed chewing (e.g. air, dung) or chewing straw
Chewing object		Chewing object or part of pen above floor level
Chewing toy		Chewing toy (chain with bal or jute bag)
SOCIAL		
Aggressive		
Fighting	# pig	Ramming or pushing a pen mate with or without biting the pen mate. Can be either mutual or individual.
Head knock	# pig	Head knock given at place other than feeder
Bite	# pig	Bite given at other place than feeder
Fighting at feeder	# pig	Push, head knock or bite given at feeder
Social		
Play behaviour		Group wise gamboling, pivoting: running around the pen, sometimes with gently nudging of pen mates
Play individually		Pivoting or gamboling without other pen mates
Substrate play		Playing with substrate like straw
Nosing head or	# pig	Touching/sniffing any part of a pen mate except nose
body	# pig	Mutual nose contact
Nose contact	# pig	Standing on hind legs while having front legs on other pig's
Mounting		body
Manipulative		
Belly nosing	# pig	Rubbing belly of a pen mate with up and down snout movements
Tail biting	# pig	Nibbling, sucking or chewing the tail of a pen mate
Ear biting	# pig	Nibbling, sucking or chewing the ear of a pen mate
Manipulating other	# pig	Nibbling, sucking or chewing part of the body of a pen mate

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Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Animal Environment and Health
P.O.B. 234
SE-532 23 Skara, Sweden
Phone: +46 (0)511 67000
E-mail: hmh@slu.se
Homepage:
www.slu.se/animalenvironmenthealth