WELFARE STATUS OF COMMERCIAL SOWS IN THREE HOUSING SYSTEMS IN SPAIN

ESTATUS DE BIENESTAR EN CERDAS COMERCIALES EN TRES SISTEMAS DE ALOJAMIENTO EN ESPAÑA

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ADDITIONAL KEYWORDS


SUMMARY

Animal welfare is difficult to measure but a combination physiological, productive and behavioural parameters can provide a good indication of stress levels. The welfare of ninety-six dry empty sows was analysed under three different housing systems: an outdoor paddock, tied in an indoor partial stall and an indoor group pen. Cortisol, creatine kinase and glucose were significantly lower in the blood samples of sows housed in paddocks, suggesting improved welfare but haptoglobin and pigMAP (major acute phase indicators) were significantly higher in paddocks, suggesting sub-clinical health problems. The polymorphic lymphocyte ratio was significantly lower in group pens, indicating improved welfare there. Sows performed more stereotypes in individual stalls, followed by group pens and paddocks. All productive variables were similar among groups except for age at first insemination and repeat inseminations that were significantly higher in paddocks. Sows in paddocks also had a lower ratio of weaned vs. live births indicating greater piglet mortality during the milking period, probably due to an increased risk of crushing outdoors. The physiological data was difficult to interpret on its own and sow welfare was better evaluated by combining physiological, behavioural and productive performance data.

RESUMEN

El bienestar animal es difícil de medir, si bien una combinación de criterios fisiológicos, productivos y etológicos puede dar una buena medida de la situación del nivel de estrés de los animales. Se evaluó el estatus de bienestar de 96 cerdas secas en tres sistemas de alojamiento: camping, jaula individual y grupos en corrales indoor. Los niveles de cortisol, creatinine kinase (CK) y glucosa fueron significativamente más bajos en las cerdas alojadas en camping, sugiriendo un mejor nivel de bienestar. Sin embargo Haptoglobina o Pig MAP (indicadores de fase aguda) fueron significativamente más elevados en camping, sugiriendo la presencia de problemas subclínicos de enfermedad. El ratio polimorfo: linfocito fue significativamente más bajo en grupos a corral indoor. Las cerdas desarrollaron una mayor frecuencia de estereotipias en jaulas individuales, seguidas de los grupos indoor y por el camping. Todos los parámetros productivos fue-
ron similares entre tratamientos, excepto para la edad a la primera inseminación y el número de inseminaciones repetidas, que fueron significativamente más elevadas en el camping. Las cerdas en camping tuvieron también un peor ratio de lechones destetados por lechones nacidos, indicando una mayor mortalidad de la camada durante la fase de amamantamiento, probablemente debido a un mayor número de lechones aplastados por la madre. Los datos fisiológicos fueron difíciles de interpretar por sí mismos y el bienestar de las cerdas fue mejor evaluado por una combinación de criterios de tipo fisiológico, comportamental y de performance productivo.

INTRODUCTION

Animal welfare is one of the most important contemporary issues in animal science but its complex nature makes it difficult to measure objectively with simple techniques. It is often difficult to separately interpret standard physiological, productive and behavioural indicators of stress and they may even provide contradictory results (Barnett and Hemsworth, 1990; Rushen, 1991; Mendl, 1991). As stated by Fraser and Broom (1997), the best approach may be a combination of indicators.

Animal welfare is a relatively new concept that is slowly being introduced into modern livestock management and is especially relevant in intensive production systems. In general, housing and stockmanship are major determinants of animal wellbeing (Rushen and De Pasille, 1992), but it is often difficult for the animal breeder to relate welfare to the rest of the elements in the production system. Although its social importance is beginning to condition the whole meat production process (Maria et al., 1999), it is unclear how improving animal welfare affects the efficiency of the production. More studies are needed on the usefulness of parameters most often associated with animal welfare and their relation with the variables that are traditionally used in animal production, especially in a commercial setting (Broom, 2000). In addition, these criteria must be validated under local conditions to prevent premature claims about welfare based on poorly understood measures. It is relatively straightforward to measure physiological parameters but it is more difficult to determine a reasonable cut-off point above (or below) which the animal’s welfare is at risk.

Modern installations have apparently minimised stressful conditions and decreased aggressive interactions (Barnett et al., 1987) but the productive cost is not yet fully apparent. New installations based on investigations performed under certain production conditions (e.g. northern Europe) should be tested before their adoption under different systems (e.g. Spain).

The aim of this study was to evaluate the welfare status of commercial sows in three housing systems in Spain using combined physiological, productive and behavioural parameters.

MATERIALS AND METHODS

Ninety-six dry, empty sows of the same line (Large white x Landrace) were studied in three different commercial housing systems in the same private company in northeastern Spain.
ANIMAL WELFARE IN COMMERCIAL SOWS

1. Paddock-outdoors in a paddock (400 m² per sow) with free access to an undercover concrete area, pigs were floor-fed under cover (n= 33 animals).

2. Individual stalls-indoor concrete floor partial stalls (1.80 x 0.65 m) with neck tethers individual feed troughs and a 0.5 m slatted dunging area (n= 31).

3. Group pen-indoor concrete floor pens (2.5 square meters per sow) individual feed troughs and a 0.5 m slatted dunging area (4 groups of 8 animals n= 32).

The feeding regime was the same for all three systems and consisted in a commercial sow diet using feed made in the same company. Indoor sows received natural daylight and artificial lighting was used from 06.00 h and turned off at 22.00 h. Indoors, the floor was anti-slip concrete. Paddocks had a dirt floor with concrete in the feeding zone and a shadowed area for resting and water for bathing. The total space allowance per sow was 400 square meters (25 sows per Ha.). The soil was quite stony and sows often chewed on stones about 4 cm in diameter, especially before feeding.

The animals were in these different housing conditions for their whole productive life. The animals we analysed were adults with two or more farrows. The study took place in summer (June-July), June and July (summer, minimum temperature 20°C, maximum temperature 37°C).

We obtained a history of the productive career of each sow from the company database. With these information we calculate for each housing system the number of live births per sow per year, the number of weaned piglets per sow per year, the age at first insemination, the percentage of repeat inseminations and a global cycle index.

The last week of June and the first week of July the sows were blood sampled to evaluate the basal physiological levels of cortisol, creatine kinase (CK), haptoglobin, PigMAP, polymorphic lymphocyte ratio and glucose and in each housing systems. Haptoglobin and PigMAP are major acute phase proteins that also indicate stress levels. For details on analysis see González-Ramón et al. (1995).

Cortisol was analysed by RIA (Immunochem™ Coated Tubes Cortisol 125I RIA kit from ICN Biomedical Inc.). CK and glucose were analysed by a multianalyser Technicom RA-500. Polymorphic lymphocyte ratio was taken by counting blood smears dyed fast-panoptic.

The last week of June and the first week of July, the sows were observed daily for approximately two hours after feeding in the morning, and two hours after feeding in the afternoon. The frequency of stereotypes in each group were recorded for one minute every five minutes following the methodology described in Cronen and Wiepkema (1984) and Dailey and McGlone (1997). The stereotyped actions observed were chewing/biting; sucking; mouth stretching; palate grinding; tongue flicking; licking; nibbling; nosing, rooting; pressing and pause. For a complete description of these actions see Cronin and Wiepkema (1984). Videotapes were analysed using the Etologo® software (Escós and María, 1998).

We established cut-off points or threshold (Mendl, 1991) according to

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values in the literature, European recommendations and field observations. For the physiological parameters, the cut-off points were 20 ng/ml for cortisol, 1000 IU for CK, 3 mmol for glucose, 1057 mg/ml for haptoglobin, 0.43 mg/ml for PigMAP, 1.38 for the polymorphic lymphocyte ratio and 1 for the mean stereotype frequency (log transformed). For the productive traits, the cut-off points were established based on the Scientific Veterinary Committee Report (September 1997): 22 live births per sow per year, 20 weaned piglets per sow and per year, 210 days old at first insemination and 8.5 percent repeat inseminations. The cut-off for the global cycle index was 1.98, based on the farm average.

We estimated the fixed effect of the housing system on the studied variables, applying a least square analysis model using the GLM procedure from SAS (SAS, 1990). We also calculated the phenotypic correlation matrix between physiological and productive variables.

RESULTS AND DISCUSSION

The basal levels of cortisol were within the ranges observed in the literature (Rampacek et al., 1984) but CK was higher than normal (see Table I for physiological data). Glucose levels were significantly lower in paddocks and there was no significant difference between individual stalls and group pens. Cortisol was significantly lower in paddock than in group pen, but similar than the values observed for individual stalls, in agreement with Barnet et al. (1985) who study the relationship between levels of cortisol and group size. The CK and glucose were all significantly lower in paddocks. These three parameters are the most commonly used to assess

Table I. Physiological parameters associated with the welfare of ninety-six adult dry sows housed in three different housing systems in Spain. (Medias mínimo cuadráticas ± s.e. para los parámetros fisiológicos y etológicos asociados al bienestar en tres sistemas de alojamiento).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Paddock (n=33)</th>
<th>Individual Stall (n=31)</th>
<th>Group Pen (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortisol ng/ml</td>
<td>23.12 ± 2.5a</td>
<td>20.21 ± 2.4a</td>
<td>33.14 ± 2.3b</td>
</tr>
<tr>
<td>CK (UI)</td>
<td>2115 ± 615a</td>
<td>3137 ± 594b</td>
<td>3286 ± 605b</td>
</tr>
<tr>
<td>Haptoglobin mg/ml</td>
<td>1.99 ± 0.09a</td>
<td>1.67 ± 0.08b</td>
<td>1.59 ± 0.07b</td>
</tr>
<tr>
<td>PigMAP mg/ml</td>
<td>1.7 ± 0.17a</td>
<td>1.29 ± 0.16b</td>
<td>1.31 ± 0.16b</td>
</tr>
<tr>
<td>PL ratio</td>
<td>1.64 ± 0.14a</td>
<td>1.54 ± 0.13b</td>
<td>1.18 ± 0.14a</td>
</tr>
<tr>
<td>Glucose (mmol)</td>
<td>3.4 ± 0.02a</td>
<td>5.20 ± 0.03b</td>
<td>4.7 ± 0.03b</td>
</tr>
<tr>
<td>Mean # stereotypes</td>
<td>1.42 ± 0.13a</td>
<td>1.98 ± 0.10b</td>
<td>1.60 ± 0.11b</td>
</tr>
</tbody>
</table>

*different letters in each row indicate significant differences (p ≤ 0.01).
Figure 1. Welfare status according to physiological criteria of ninety-six adult dry sows housed in three different production systems expressed as a percentage of their relative cut-off values. (Estatus de bienestar animal en cerdas alojadas en tres sistemas de producción según los indicadores fisiológicos y etológicos de bienestar animal, expresados en porcentaje respecto de los umbrales relativos de referencia establecidos para cada parámetro. Valores superiores al umbral (cut-off) indican situación de riesgo para el bienestar).

welfare in domestic animals and here they suggest that sows in paddocks are better off than the indoor groups. However, within indoor-housed animals, individual pens seem to have better physiological indicators than group pens.

Haptoglobin and PigMAP are indicators of the major acute phase, rather than stress itself (González-Ramón et al., 1995). As opposed to the above parameters, they were significantly higher in paddocks, possibly indicating sub-clinical health or welfare problems as a result of the immunosuppressive effect of chronic stress (Rampacek et al., 1984). The high sensibility of these acute phase proteins could be an important limitation for its practical use as chronic...
stress indicators in domestic animals.

The polymorphic lymphocyte ratio, a chronic stress indicator (Lawrence and Rushen, 1993), was significantly lower in group pens. As opposed to the above parameters, this ratio suggests that welfare was better in group pens. There was no significant difference between paddocks and individual stalls.

The mean number of stereotypes, another chronic stress indicator, was higher in individual stalls, followed by group pens and individual stalls (table I). Sows housed indoors in a small space had greater number of abnormal behaviours and were not as able to express substitutive normal behaviours to occupy their time as much as those outdoors in paddocks. Thus, according to the behavioural parameters, welfare was better in paddocks, followed by group pens and individual stalls. These results confirm the difficulties in interpreting data to assess animal welfare (Rushen, 1991). Nevertheless, the reliability and the feasibility of the

<table>
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<tr>
<th>Table II. Productive indicators of ninety-six adult dry sows housed in three different production systems in Spain. (Medias mínimo cuadráticas ± s.e. para los parámetros productivos asociados al bienestar en tres sistemas de alojamiento).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing system</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Live births/sow/year</td>
</tr>
<tr>
<td>Weaned/sow/year</td>
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<tr>
<td>Age 1st insemination (d.)</td>
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<tr>
<td>percentage repeated. Insem.</td>
</tr>
<tr>
<td>Cycle index</td>
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*different letters in each row indicate significant differences (p≤0.01).
#there is a tendency very nearly significant (p≤0.01).

The interpretation of physiological values may be better understood graphically in terms of cut-off values (figure 1, see methods for definitions). With the exception of the P:L ratio, almost all the other parameters indicate that welfare is at risk since they exceeded the established cut-off points. The most extreme were CK, Haptoglobin and PigMAP (more than 100 percent) while cortisol, glucose and stereotypes and P:L ratio were closer to normal values (exceeded less than 50 percent).

All the productive variables indicated an excellent reproductive performance of the sows in all three housing systems, reflected by similar global reproductive indices (table II). The only significant differences were age at first insemination and repeat inseminations, which were higher in paddocks. There were no differences in live or weaned piglets per sow per
year but paddock sows had a lower ratio of weaned vs. live births. This suggests greater piglet mortality during the milking period, probably due to an increased risk of piglet crushing outdoors (see English and Wilkinson, 1982; Wechsler and Hegglin, 1997).

It is important to emphasise here that the Scientific Veterinary Committee of the European Commission (Animal Welfare Section) highlights reproductive performance as a good indicator of the welfare in sows (Scientific Veterinary Committee, 1997). Other ethologists have also mentioned this when referring to aptitude or fitness (evolutionary success of organism) in relation to its reproductive rate (Fraser and Broom, 1997).

We also considered productive traits in terms of the cut-off values described in the methods (see figures 2 and 3). All the parameters indicated a good level of welfare in the three systems, with indoor animals performing even better than outdoors (problems with outdoor group housing are presented at http://www.pighealth.com/housing.htm).

None of the correlation coefficients between the physiological and productive variables were significant, in agreement with Gross and Siegel (1993) and Ladewig et al. (1993), who mention the difficulty of correlating

*Figure 2. Welfare status according to productive criteria of ninety-six adult dry sows housed in three different production systems expressed as a percentage of their relative cut-off values. (Estatus de bienestar animal en cerdas alojadas en tres sistemas de producción según indicadores productivos de bienestar animal, expresados en porcentaje respecto de los umbrales relativos de referencia establecidos para cada parámetro. Valores inferiores al umbral (cut-off) indican situación de riesgo para el bienestar).*
physiological stress indicators with productive and behavioural variables. Our results confirm the problems of interpreting physiological and productive data to evaluate farm animal welfare, as also been pointed out by Rushen (1991), Mason and Mendl (1993) and Barnett and Hemsworth (1990) Physiological analyses of welfare that ignore productive and reproductive performance can lead to erroneous conclusions. A high level of glucocorticoids or a simple measure of growth rate provides little reliable information about stressful conditions (Fraser and Broom, 1997). Behavioural parameters appear to be more reliable and easier to interpret, less invasive and less expensive. Sow welfare should be evaluated by a combination of methods, including physiological, behavioural, sanitary and productive performance. New installations designed to satisfy the social demands for improved animal welfare should be tested under local conditions in order to assure that they really benefit the animal.

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