Comparison of scratching behaviour of growing pigs with sarcoptic mange before and after treatment, employing two distinct approaches

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Abstract

In a closed pig breeding and finishing herd suffering from sarcoptic mange, two selected groups of pigs were filmed during a period of 10 days before and after treatment. The observation always commenced each hour and lasted for 15 min. Before treatment, observations were done round the clock, after treatment from 8:00 to 22:15.

Before treatment the pens were stocked with 11 (pen A) and 10 (pen B) growing pigs (Large White × Landrace sows; 5 months old) with an average weight of ~70 kg examined for sarcoptic mange by skin scrapings and ELISA. The animals had never been treated with an acaricide or endectocide before.

After 10 days, the pigs were treated twice (18 days interval) with Dectomax® 1% solution for pigs (Pfizer, Austria) at a dose of 0.3 mg Doramectin i.m./kg body weight. After treatment, seven pigs were observed in both pens.

Most scratching actions both before (83.1%) and after (94.5%) treatment were of one to 10 s. After treatment, the 10 s-scratching episodes decreased by 67.3% (from 21.2 to 6.9 mean SRE/pig), and the scratching actions of longer than 10 s by 91.7% (from 4.3 to 0.4 mean SRE/pig), such that the latter could be observed only occasionally after treatment.

A distinct increase in scratching activity both before and after treatment could be observed primarily between 10:00 and 15:00. Significant differences of scratching and rubbing activity between before and after treatment could also be seen at midday.

The interpretation of the scratching index values before and after the treatment were carried out according to Cargill et al. [Cargill, C., Davies, P., Carmichael, I., Hooke, F., Moore, M., 1994. Treatment of pigs with doramectin to control sarcoptic mange. Proceedings of the 13th IPVS Congress, Bangkok, Thailand, p. 238] with the maximum and minimal limiting values specified in the literature, and compared with calculations using the method described by Hollanders et al. [Hollanders, W., Harbers, A.H.M., Huige, J.C.M., Monster, P., Rambags, P.G.M., Hendrikx, W.M.L., 1995. Control of Sarcoptes scabiei var. suis "www.elsevier.com/locate/vetpar
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Depending on the methods used and the limiting values set, 6.7–34.6% of the observations before and 2.0–17.3% of the observations after treatment revealed a “strong evidence of mange” or a “suspicion of mange”. All other observations indicated that the pigs were free from mange.

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Keywords: *Sarcoptes scabiei*; Sarcoptic mange; Diagnosis; Scratching index; Pig

1. Introduction

Sarcoptic mange in pig breeding and finishing farms is a major economic problem. The economic losses by mange are caused by the costs of treatment and damage to piggery fixtures through permanent rubbing, reduced feed conversion efficiency, increased return rates and piglet mortalities (Davies, 1995). Horst (2004) estimated that the loss due to reduced feed conversion efficacy and increased piglet mortalities at €66 per mangy sow and year. Kirchner (1998) reported a mortality of 11.5% in piglet as a consequence of frequent unrest (pruritus) in untreated mangy sows, in contrast to 3.7% in treated sows. Damriyasa et al. (2004) examined 11 breeding farms with a total of 2754 sows and estimated the mean economic loss due to *Sarcoptes scabiei* infestation at €4200 per affected farm and year. Based on these economic losses and the animal welfare issues, there is a need to eradicate and prevent sarcoptic mange and to establish mange-free pig farms.

To achieve a mange-free status and certification a reliable management and control program, and sensitive and specific diagnostic methods are required as complementary tools. The enzyme-linked immunosorbent assay (ELISA), skin scraping, clinical score, papular dermatitis score and scratching index are tools with differing specificities and sensitivities (Cargill and Dobson, 1979a,b; Davies et al., 1991, 1992; Hollanders et al., 1992, 1995; Cargill et al., 1994, 1996, 1997; Davies, 1995; Rambags et al., 1998; Smets et al., 1998, 1999; Vesseur et al., 1998; Bokma-Bakker et al., 1999; van der Heijden et al., 2000; Smets and Vercruysse, 2000; Matthes and Wendt, 2003; Vercruysse and Geurden, 2003).

Of these, the scratching index using different limiting values is often used and has been recommended by various authors as an additional method for the diagnosis of sarcoptic mange (Davies et al., 1992; Hollanders et al., 1992, 1995; Pointon et al., 1995; Cargill et al., 1996; Bokma-Bakker et al., 1999; Richter and Barthel, 1999; Matthes and Wendt, 2003).

The aim of the present study was to observe the scratching behaviour of growing pigs suffering from sarcoptic mange in a closed herd before and after treatment, to calculate scratching indices using different methods and to critically evaluate the results obtained employing recommended limiting values.

2. Materials and methods

2.1. Pigs, treatment and trial setup

On a closed pig breeding and finishing farm sarcoptic mange was diagnosed in gilts, sows, piglets and finishing pigs by means of skin scraping and ELISA and the total prevalence in this farm was 38.7% according to the results of skin scrapings and 28.2% according to the ELISA-results (Dolischka, 2001).

Two pens (A and B) in the breeding area (growing pens) were selected randomly and observed using video cameras over a period of 10 days each, both before and after treatment. The position of the video cameras enabled the complete area of the pens to be filmed. Eleven and 10 growing pigs (Large White × Landrace; average body weight of ~70 kg; 5 months of age) were housed in pens A and B, respectively, before treatment. The pigs had not been treated previously with an acaricide or an endectocide. After the first recording (10 days), the pigs in pens A and B were treated two times (at an interval of 18 days) with Dectomax® 1% solution for pigs...
Pfizer, Austria) at a dose of 0.3 mg Doramectin i.m./kg body weight. During the second observation interval, which commenced 14 days after treatment, seven pigs in each pen were observed. The pigs were marked with colour symbols on their back to unequivocally distinguish them in the analysis of the video recordings. Recording was carried out using the Longplay-mode for VHS-cassettes, and the cassettes were exchanged daily at the same times. The observation always commenced each hour for 15 min. Before treatment, the observation was conducted continuously, after treatment, because of a technical defect only from 8:00 to 22:15. In total, the pigs were observed before and after treatment for 3600 and 2250 min, respectively.

The pigs were kept on partially slatted floors, and liquid swill was fed three times a day at 6:00, 11:00 and 15:00.

Before recording and treatment, the mange status of all pigs was verified by skin scrapings and ELISA. Skin scrapings of the same size (≈9 cm²) were taken from the ear canal and the external ear. Skin scrapings were examined using the potassium hydroxide method followed by parasite counting. Blood was collected from the Vena cava cranialis, centrifuged at 2800 g, and the serum stored at −20 °C.

Specific antibody against S. scabiei var. suis was measured using an indirect ELISA (SARCOPTES-ELISA 2001®, AFOSA GmbH, D-14943 Luckenwalde), according to the manufacturer. Negative and positive controls were included on each plate. The absorbance/optical density values were measured at 450 nm and corrected according to the following formula:

\[
\frac{\text{OD serum sample} - \text{OD-negative control serum}}{\text{OD-positive control serum} - \text{OD-negative control serum}}
\]

After treatment, no further testing was carried out in the experimental groups, because neither skin scrapings nor ELISA are meaningful at this time, because of the persistence of serum antibodies against Sarcoptes sp. and dead mites in the skin scrapings.

However, skin scrapings and ELISA were performed for the remaining stock (gilts, sows, piglets and finishers) of this farm over a period of 10 months after treatment, and all showed negative results as of the fifth month, what confirms the success of the treatment procedure (Dolischka, 2001).

2.2. Video recording

For the analysis of the video recordings, the observed scratching and rubbing episodes (SRE) in relation to the time of day and the duration of the SRE were recorded. The SRE were scored according to the time interval of ≤10 and >10 s. Also, the mean number and mean duration of the SRE per pig were calculated before and after treatment.

2.3. Comparison of scratching indices

Calculation and interpretation of the scratching index (SI) were carried out according to following methods:

(i) Cargill et al. (1994): SRE during 15'/number of observed animals (=N).

(ii) Hollanders et al. (1995): \(\log\{[(SRE \text{ during } 3 \times 5') \times 100/3 \times \text{N}] + 5\}\).

To be able to compare results (interpretations) obtained using the two methods, observations were done 3 × 5 min instead of 2 × 5 min.

The SI-values calculated with the formula of Cargill et al. (1994) were interpreted using maximum and minimum limiting values as specified in the literature. These values were >1.5 (Vesseur et al., 1998; Bokma-Bakker et al., 1999; Matthes and Wendt, 2003) and >0.1 (Cargill et al., 1997; Vercruysse and Geurden, 2003), respectively, are considered to provide strong evidence of mange.

The limiting values employed in the method of Hollanders et al. (1995) were >1.1 (strong evidence of mange), 0.81–1.1 (suspicion of mange) and ≤0.8 (no mange) (Bokma-Bakker et al., 1999).

2.4. Statistical analysis

Numbers and durations of scratching episodes recorded in pens A and B were compared by means of the Student’s t-test. Correlation between two parameters (numbers of SRE or durations of SRE/numbers of mites in skin scraping/OD-values of
ELISA) were tested using the Spearman’s rank correlation coefficient.

3. Results

3.1. Parasitological, serological results and video recordings

The mean numbers of SRE during 10 days (8:00–22:15) in pens A and B were 21.8 and 29.6 SRE/pig before treatment (Table 1) and 7.4 and 7.1 SRE/pig after treatment (Table 2). The mean time of SRE during 10 days (8:00–22:15) in pens A and B were 155.2 and 200.5 s/pig, respectively, before treatment and 27.9 and 30.1 s/pig, respectively, after treatment (Table 2). The results of the SRE (numbers and duration) of the individual pigs in pens A and B before and after treatment (10 days) and results of skin scrapings and ELISA before treatment are given in Tables 1 and 2.

The numbers of SRE or the duration of total scratching times did not show any significant correlations to ELISA (OD-values) or to the numbers of mites obtained via skin scrapings.

The highest percentages (82.1–84.9% before and 92.0–98.1% after treatment) were the SRE of \( <10 \) s, which constituted the greatest proportion of the total scratching time. After treatment, the mean number of SRE/pig \( \leq 10 \) s decreased by 67.3%, the SRE \( >10 \) s by

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
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<tbody>
<tr>
<td>Scratching and rubbing episodes and scratching time (s) of individual pigs up to and more than 10 s in pens A and B before treatment from 8:00 to 22:15 h during 10 days</td>
</tr>
<tr>
<td>No. of mites</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Pen A</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>4</td>
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<td>9</td>
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<tr>
<td>10</td>
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<tr>
<td>11</td>
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<tr>
<td>Ø</td>
</tr>
<tr>
<td>Pen B</td>
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<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td>4</td>
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<td>8</td>
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<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>Ø</td>
</tr>
<tr>
<td>Ø pen A + B</td>
</tr>
</tbody>
</table>

Observations always began from the very hour and lasted for 15 min. Results of the skin scrapings (numbers of *Sarcoptes* mites) and ELISA 2001 before treatment (OD-values: positive: >0.24; doubtful: 0.16–0.24; negative: <0.16).
91.7% (8.00–22:15). This is also reflected in the average total scratching time/pig, where the time for SRE of <10 s decreased by 76.5% and for SRE >10 s by 93.0%.

The mean number and duration of the SRE per pig in pens A and B for an observation period of 10 days and significant differences before and after treatment are shown in Figs. 1–4. A distinct increase in scratching activity both before and after treatment was observed between 10:00 and 15:00. A slight increase in scratching activity for both pens before treatment was recorded between 4:00 and 6:00.

3.2. Interpretation of scratching indices

The interpretation of the SI-values before and after treatment are given in Tables 3 and 4 using both methods (Cargill et al., 1994; Hollanders et al., 1995) Depending on the method and limiting values employed, between 6.7 and 34.6% of the observations before and 2.0 and 17.3% of the observations after treatment indicated the interpretation of “strong evidence of mange” or “suspicion of mange”.

4. Discussion

The diagnosis and control of mange in breeding farms is of paramount importance. The SI is one of the methods which has been recommended or used in various investigations employing different approaches for the recording and interpretation of the observations (Lee et al., 1980; Courtney et al., 1983; Fujii et al., 1994; Cargill et al., 1994, 1996, 1997; Hollanders et al., 1995; Rambags et al., 1998; Vesseur et al., 1998;
Regarding the interpretation of the SI-values, different limiting values have been described. Limiting values of $>1.5$ (Vesseur et al., 1998; Bokma-Bakker et al., 1999; Matthes and Wendt, 2003; or $>0.4$ (Vercruysse and Geurden, 2003; Smets et al., 1998, 1999) and $>0.1$ (Cargill et al., 1997) for “strong evidence of mange”, values of $0.5–1.5$ (Bokma-Bakker et al., 1999), $0.4–1.5$ (Matthes and Wendt, 2003) or $0.1–0.4$ (Vercruysse and Geurden, 2003) for “suspicion of mange” and $<0.5$ (Bokma-Bakker et al., 1999), $<0.4$ (Matthes and Wendt, 2003), or $<0.1$ (Vercruysse and Geurden, 2003) for “no evidence of mange” in the herd.

Regarding the methodological approach, e.g., time of observation and age of the animals are contradictory or missing all together. According to Vercruysse and Geurden (2003), the SI should be used only for fattening pigs, but for piglets and sows the SI, with a cut-off of 0.4, is irrelevant. Investigations by Smets and Vercruysse (2000) showed that the
sows achieved most positive results (8 of 11 farms) by means of the SI, and pigs on 6 of these farms were also positive when other methods (skin scraping, ELISA) were used. However, for the groups “light fatteners” and “finishers” they recorded higher SI-values for one farm, but only one and two farms, respectively, were classified as “mange positive” when SI was determined of these groups. However, these farms were also positive when SI was determined for the sows. In contrast, pigs on farms diagnosed as “mange positive” by means of skin scraping and/or ELISA, gave negative results, when the SI was investigated for light fatteners or finishers. However, various studies have demonstrated that piglets often have the lowest (Smets et al., 1998, 1999; Davies et al., 1991; Smets and Vercruysse, 2000) and finishers the highest (Vesseur et al., 1998; Smets et al., 1998, 1999; Davies et al., 1991; Smets and Vercruysse, 2000) SI-values. Based on these findings, the present study examined growing pigs of ~70 kg body weight and 5 months of age.

Table 3
Interpretation of the scratching index using different limiting values during observation time of 10 days before treatment

<table>
<thead>
<tr>
<th>Day</th>
<th>A Pen A (+/−/)</th>
<th>B Pen B (+/−/)</th>
<th>C Pen A (+/−/)</th>
<th>D Pen B (+/−/)</th>
<th>E Pen A (+/−/)</th>
<th>F Pen B (+/−/)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/0/23</td>
<td>0/0/24</td>
<td>3/21</td>
<td>5/19</td>
<td>2/4/18</td>
<td>5/5/14</td>
</tr>
<tr>
<td>2</td>
<td>1/1/22</td>
<td>1/1/22</td>
<td>6/18</td>
<td>3/21</td>
<td>5/1/18</td>
<td>3/2/19</td>
</tr>
<tr>
<td>3</td>
<td>0/1/23</td>
<td>1/0/23</td>
<td>3/21</td>
<td>6/18</td>
<td>3/2/19</td>
<td>6/1/17</td>
</tr>
<tr>
<td>4</td>
<td>0/1/23</td>
<td>0/3/21</td>
<td>7/17</td>
<td>4/20</td>
<td>4/5/15</td>
<td>4/5/15</td>
</tr>
<tr>
<td>5</td>
<td>0/2/22</td>
<td>1/0/23</td>
<td>5/19</td>
<td>6/18</td>
<td>4/4/16</td>
<td>4/3/17</td>
</tr>
<tr>
<td>6</td>
<td>0/2/22</td>
<td>0/3/21</td>
<td>7/17</td>
<td>6/18</td>
<td>4/3/17</td>
<td>5/3/16</td>
</tr>
<tr>
<td>7</td>
<td>0/1/23</td>
<td>1/4/19</td>
<td>6/18</td>
<td>10/14</td>
<td>5/3/16</td>
<td>6/5/13</td>
</tr>
<tr>
<td>8</td>
<td>1/2/21</td>
<td>0/0/24</td>
<td>7/17</td>
<td>7/17</td>
<td>6/2/16</td>
<td>2/6/16</td>
</tr>
<tr>
<td>9</td>
<td>0/1/23</td>
<td>1/2/21</td>
<td>4/20</td>
<td>7/17</td>
<td>2/5/17</td>
<td>4/5/15</td>
</tr>
<tr>
<td>10</td>
<td>0/2/22</td>
<td>0/2/22</td>
<td>4/20</td>
<td>5/19</td>
<td>3/3/18</td>
<td>5/4/15</td>
</tr>
<tr>
<td>Σ (n = 240)</td>
<td>3/13/224</td>
<td>5/15/220</td>
<td>52/188</td>
<td>59/181</td>
<td>38/32/170</td>
<td>44/39/157</td>
</tr>
</tbody>
</table>

There are no previous investigations available for the daily scratching activity of pigs suffering from sarcoptic mange. Only Davis and Moon (1990) examined the behaviour of experimentally infected pigs with \textit{S. scabiei} var. \textit{suis}, where the scratching and rubbing activities were greatest in the evening (15:00–21:00) and at midday (11:00–15:00).

In the present investigation, a distinct increase in the SRE and mean scratching/rubbing time was observed between 10:00 and 15:00, both before and after the treatment, but with significant differences ($p > 0.05$) between before and after treatment (see Figs. 1–4). A further increase in scratching activity for pigs in both pens could be determined between 4:00 and 6:00. However, it was considerably lower than between 10:00 and 15:00. No effect of feeding on the scratching activity could be observed. In contrast to Davis and Moon (1990), we could not observe an increase between 16:00 and 21:00, but only slightly higher scratching activity at 18:00 and 21:00 (pen B) and at 21:00 (pen A).

Cargill et al. (1996) described a negative correlation between the number of mites from ear lesions and the rubbing index (frequency of scratching episodes) caused by a well-developed hypersensitivity and following reduction of the mite population. They reported that the mean rubbing index of pigs with a mite count score of 2 and more was significant lower compared with pigs with a mite-count score of 0 or 1, but without calculating statistical correlation between mite number and mean rubbing index. The negative correlation seems to agree with the results of the present study, but there are single outliers, and a statistical correlation between frequency of SRE or duration of SRE and number of mites was not possible. For two pigs showing the most frequent scratching episodes and the longest total scratching times, only one mite was found in the skin scraping and a negative OD-value in ELISA for pig 3 (pen A), 1030 mites and a positive OD-value were recorded for pig 2 (pen B). In contrast, the pigs displaying the lowest scratching episodes and the shortest total scratching times in both pens (pen A: pig 8, 9; pen B: pig 10) had no mites in skin scrapings and also had low (negative) OD-values. However, there was considerable variation among pigs in mite numbers, OD-values, number of SRE and scratching time. The reason for this variation can be explained by the fact that pigs possibly were infected at different times, whereas Cargill et al. (1996) undertook experimental infection using pigs with a similar immune status.

Before treatment 83% of all SRE (pen A and B) were of $< 10$ s, and 17% of $> 10$ s were recorded for pig 2 (pen B). In contrast, the pigs displaying the lowest scratching episodes and the shortest total scratching times in both pens (pen A: pig 8, 9; pen B: pig 10) had no mites in skin scrapings and also had low (negative) OD-values. However, there was considerable variation among pigs in mite numbers, OD-values, number of SRE and scratching time. The reason for this variation can be explained by the fact that pigs possibly were infected at different times, whereas Cargill et al. (1996) undertook experimental infection using pigs with a similar immune status.

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the SRE of up to 104 s was observed, but most of them were between one and 20 s (average 6.8 s). After treatment, the longest SRE was up to 21 s, with the main part being between one and 8 s (average 3.98 s). Based on similar observations, Rambags et al. (1998) only used an SRE of up to 10 s for the calculation of the SI. Remarkable was also a sharp decline in the SRE after treatment within a short time, which has been described by others previously (Lee et al., 1980; Courtney et al., 1983; Fujii et al., 1994; Cargill et al., 1996).

In most previous studies, the interpretation of the results has been carried out according to the method of Cargill et al. (1994), employing maximum and minimum limiting values specified in literature or using the formula described by Hollanders et al. (1995). When using SI-limiting values of >1.5 for “evidence of mange” and 1.5–0.5 for “suspicion of mange” (Tables 3 and 4: column A/B) only 8 cases of 480 observations in pens A and B indicated “evidence of mange” and 28 cases “suspicion of mange”. After treatment, the SI-values decreased remarkable for 8 cases with “suspicion of mange” (300 observations). When the limiting value was reduced to 0.1 (Tables 3 and 4: column C/D) in both pens 111 cases showed “evidence of mange” and in 369 cases “no mange” was diagnosed. Regarding this limiting value, mange-positive results declined by >50% shortly after treatment. The calculation and interpretation of the SI according to Hollanders et al. (1995) (Tables 3 and 4: column E/F) before and after treatment are similar, and also most SI-values indicated a mange-free herd.

Depending on used method and limiting values between 68.1 and 92.5% of the observations before treatment were classified as “no evidence of mange”, despite evidence of Sarcoptes in the skin scrapings and positive ELISA results. The lower the limiting values, the higher the sensitivity. However, in the case of non-specific indicators, such as the SI, the specificity is reduced. Therefore, pruritus can also caused by numerous factors, such as stocking density, dominance interactions (Davies, 1995), pen structure, environmental temperature, humidity of the skin (Davis and Moon, 1990), age of pigs, smoke and draught (Rambags et al., 1998), which can readily lead to a false diagnosis. As shown in Figs. 1 and 2 and Tables 3 and 4, the results are influenced by the time of day of the observations.

In conclusion, the contradictory statements and information gaps make interpretations of the SI complicated. Different results from the literature and our present investigation and these various factors, influencing the scratching and itching behaviour, make the SI a non-specific and unreliable method. Therefore, it should be recommended only as an additional tool for mange diagnosis.

Nevertheless, if the SI is used, the exact period of time must be considered (see Figs. 1 and 2) and observations should be carried out by means of different untreated age groups. The application of different methods and limiting values for interpretation of the results increase the safety of this method only insignificantly. The use of SI as a simple method, however, is the first indication of a successful therapy (quick decreasing SI-values) or a re-infestation (sudden increasing SI-values) on a mange-free farm, in which the evidence needs to be supported using other methods.

Therefore, we recommend the use of an SRE of more than 10 s, in contrast to Rambags et al. (1998), because the scratching activities are a pronounced feature of many pigs, as has been demonstrated in the present study.

References


Courtney, C.H., Ingalls, W.L., Stitzlein, S.L., 1983. Ivermectin for control of swine scabies: relative values of prefarrowing treat-


