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Elimination of Mange Mites *Sarcoptes scabiei* var. *suis* from Two Naturally Infested Danish Sow Herds Using a Single Injection Regime with Doramectin

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Jensen JCE, Nielsen LH, Arnason T, Cracknell V: Elimination of mange mites *Sarcoptes* scabiei var. *suis* from two naturally infested Danish sow herds using a single injection regime with doramectin. Acta vet. scand. 2002, 43, 75-84. – Attempts to eliminate *Sarcoptes scabiei* var. *suis* were made in 2 naturally infested sow herds, by intramuscular (IM) injection of doramectin (Dectomax®, Pfizer, New York, USA). A single injection strategy was used. In one of the herds, the environment was treated with an acaricide following dry cleaning of floors, walls and equipment. In the second herd, no environmental treatment was performed. Results were measured by skin lesion scoring, ear scrapings to show Sarcoptes scabiei var. *suis,* and calculating rubbing index throughout the observation period of 20 months following treatment. Skin lesion scores decreased and stayed low following treatment for the entire observation period. Live *Sarcoptes scabiei* var. *suis* mites were isolated prior to treatment from both herds, but not following treatment. Rubbing index decreased following treatment, but was occasionally at or above 0.4. The results of these studies indicate that elimination of *Sarcoptes scabiei* var. *suis* from 2 naturally infested herds was successful, using doramectin in a single injection strategy. Precautions must be taken to ensure adequate dosing of every pig, and to avoid reinfestation due to poor biosecurity.

doramectin; mange elimination; pigs; medical elimination; ectoparasites; ear scrapings; rubbing index; SPF; acaricide.

Introduction

Mange, caused by *Sarcoptes scabiei* var. *suis,* is the most widespread and important ectoparasite disease in pigs. Clinical signs such as rubbing, scratching and skin lesions indicate the significant economic influence on production parameters, and demonstrate the welfare problems of infested pigs (*Cargill & Davies* 1999).

The phrase: 'Elimination of mange mites from a herd' is used here specifically to describe the achieving of total removal of the infectious agent on a herd basis, whilst the word 'eradication' should be reserved for national / regional programs. Elimination of mange has, for many years, been of great interest in many swine producing countries. In Danish pig herds, elimination of mange has been accomplished extensively, either by restocking to specific pathogen free (SPF) methods or by implementing a medical elimination programme.

When strict biosecurity measures are followed, as within the Danish SPF system, risk of reinfestation is very low. The Danish SPF system was established in the early 1970's, and as from 1987 comprised more than 3000 herds. Among these herds, only 2 reinfestations have occurred (*Barfoed* 2000) over a 30-year period. Medical elimination programmes in conventional Danish herds were developed during the early

1980's (*Ebbesen & Henriksen* 1986, *Henriksen et al.* 1987, *Jensen* 1988a, Jensen 1988b). Using ivermectin (Ivomec®, Merial, Lyon, France) alone, all pigs were injected twice with a 14-day interval. Using pour-on formulations, 3 treatments with a 6-day interval have been proven successful (*Madsen* 1990), while 2 treatments with a 14-day interval were not successful in eliminating mange (*Jensen* 1988b). Both strategies involved treatment of the environment with an acaricide. Later studies have shown that treatment of the environment with an acaricide was not needed (*Jacobson et al.* 1998, *Jacobson et al.* 1999). Doramectin (Dectomax®, Pfizer, New York, USA) has been shown to have a longer duration (up to 18 days) of activity than ivermectin (up to 9 days) in experimental trials following one injection (*Arends et al.* 1999). In phamacokinetic studies (*Friis & Bjoern* 1996) doramectin has also been shown to have a longer duration of activity than ivermectin. A single injection with doramectin has been shown to be effective in eliminating mange mites under experimental conditions (*Cargill et al.* 1996). It has recently been reported from Sweden (*Jacobson et al.* 2000) that mange was successfully eliminated from a 21-sow, naturally infested herd, using a single-injection programme with doramectin, and without treatment of the environment with an acaricide. The aim of the present study was to show that a single-injection programme using doramectin could successfully eliminate mange from 2 Danish sow herds.

Materials and methods

Herds

The study was conducted in 2 conventional, severely mange-infested sow herds; in the following they are referred to as *Herd A* and *Herd B,* respectively. *Herd A* was a 95-sow herd, including mated and non-mated gilts and 5 boars. Crossbred gilts were produced from purebred Danish Landrace (L) gilts/sows by using artificial insemination (AI) with Yorkshire (Y) semen. The crossbred F1 gilts/sows (L/Y) were mated with Hampshire (H) boars. Pigs were weaned at approximately 28 days of age.

Housing: Gestation and mating areas, as well as farrowing pens, had slatted flooring. Pregnant sows were kept in stalls. Pigs were weaned into a climate-controlled 2-stage weaning accommodation, with 4 pens and slatted flooring. Pigs remained in the weaning barn for 2 to 3 weeks and were then moved to a grower accommodation with slatted flooring for another 2 to 3 weeks. Finally, they were moved to another growing house, with concrete flooring and straw bedding. They stayed there until they were sold at around 30 kg. All rooms in the herd were run on a continuous flow basis.

Herd B was a 250-sow herd, including mated and non-mated gilts and 3 boars. Crossbred gilts (L/Y) had been purchased from a multiplier herd. Gilts and sows were mated with (H) boars or AI with Duroc (D) semen. Sows were farrowed every second week and piglets were weaned at around 27 days of age.

Housing: There were 2 gestation rooms with tethered sows and concrete flooring. The farrowing accommodation comprised of 2 rooms with slatted flooring. The mating area had 3 boar pens, tethered sows, and 2 pens with concrete flooring, for non-mated gilts. There was one room, containing 2 pens with concrete flooring, for mated gilts. The weaning accommodation comprised of 3 rooms of 10 pens each, with slatted flooring. The weaners stayed for 10 to 15 days before being moved into a 2-stage, climate-controlled grower accommodation, consisting of 2 rooms with 8 pens in each, and partially slatted flooring. Pigs stayed here until they were sold at a weight of 25 to 30 kg. With the exception of weaner accommodations, all rooms were run on a continuous flow basis.

Biosecurity implemented to prevent reinfestation

In both herds, purchase of gilts and boars for breeding was restricted to SPF nucleus or SPF multiplying herds. No quarantine facilities or acaricide treatments for these animals were established during the study. An entrance room was established to facilitate changing of clothes and footwear. Loading facilities for pigs or breeding animals to be sold were also established. Dogs were not allowed to come into contact with the herds. Cats were allowed to mingle with the herds, and were treated with an acaricide on the same day that the pigs were injected.

Inclusion criteria

In both herds the diagnosis of mange was confirmed by microscopic identification of live mites (*Sarcoptes scabiei* var. *suis*) at the Danish Veterinary Laboratory.

Experimental design and treatment strategy

All pigs more than 3 days old were treated with doramectin at 300 μg per kg bodyweight over one day (day 0); *Herd A:* January 14th, 1998. *Herd B:* April 14th, 1998. Pigs less than 3 days old on day 0 or those born during the next 21 days were treated when they became 3 days old. Breeding animals were all individually weighed prior to treatment. Suckling pigs and weaners were weighed as groups, and the average weight determined the dosage.

In *Herd A,* the environment was cleaned and treated with phoxim (Sebacil® vet, Linement 50%) according to the manufacturer's instructions. From day 21 onwards, no acaricide or endectocide was used in any of the herds.

In *Herd B,* the environment was not treated at any time.

Monitoring

In both herds, 6 days prior to treatment (day –6), all breeding animals were identified by ear tags and assigned a clinical score according to the severity of visible skin lesions, ranked from 0 to 4. All breeding animals more than 8 months old and with a clinical score of 1 or more had ear/skin scrapings taken. Additionally, 10% of the breeding animals with a score of 0 were randomly selected for ear/skin scraping. Any breeding animals with a score of 4 were culled before treatment.

Adult animals given a clinical score of 1 or more were re-tested by skin scraping on day 28 and every 4 month throughout the study period of 20 months. Additionally, all adult pigs removed or culled during the period from day 28 to month 4 were sampled by ear scraping before they left the herd. In this trial, isolation of dead mange mites at month 4 or later also lead to a new scraping of these animals within a few days. These samples were brought to the Danish Veterinary Laboratory on the same day in order to determine if live mites were present.

A rubbing index for sows as well as weaners was calculated prior to treatment (day –6) and every month throughout the study period of 20 months.

Clinical score value descriptions

0 = Normal. No visible mange skin lesions, no indication of scab in the ears, no rubbing.

1 = Mildly clinically infected. Only occasional, small (0-4 cm in diameter) visible mange body skin lesions (covered with wheat bran powder-like coating). At predilection sites (ear, ground and back region, knee region etc.), no bloody skin injuries and/or small lesion in the ears, good overall body condition, only occasional rubbing.

2 = Moderately clinically infected. Occasional, medium sized (4-8 cm) mange body skin lesions (covered with wheat bran powder-like coating). At predilection sites (ear, ground and back region, knee region etc.) covering less than 2% of the body surface, no bloody skin in-

juries, combined with small visible lesions in the ears, good overall body condition, rubbing is more frequent.
3 = Severely clinically infected. Obvious severe body mange skin lesions (covered with wheat bran powder-like coating). At predilection sites (ear, ground and back region, knee region etc.) covering large areas of the body surface, body skin may have bloody skin injuries due to rubbing, large visible scab lesions in the ears with bran-like coating, reduced overall body condition possible, extended rubbing is observed.
4 = Chronically infected (to be culled). Thick asbestos-like scab in the ears, chronically thickened skin with thick asbestos-like coating and/or skin injuries and/or overall reduced body condition.

Method for skin scraping and identification of Sarcoptes scabiei
Skin scrapings were taken from the internal pinna of the ear and additional samples were collected if extensive lesions were present on other areas of the body. Animals were restrained, and the area was scraped with a sharp spoon until blood was visible. The material obtained from the scraped area was transferred into a Vacutainer® glass tube labelled with the identification number of the animal. Samples were forwarded to the Danish Veterinary Laboratory within 24 h and examined for the presence or absence of adult mites, immature mites and eggs. Each sample was heated at 37 °C for 20 to 30 min, then examined for live and dead mites using a stereo microscope. If no mites were found, samples were mixed with potassium hydroxide (KOH) solution for 12 to 24 h, centrifuged and re-examined for *Sarcoptes scabiei.*

Method for calculating rubbing index
The rubbing index is defined as the number of rubbings among at least 10 breeding animals and at least 10 weaners over a period of 15 min, divided by the number of animals observed. A rubbing index of >0.4 was denoted as a possible mange infection. The rubbing index was measured during periods of the day when pigs were not eating.

Results
Results obtained prior to treatment (day –6).
Pigs in both herds had moderate to severe clinical signs of mange infestation. In *Herd A,* the mean clinical score was 1.48 for sows, 2.25 for boars and 1 for gilts. One boar with a clinical score of 4 was culled before day 0. Mange mites were isolated from 8 out of 95 sampled animals

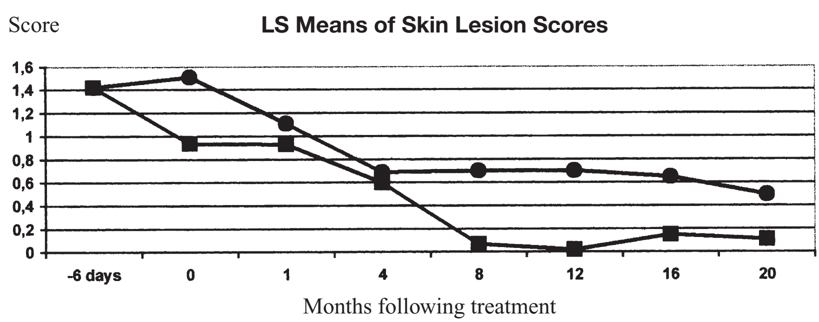

Figure 1. Skin lesion scores for *herd A* (●) and *herd B* (■) before and after IM injection (Day 0) with do-

Table 1. The presence of *Sarcoptes scabiei* var. *suis* in skin scrapings from breeding animals in *Herd A* and *Herd B* before and after IM injection (day 0) with doramectin at a dosage of 300 μg/kg bodyweight. Live mites were isolated prior to treatment, from both herds. Following treatment, only dead mites were found in the scrapings.

Time in relation to treatment (months)	Herd A	Herd B
	No. pigs with dead mites/ No. pigs scraped	No. pigs with dead mites/ No. pigs scraped
<0 (before treatment)	8/95	23/203
0 - 1	2/96	8/214
1 - 4	1/99	3/219
4 - 8	0/81	1/166
8 - 12	1/67	0/132
12 - 16	1[1]/62	0/106
16 - 20	0/47	0/81
Total (after treatment)	5/452	13/918

[1] Parts of a dead mite.

that remained in the study. Seven of these 8 positive scrapings were evaluated as having a low number of mites (<5 mites), while one sample had massive numbers of mites (>25 mites). The mean rubbing indexes were 8.0 and 1.8 for sows and weaners respectively.

In *Herd B,* the mean clinical score was 1.54 for sows, 2.0 for boars and 0 for gilts. Five sows with a clinical score of 4 were removed from the herd before day 0. Mange mites were isolated from 23 out of the 203 samples. Of these 23 animals, 22 remained in the study. Five of the positive samples had massive numbers of mites (185 to approximately 800) mites. The mean rubbing indexes were 0.9 and 1.4 for sows and weaners respectively.

Results obtained following treatment on day 0

No adverse reactions were observed following injection of the pigs with doramectin in either herd. Mean clinical scores dropped to 0.5 in *Herd A* and 0.1 in *Herd B* by the end of the study period (Fig. 1).

Following treatment, live mites were not iso-

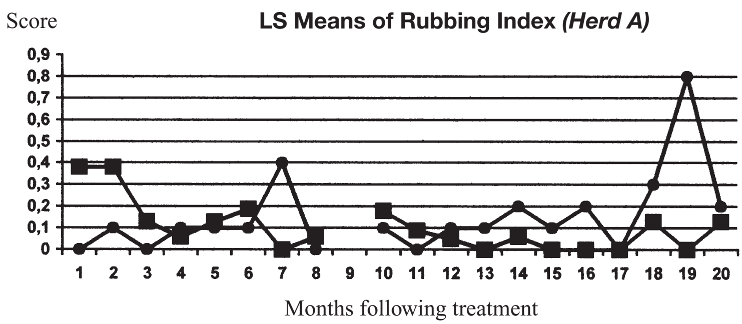

Figure 2. Rubbing index for sows (●) and weaners (■) in *herd A.* Initial rubbing indexes on day –6 were 8.00

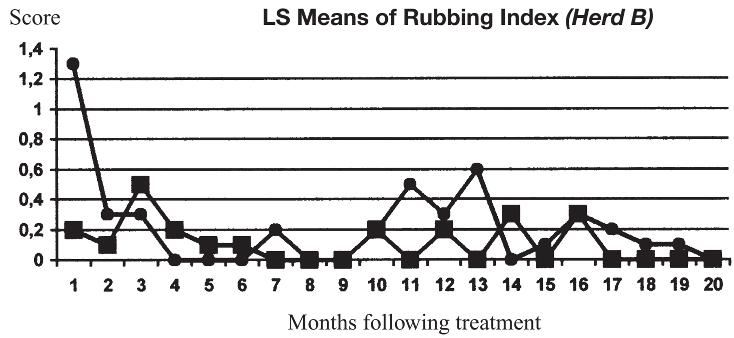

Figure 3. Rubbing index for sows (●) and weaners (■) in *herd B.* Initial rubbing indexes on day –6 were 0.90

lated in scrapings from any of the animals in either herd. Also, mites were not isolated from any of the SPF breeding animals introduced into the herds during the study period. However, dead mites were frequently demonstrated during the first month following treatment (2% in *herd A* and 4% in herd B). From one sow in Herd A, parts of a dead mite were found 16 months following treatment. In *Herd B,* one dead mite was isolated from one sow 8 months following treatment (Table 1).

In *Herd A,* the mean rubbing index dropped to or below 0.4 for sows, except for one observation on month 19, when it was 0.8. The mean rubbing index for the weaners stayed below 0.4 throughout the trial period (Fig. 2)

In *Herd B,* the mean rubbing index was higher than 0.4 for sows on 3 occasions during the study period (1.3 at month 1; 0.5 at month 11; and 0.6 at month 13). For the weaners it stayed below 0.4 except for one occasion, where it was 0.5 on month 3 (Fig. 3).

Discussion

Mange was successfully eliminated from both herds following a single-injection treatment with doramectin. This is in accordance with the trial in Sweden (*Jacobson et al.* 2000), and supports the results of earlier experimental trials (*Arends et al.* 1999), where doramectin was shown to have a duration of activity of up to 18 days following a single injection. Treatment of the environment with an acaricide did not change the result, which also is in line with other observations (*Jacobson et al.* 1998). An observation period of 20 months and the number of skin scrapings would have left enough time to show a potential surviving mange mite population (*Stegeman et al.* 2000).

Mean clinical scores (sows, boars and gilts) dropped from 1.4 (day –6) to approximately 1.0 within 4 months following day 0 for both herds. In *Herd A,* the score stayed near 0.6 throughout the rest of the observation period, whilst it dropped to below 0.2 in *Herd B*. The results are within the range of what has been found by others (*Jacobson et al.* 2000).

The demonstration of dead mange mites in ear scrapings following day 0 was not surprising, even though mites were absent in experimental trials within 28 days following efficacious treatment (*Cargill et al.* 1996). The severity and chronic nature of the mange infestation in these 2 herds, as well as the total number of animals examined by scrapings following treatment (452 in *Herd A* and 918 in *Herd B*) may provide the answer. From another reported trial (*Henriksen et al.* 1987), dead mites were isolated as late as 10 months following treatment in a 500-sow herd, where 231 scrapings were taken during an observation period of 17 months.

Additionally, in the study reported here, in both *Herd A* and *Herd B,* 10% of gilts or boars purchased following day 0 were scraped every 4 month. None of these animals serving as sentinels showed any clinical signs or had mites isolated.

Rubbing index is a relatively simple tool for veterinarians to diagnose mange infestations in a herd. The specificity of the test, however, makes it insufficient for use as the only tool. According to findings in other studies (*Smets et al.* 1999, *Jacobson et al.* 2000) a rubbing index at or above 0.4 may be found even in mange-free herds. A seasonal variation has been suggested (*Jacobson et al.* 2000) with a higher index recorded during the summer months. In the present study mean indexes at or above 0.4 were found on different occasions in both herds: *Herd A,* sows: 0,4 (August 18th 1998) and 0.8 (September 1st 1999). *Herd B,* sows: 1.3 (May 12th 1998), 0.5 (March 22nd 1999) and 0.6 (May 17th 1999). Weaners: 0.5 (July 17th 1998). Besides mosquito bites, which can create pruritus in pigs, general hygiene and differences in housing systems (loose versus tethered sows) must be anticipated to influence the rubbing index.

The economic implications of initiating a mange elimination attempt in a herd should always be carefully considered and compared to the expense of ongoing control measures. A common management strategy for controlling mange is to inject sows with an avermectin during pregnancy, prior to farrowing. Using this type of mange control management, all sows would be injected between 2 to 2.4 times annually. In a 100 sow unit, this is equivalent to injecting 200-240 sows per year. Conversely, conducting an elimination program using a single injection strategy would necessitate all sows, piglets and weaners being injected on one day. To calculate and compare how much endectocide would be used for piglets and weaners, an example could be as follows, using a 100-sow herd producing 2400 pigs annually at 25 kg per pig, in which the production period of a 25 kg pig is 10 weeks. During any one week in a year, there will be 2400/5.2 = 462 piglets or weaners on the farm. The average weight would be a maximum of 11.5 kg/pig, which is equal to 5313 kg, equivalent to the weight of 24 sows. Therefore, conducting an elimination attempt with a single-injection strategy using doramectin leads to a use of endectocide equivalent to treating 1.24 × the number of sows in the herd, as compared to treating 2.0-2.4 × the number of sows in the herd annually in a continuos control program.

Using a two-injection elimination program with ivermectin would, of course, lead to a doubling of the amount of endectocide and labour used in an elimination attempt (*Reddin* 1997).

Avermectins, as well as other acaricides, are not effective against mite eggs (*Alva-Vades et al.* 1984). In order to achieve elimination of mange from a naturally infested herd, it is necessary that the concentration of the drug be sufficiently high in the target tissue whenever a new egg hatches. Hatching of eggs generally takes 3 to 4 days, but under laboratory conditions it has been shown to take as long as 10 days (*Arends* 1998). Following subcutaneous (SC) injection with ivermectin, peak serum values (T_{max}) are reached within 3.1 days with a variation of 1.4 days. Following an intramuscular (IM) doramectin injection, T_{max} was 2.6 days ± 1.3 (*Friis* 1996). In naturally infested herds, it is possible for eggs to be laid one to 2 days following injection, and hatching can occur up to 10 days later. So, in order to eliminate mange with a single-injection programme, the duration of activity in target tissue should be at least 12 days. Survival of mites in the environment is normally very limited, but can be up to 12 days (*Cargill & Davies* 1999), which also indicates the necessity of a duration of activity of at least 12 days.

A single injection with ivermectin injection to sows prior to farrowing was found to be an effective control program for a farrow-to-finish, continuous flow swine facility in preventing mange infestation in weaners and growers. The efficacy of ivermectin gave considerations for an eradication scheme (*Courtney et al.* 1983). A single injection with ivermectin cleared a rather acute infection in 7 gilts and one boar that were isolated and scraped weekly 4 times following treatment. However, 5 live mites were recovered from one gilt 14 days following the injection, but no live mites were isolated during the second14-day observation period (*White & Ryan* 1987).

Single oral dosing of ivermectin at 300, 400 or 500 μg/kg bodyweight under experimental conditions has also been shown to effectively reduce the number of mange mites in naturally infested pigs. This programme, however, did not eliminate the mites from 2 of 3 groups during an observation period of 28 days (*Alva-Valdes* 1984).

A single injection of ivermectin to all pigs in a herd of 443 pigs of different ages appeared to eliminate mange for 125 days. However, 169 days post-treatment, mange was present again, possibly due to reintroduction of mites by a purchased boar (*Hogg* 1984).

Three injections with ivermectin plus treatment of the environment with an acaricide during a 35-day period did not eliminate mange from a naturally infested herd. Only adult animals were treated (*Thomas et al.* 1986).

Injecting sows with ivermectin at a dosage of 300 μg/kg bodyweight prevented mange infestation from establishing in their offspring, as measured by 74 ear scrapings of pigs at 59 to 77 days of age compared to untreated controls, where 41 of 74 pigs were positive (*Dalton & Ryan* 1988).

Each of these studies emphasizes that thorough precautions and preparations should always be an integral part of a mange elimination program. Under-dosing or missing one single animal could lead to failure, if the goal is to eliminate the mange mite from the herd. Injecting pigs IM is more convenient and is less likely to cause leakage back from the injection site, compared to a SC injection (*Reddin* 1997).

Reintroduction of mange by purchased breeding gilts and boars must be avoided. Should an SPF programme like the Danish system, (which has an extremely high guarantee of mange-free status) not be available, a quarantine facility must be used and managed on an all-in, all-out basis. Pigs to be introduced must be treated against mange before physically entering the herd. In farrow-to-finish, continuous flow production sites, a barrier zone must be established between treated and non-treated pigs (*Henriksen et al.* 1986) in order to prevent reinfection of treated pigs from non-treated fatteners. Alternatively, pigs close to slaughter could be treated with an acaricide that has a shorter withdrawal period than the injectable avermectins (*Smets et al.* 1999).

In conclusion, a 2-injection strategy which has been used successfully under field conditions for many years (*Ebbesen & Henriksen* 1986, *Henriksen et al.* 1987, *Jensen* 1988a + b, *Hogg* 1989, *Cargill et al.* 1996 b, *Reddin* 1997, *Jacobson et al.* 1998, *Smets et al.* 1999) seems to be the most effective method, when using ivermectin. According to this study, the results from an experimental trial (*Cargill et al.* 1996 a) and results reported in a field trial (*Jacobson et al.* 2000), the single injection strategy is effective when using doramectin.

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Sammendrag

Eliminering af skabmider fra to naturligt inficerede danske sobesætninger ved at give een injektion med doramectin.

Forsøg på at udrydde skab (*Sarcoptes scabiei* var. *suis*) gennemførtes i 2 danske sobesætninger på henholdsvis 95 og 240 søer ved at give een IM injektion med doramectin (Dectomax®, Pfizer, New York, USA). I den ene besætning behandledes miljøet med phoxim (Sebacil® vet, Linement 50%). I den anden besætning blev miljøet ikke behandlet. Observationsperioden var på 20 måneder. Der blev foretaget hudlæsion score, udtaget skrabprøver (i alt 452 i den ene og 918 i den anden) hver fjerde måned og lavet kløeindex hver måned i besætningerne. Scoren for hudlæsioner faldt efter injektionen og holdt et lavt niveau derefter. Levende mider blev påvist i begge besætninger før dyrene blev behandlet, men ikke siden. Kløeindexet faldt ligeledes, men blev ved enkelte lejligheder registreret til 0,4 eller derover i begge besætninger. Skabsaneringen lykkedes i begge besætninger. Der skal tages vare på, at alle dyr får den korrekte dosis ligesom reinfektioner skal undgås.

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