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The efficacy of collars impregnated with flumethrin and propoxur against experimental infestations of adult *Rhipicephalus sanguineus* on dogs

L J Fourie^a, D Stanneck^b and I G Horak^a

ABSTRACT

The efficacy of 2 sets of collars (Kiltix[®] Collar, Bayer AG), containing different plasticisers and impregnated with the acaricides flumethrin (2.25 %) and propoxur (10 %), was compared against adult *Rhipicephalus sanguineus* on experimentally infested, kennelled dogs. Thirty individually penned dogs were infested with 25 male and 25 female, unfed *R. sanguineus*. On the following day they were allocated to 3 groups of 10 dogs each on the magnitude of their tick burdens. Two days after infestation, medicated collars containing 1 of the plasticisers were fitted to 10 of the dogs and similar collars containing the other plasticiser were fitted to 10 others. The remaining 10 dogs were the untreated controls. Seven and 28 days after having fitted the collars, all dogs were re-infested with 50 unfed adult ticks of both sexes, and again at approximately 28-day intervals up to the 5th month, and then at approximately 14-day intervals during the 6th month. Efficacy was determined by comparing the mean number of live, attached ticks on the untreated control group with those on the collared dogs 2 days after each re-infestation. Immediate efficacy of the collars (Day +2) was >95 %, and residual efficacy was >98 % up to and including Day +114, and >93 % up to Day +170 on both groups of collared dogs. The mean tick counts on the 2 groups of collared dogs did not differ significantly ($P < 0.0001$) for any of the assessment days.

Key words: acaricide-impregnated collar, dogs, efficacy, experimental infestation, flumethrin, propoxur, *Rhipicephalus sanguineus*.

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INTRODUCTION

Rhipicephalus sanguineus, colloquially known as the kennel tick, has probably the most widespread global distribution of any ixodid tick^{1,3}. It has a 3-host life cycle and all stages of development virtually exclusively use domestic dogs as hosts^{1,3}. Although it is widespread in South Africa, its distribution is patchy in that it is confined to localities within urban, suburban, peri-urban and rural areas where there are both domestic dogs and human dwellings and/or associated man-made structures to which the tick's free-living stages have become adapted.

During the past 27 years, 6 surveys of ticks infesting domestic dogs have been conducted at various localities in South Africa^{1,5–9}. In 3 of these surveys, *R. sanguineus* was the only or the dominant species, in a 4th its presence was subordinate to that of *Haemaphysalis leachi*

and in the others it was absent. Infestation with any tick has a nuisance value, but *R. sanguineus* also transmits *Ehrlichia canis* to dogs³. In countries other than South Africa, where *H. leachi* is the vector of *Babesia canis*¹⁰, *R. sanguineus* also transmits this parasite to dogs¹¹. In addition, it can transmit *Rickettsia conorii*, the causative organism of tick-bite fever in humans¹², hence its control from both a veterinary and medical perspective is important.

The 1st published report on the efficacy of an acaricide-impregnated collar against ticks on dogs in South Africa appeared in 1976⁴. That collar contained propoxur and its efficacy was determined against *R. sanguineus* in a kennel environment that was heavily infested with ticks. Although several acaricide-impregnated collars have subsequently been registered for use on dogs in South Africa, to our knowledge none of the efficacy studies in support of registration have been published. A recent publication does, however, detail the efficacy of an amitraz-impregnated collar against experimental and natural infestations of *R. sanguineus* on dogs in Spain². The present study was

conducted to compare the efficacy of collars (Kiltix[®] Collar, Bayer AG) containing different plasticisers and impregnated with both a synthetic pyrethroid (flumethrin) and a carbamate (propoxur) against adult *R. sanguineus* on experimentally infested, kennelled dogs over a period of nearly 6 months.

MATERIALS AND METHODS

Dogs

Thirty-two mainly mixed-breed adult dogs, of both sexes, with hair-coats varying in length from 9 mm to 46 mm, that had not been treated with an insecticide for at least 3 months prior to the commencement of the study, were infested with ticks. The following day the ticks that had attached were counted *in situ* and the dogs with the highest and the lowest tick count were excluded from the study. The 30 remaining dogs were fitted with implanted transponders with unique alphanumeric codes and were allocated to 3 groups of 10 dogs each by randomisation through minimisation according to their tick counts. An attempt was made also to balance the groups by sex, body mass and hair length. The dogs were allocated to 3 study groups by random draw.

The dogs were housed individually in pens identified with the corresponding animal number. No contact between dogs was possible. The pens consisted of a 1.69 × 0.7-m sleeping area, with under-floor heating and an outside run of 1.69 × 3.0 m. Each dog was allowed to move around freely in an exercise area for 15 minutes on weekdays. Different exercise areas were used for treated and control dogs. Dry food pellets (Classic, Montego Feeds) and fresh water were provided *ad libitum* in stainless steel bowls. All dogs were treated with Diworm Tablets (Niclosamide 500 mg and Levamisole HCl 25 mg/tab, Centaur (Bayer Animal Health)) on Day +9.

Tick infestation

Adult *R. sanguineus* were bred in the laboratory, using dogs as hosts for all stages of development. When required for infestation, unfed ticks were released

^aDepartment of Zoology and Entomology, University of the Free State, PO Box 339, Bloemfontein, 9301 South Africa.

^bBayer AG, Building 6700, Agricultural Center Monheim, 51368 Leverkusen, Germany.

*Author for correspondence. E-mail: fourie@clinvet.com

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Table 1: Experimental design of a study to determine the efficacy of acaricide-impregnated collars against adult *Rhipicephalus sanguineus* on dogs.

Day	Activity
-2	Pre-treatment infestation with 25 male and 25 female <i>R. sanguineus</i>
-1	Pre-treatment tick counts and allocation to 3 study groups
0	Collars fitted to the 10 dogs in Group 2 and the 10 dogs in Group 3
+7, 28, 56, 84, 112, 138, 154, 168	Post-treatment infestations with 25 male and 25 female <i>R. sanguineus</i>
+1, 2, 8, 9, 29, 30, 57, 58, 85, 86, 113, 114, 139, 140, 155, 156, 169, 170	Post-treatment and post-re-infestation tick counts

into a counting chamber from where escape was prevented by an electric barrier. The required numbers (25 males and 25 females for each dog) were collected in separate vials by means of an aspirator and the dogs were each infested with 50 ticks on Days -2, +7 and +28, and subsequently on an approximately 4-weekly basis up to the 5th month (Table 1). During the 6th month the dogs were infested at 16- and 14-day intervals. The dogs were sedated with Rompun (Bayer Animal Health) just before infestation and thereafter placed on the heated floors of their sleeping quarters. This was done to ensure that the ticks, which had been released onto the ventral surface of the dogs, were not disturbed during their initial period of establishment.

Collars

Two sets of acaricide-impregnated collars containing different plasticisers, into which both flumethrin (2.25 %) and propoxur (10 %) had been incorporated, were used. Two days after initial infestation

(Day 0) a collar was fitted around the neck of each of the dogs in Groups 2 and 3, and any surplus length was cut off, allowing 5–7 cm of spare collar for future growth and adjustments. The collar fitted to each dog was weighed before and after use. No collars were fitted to the dogs in Group 1. As a precaution, protective clothing and disposable gloves were worn during the collar-fitting procedure and these items were changed after the treatment of all of the animals in a specific treatment group.

Tick counts

Ticks were counted *in situ* on Day -1, on Day +1 and on the days following each fresh infestation. On Day +2 and then 2 days after each re-infestation all the ticks were removed from the dogs and placed in labelled bottles containing 70 % ethanol for later identification and quantification. Irrespective of whether they were counted *in situ* or removed and then counted, the procedure followed was similar in that ticks were detected by parting the hair coat and by palpation. For the duration

of the study tick counts or collections were completed on the untreated control animals before commencing with the dogs in the treated groups. Separate sets of table covers and aprons were used for each group.

Efficacy of the collars was calculated as follows:

$$\text{Efficacy (\%)} = \frac{C - T}{C} \times \frac{100}{1}$$

where *C* and *T* are the arithmetic means of live, attached ticks on the untreated control and treated groups, respectively.

Upon termination of the study all dogs were washed and placed in communal kennels at the research facility.

RESULTS AND DISCUSSION

The collars fitted to dogs in Group 2 lost a mean mass of 3.57 g during the trial, while the mean loss in Group 3 was 3.84 g. On Day +118 a dog in Group 2 dislodged and partially damaged its collar. The same collar was refitted with the aid of string ties. Because a section of this collar was

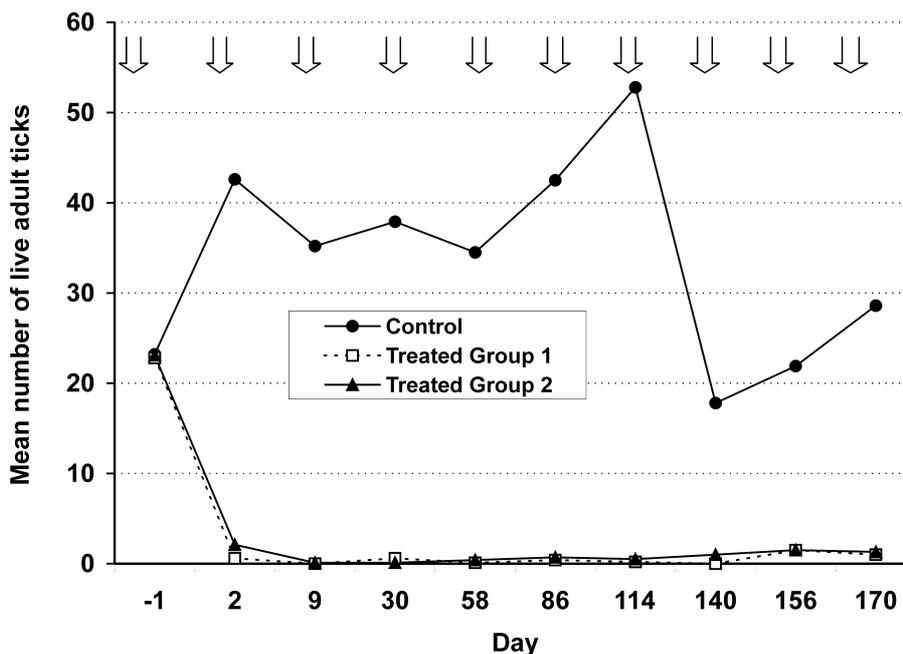


Fig. 1: Mean counts of live adult *Rhipicephalus sanguineus* on untreated control and 2 treated groups of dogs 2 days post-application of acaricide-impregnated collars and then 2 days after each re-infestation. ↓ = Infestation with 25 male and 25 female *R. sanguineus*.

destroyed it was not included in the mass loss calculations. None of the other dogs damaged their collars during the course of the study. Except for a barely perceptible transient erythema below the collars of 4 dogs, the collars were well tolerated. A dog in the untreated control group developed acute wet eczema on Day +42, another was anaemic and feverish on Day +84 and a 3rd was diagnosed with babesiosis on Day +100, while a single dog in Group 3 was anaemic and feverish on Day +56. Appropriate treatments were administered to these dogs and they all recovered.

The mean tick counts on the dogs in the control group and on the 2 treated groups are illustrated in Fig. 1, and the efficacy of the collars against the initial and subsequent tick infestations on the 1st and 2nd days after each re-infestation in Fig. 2.

On Days +86 and +114, tick counts on some of the dogs in Group 1 (untreated controls) were greater than the number of ticks with which they had been infested 2 days previously. This implied that a natural infestation of *R. sanguineus* had become established in the kennels occupied by the untreated dogs. These dogs were moved on Day +121 to clean the kennels and their erstwhile sleeping quarters were sprayed with a 2 % m/v flumethrin solution (Bayticol, Bayer Animal Health). On Day +125 their kennels were thoroughly washed with soap and water and on Day +126 all the dogs were thoroughly examined for ticks, all of which were removed. The dogs were then returned to their original kennels. The tick assessments made on Day +140 indicated that the treatment of the kennels had been successful. However, the mean tick count was lower than expected, suggesting that some of the dogs may have become contaminated with residues of the acaricide with which the kennels had been treated. The number of ticks on the control dogs on Days + 156 and + 170 was again satisfactory (Fig. 1).

The efficacy of the collars exceeded 70 % 1 day after initial infestation and, with a single exception, exceeded 75 % on the 1st day after every re-infestation. Immediate or therapeutic efficacy of the collars was assessed from the tick counts done 2 days (Day +2) after initial fitting of the collars and was 98.6 % and 95.1 % on the dogs in Groups 2 and 3, respectively. Residual efficacy was calculated from tick counts done 2 days after each re-infestation and was >98 % up to and including Day +140, and >93 % to Day +170 on Group 2 dogs. Residual efficacy on Group 3 was >98 % up to and including Day +114 and >93 % to Day +170. The mean tick counts of

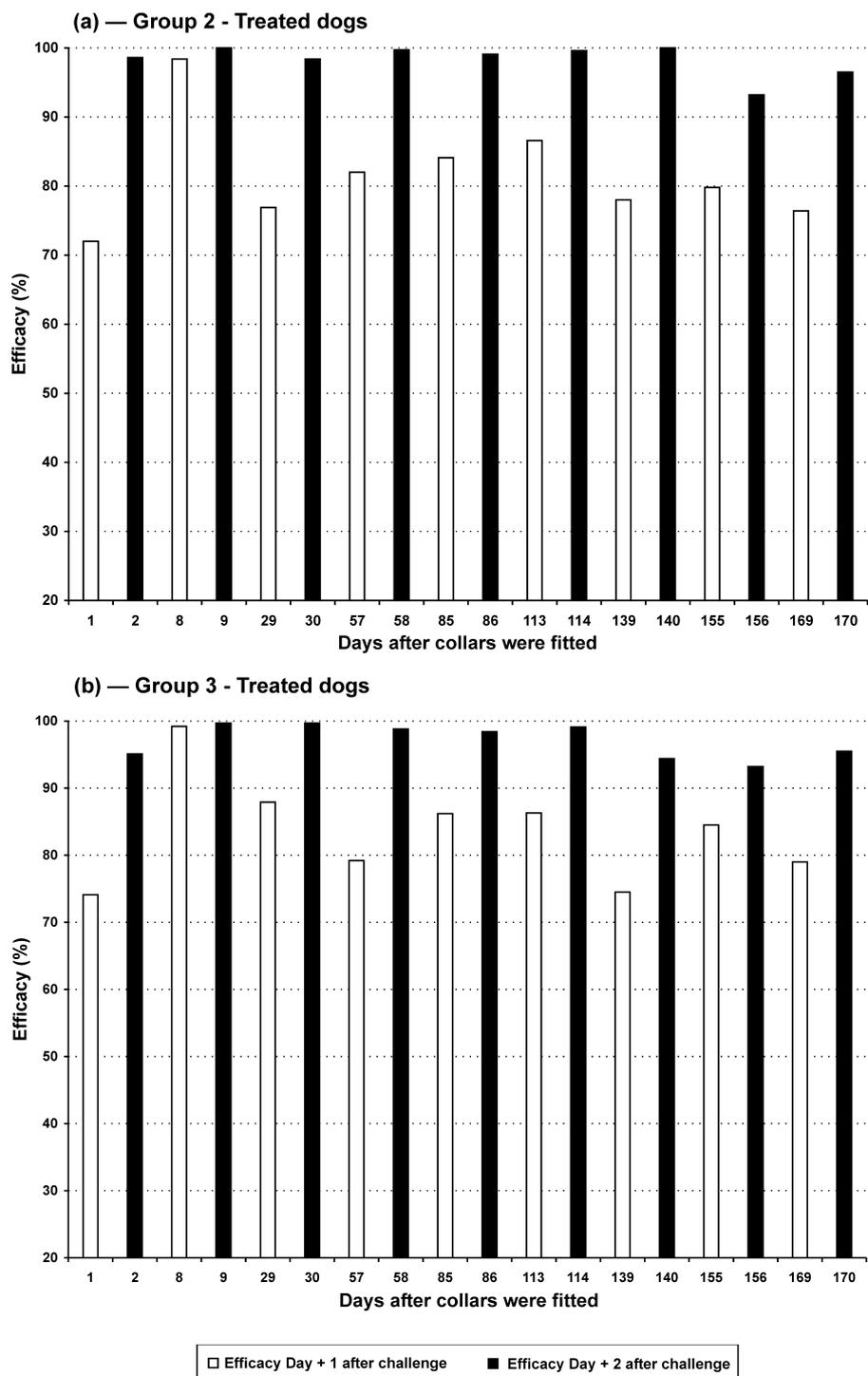


Fig. 2: Mean efficacy of acaricide-impregnated collars 1 and 2 days after initial and subsequent infestations of dogs with adult *Rhipicephalus sanguineus*. a: Group 2 dogs ($n = 10$); b: Group 3 dogs ($n = 10$).

Groups 2 and 3 did not differ significantly ($P < 0.0001$) on any of the assessment days.

In a previous trial in South Africa, the collar tested contained only propoxur (9.4 %). Its efficacy in a naturally heavily infested environment exceeded 87 % for 35 days and 94 % for 63 days against adult and immature *R. sanguineus*, respectively⁴. The inclusion of flumethrin in the collars used in the present study considerably enhanced their residual efficacy against

adult ticks. In Spain, the efficacy of an amitraz-impregnated collar exceeded 90 % against natural infestations of *R. sanguineus* during the 70-day study period².

The distribution of attached ticks on the untreated and collared dogs is graphically illustrated in Fig. 3. Most ticks on the untreated dogs attached to the head, ears and neck, whereas the greatest proportion of ticks attached along the dorsal strip of the back on the treated dogs. The greater proportion of ticks found

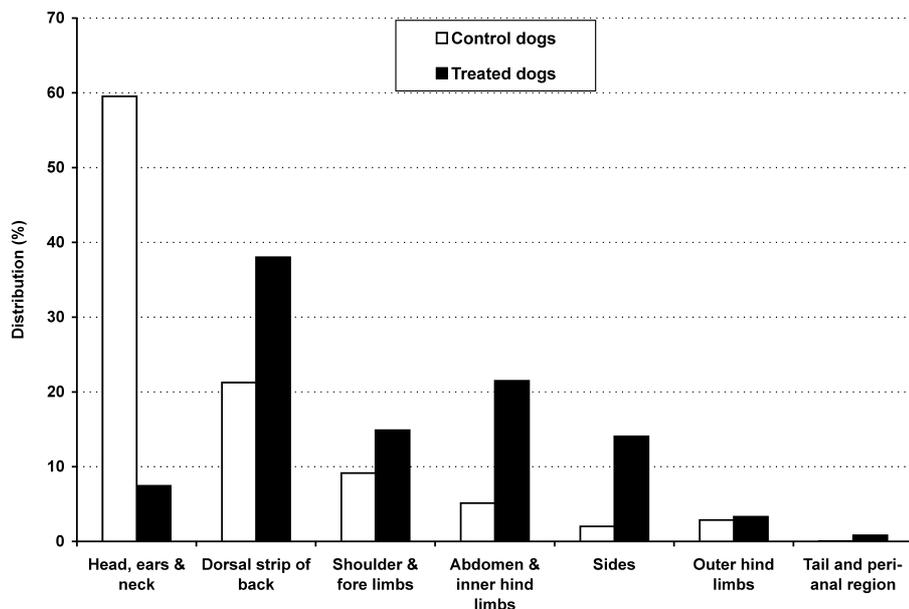


Fig. 3: Distribution of adult *Rhipicephalus sanguineus* on untreated dogs (total 3138 ticks), and on treated dogs (total 121 ticks).

posterior to the head, ears and necks of the latter dogs may indicate a slightly higher efficacy of the collars within their immediate vicinity. Only 121 ticks were collected from the 20 treated dogs during the 170 days of the study compared to 3138 from the 10 untreated dogs.

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