Influence of sheep breed and application site on the efficacy of a flumethrin pour-on formulation against ticks

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ABSTRACT

The objectives of this study were to determine the influence of application site and sheep breed on the efficacy of a flumethrin (1 % m/v) solution for the control of 'bont'-legged (*Hyalomma* spp.) and red-legged ticks (*Rhipicephalus evertsi evertsi*). This study was conducted from November 1996 to February 1997 on 3 farms in the southwestern Free State Province. Two trials were conducted on Dorper sheep and 2 on Merino sheep. For each specific application 30 sheep were selected and allocated to 3 groups of 10 animals each using randomisation through minimisation, with pre-treatment total tick count as only criterion. Groups consisted of an untreated control group, a group treated with 3 mℓ of a flumethrin (1 % m/v) solution applied only to the anogenital region, and a group treated at a dose rate of 1 mℓ flumethrin (1% m/v)/5 kg host body mass. The total dose volume for animals in the last group was divided into 3 equal parts and applied to the brisket/axillae, groin and anogenital regions respectively. Animals grazed under extensive farming conditions and were infested by ticks that occurred naturally in the environment. Ticks were counted and removed weekly over a 6-week period. In all 4 trials, *Rhipicephalus e. evertsi* was the dominant tick species, followed, in 3 of the trials, by *Hyalomma* spp. Efficacy (%) of control against ticks for Dorper sheep, treated only on the anogenital region, was variable, ranging between 29.5 and 97 %. In Merino sheep the efficacy values ranged between 23.1 and 90 %. The site-spcific (anogenital region) efficacy of control against ticks infesting Merino sheep was in general 100 % or almost 100 %. In Dorper sheep the efficacy values were >80 % for 3–5 weeks. The efficacy (%) of control against ticks for sheep treated on the brisket/axillae, groin and anogenital regions was always higher compared to sheep treated only on the anogenital region. In Dorper sheep, efficacy of control was >80 % for up to 4 weeks and in Merino sheep >80 % for 6 weeks.

Key words: ticks, efficacy of control, flumethrin, sheep.

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INTRODUCTION

About 100 different tick species, belonging to 11 different genera, parasitise sheep worldwide[13]. Apart from the damaging effects of the infestation[10], many of these ticks are also vectors of tickborne disease agents[16,17] or can cause paralysis[4]. In the extensive sheep-farming areas of South Africa, 'bont'-legged ticks (*Hyalomma* spp.) feeding on sheep can cause severe abscesses at the sites of attachment. Damage to the udder, lameness and the induction of blowfly strike often result from such lesions[10]. The red-legged tick (*Rhipicephalus evertsi evertsi*) can induce paralysis in lambs[8], and heavy infestations may also damage the udder and induce blowfly strike. Adults of both genera attach preferentially to the anogenital, udder and groin regions, or other body regions on the ventral aspects of sheep[2,8]. Experience with the use of various pour-on compounds has shown that the control of ticks attached to these regions is difficult. This is especially true for *Hyalomma* ticks attached to the interdigital clefts and fetlocks of lambs, which often cause lameness in infested animals, a phenomenon that typically occurs in regions of *Hyalomma truncatum* dominance[10]. Furthermore, it has been shown that the breed of small livestock can influence the efficacy of a pour-on[11]. For the treatment of *Ixodes rubicundus* the best results in control have been obtained when pour-on compounds were applied to the axillae and groin areas[11]. Sites of attachment for *I. rubicundus* and the other ticks (*Hyalomma* spp. and *Rhipicephalus* spp.) that commonly infest sheep differ markedly[2,3], implying that application of pour-on preparations to other sites needs to be investigated. For example, Hamel[5] treated Karakul sheep on the back, belly or axillae, groin and tail against *H. truncatum* and suggested that site of application may influence efficacy of the compound. Spot treatments of the anogenital region of sheep are often carried out by farmers in South Africa because ticks infesting these regions are conspicuous, are easier to treat than those attached to other areas, and also because it is widely believed that ticks attached to the anogenital region may induce blowfly strike[12]. The efficacy of such a site-specific treatment to control ticks on other body regions of the sheep is not known. The objectives of this study were to determine the efficacy of a flumethrin (1 % m/v) solution for the control of *Hyalomma* spp. and *Rhipicephalus e. evertsi* on sheep using different application sites, and to determine the influence of the breed of small livestock on efficacy.

MATERIALS AND METHODS

Study area

The study was conducted from November 1996 to February 1997 on 3 farms in the Fauresmith district (29°46'S, 25°19'E), Free State Province of South Africa. On the farm Bergplaas only Merino sheep were evaluated, on the farm Fanida only Dorper sheep, and on the farm Lemoenkloof both Merino and Dorper sheep. Lemoenkloof and Fanida are situated about 4 km apart, whereas Lemoenkloof and Bergplaas are adjacent farms. All 3 farms are situated within 10 km to the west of Fauresmith.

The ticks that commonly infest sheep in the southwestern Free State are *I. rubicundus, R. e. evertsi, Rhipicephalus warburtoni* and *Hyalomma marginatum rufipes*[1,7]. With the exception of *I. rubicundus,* which is active during the winter months (April to August), adults of the other species are mainly active during the warmer months of the year (November to March)[1,7].

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Survey animals

The Dorper and Merino sheep used in this study grazed under extensive farming conditions in a specific fenced area. The procedure was to select, on the basis of conspicuous and apparent tick infestations, 30 Merino and/or 30 Dorper sheep. Only ewes were used and on each property the sheep of a particular breed were of similar age and size. The Merino sheep were about 15 months old, carried 5 months of wool growth, and weighed between 36 and 46 kg. The Dorper sheep on the farm Fanida were about 10 months old and weighed between 35 and 52 kg. Dorpers on the farm Lemoenkloof were older than 2 years and weighed between 46 and 63 kg.

For ranking purposes, the ticks were counted on Day 0 but were not removed. Sheep were divided into 3 groups of 10 animals each, using randomisation through minimisation, with pre-treatment total tick count as the only criterion. All the survey animals were earmarked with colour-coded, numbered tags for proper identification.

Treatment

Body mass was determined on Day 0 using an electronic scale. Animals in Group 1 served as untreated controls. Animals in Group 2 were treated with 3 mℓ of a flumethrin 1 % m/v solution (Drastic Deadline , Bayer AH), regardless of mass. The solution was applied to the anogenital region with the aid of a vaccinator fitted with a spray nozzle. The adjustable nozzle was set to deposit the solution mainly on the bare areas. For animals in Group 3, a dose volume was calculated at a dose rate of 1 mℓ flumethrin (1 % m/v)/5 kg host body mass, based on the mass of the heaviest animal in the group. The total dose was divided into 3 equal parts that were applied to the brisket/axillae, groin and anogenital regions respectively.

The sheep were placed on their backs and both front and hind legs were kept apart by an assistant in order to facilitate treatment. The required volume was first sprayed on the brisket/axillae, followed by the groin and then the anogenital region. The solution was mainly deposited on the bare areas, but also on the wool/hair on the brisket.

The sheep (treated and control) on each property were restricted to a specific camp for the entire period (6 weeks). All non-study animals were withdrawn from those camps. The study animals ranged freely in the camps and were infested by ticks that occurred naturally in the environment.

Table 1**: Percentage composition of ticks collected from Dorper and Merino sheep on each farm.**

Farm	Sheep Breed	*Hyalomma* spp.	*Rhipicephalus e. evertsi*	Other*
Lemoenkloof	Dorper	25.8	37.6	36.6
Fanida	Dorper	30.0	62.9	7.1
Bergplaas	Merino	14.8	73.6	11.6
Lemoenkloof	Merino	23.1	66.0	10.9

**R. warburtoni* mainly.

Assessment

During post-treatment examination, which took place weekly for 6 weeks after treatment, control and treated groups were separated into different pens. Untreated control sheep were examined first, and hands and work surfaces washed between groups. During examination, all attached ticks were removed and identified as *Hyalomma* spp., *R. evertsi evertsi,* or 'other', which mainly consisted of *R. warburtoni.* The reference tick collection in the Department of Zoology and Entomology at the University of the Free State was used for identification. The sites of attachment of the ticks were also recorded. For this purpose 5 different body regions were recognised. These included the head/neck/brisket/axillae, belly/udder/groin, front and hind legs, fetlocks/interdigital clefts and anogenital area. Efficacy of control for each assessment date was expressed as the percentage of attached live adult ticks on treated animals compared to untreated control animals.

The following formula was used:

$$E = 100 - \left(\frac{x}{y} \times 100\right),$$

where E = efficacy (expressed as percentage), x = mean tick burden on treated animals, and y = mean tick burden on untreated control animals

The same formula was used to determine site-specific efficacy. In the context of this study, site-specific efficacy refers to the percentage of adult ticks attached to the anogenital areas of treated animals compared to the untreated control animals.

RESULTS

The percentage composition of ticks collected from Dorper and Merino sheep on each farm is summarised in Table 1. On all the farms *R. e. evertsi* was the dominant tick species (range 37.6–73.6 %) followed by *Hyalomma* spp. (range 14.8–25.8 %). The only exception was the flock on the farm Lemoenkloof, where the class 'other' ticks, mainly *R. warburtoni,* was 2nd in abundance (Table 1).

Data on the numbers of ticks collected from Dorper and Merino study groups on the different farms are summarised in Table 2, and the efficacy of control for the various treatment groups is summarised in Table 3. With specific reference to sheep treated on the anogenital areas (Group 2), efficacy of control for Dorper sheep on the farm Lemoenkloof varied between 29.5 and 78.3 %, recorded 1 and 3 weeks after treatment respectively. For the Dorper sheep on the farm Fanida, efficacy of control varied from 97 to 33.8 %, 1 and 6 weeks post-treatment respectively. Except for the 29.5 % recorded 1 week post-treatment on Dorpers on the farm Lemoenkloof, efficacy values for the Dorper groups showed a consistent decline over the 6-week assessment period. In Merino sheep on the farm Bergplaas, the efficacy of control values declined steadily from 90.8 %, 1 week post-treatment, to 65.5 %, 5 weeks post-treatment. The value increased to 77.8 %, 6 weeks post-treatment. Efficacy of control for Merino sheep on the farm Lemoenkloof was highly variable, with no trend discernible (Table 3).

Efficacy of control against ticks in sheep treated on the brisket/axillae, groin and anogenital regions (Group 3) was always higher than in those treated only at the anogenital site (Group 2) (Table 3). For Dorper sheep, efficacy of control was >80 % for up to 4 weeks and for Merino sheep >80 % for 6 weeks (Table 3).

The site-specific (anogenital region) efficacy of control against ticks infesting Dorper and Merino sheep (Group 2) is summarised in Table 4. In Merino sheep, few ticks were collected from the anogenital region of treated sheep, and efficacy values were in general close to 100 %. In Dorper sheep, the efficacy values were variable. On Lemoenkloof, the efficacy values were >80 % for up to 5 weeks, and on Fanida, >80 % for up to 3 weeks post-treatment (Table 4).

DISCUSSION

Sheep breed influences the efficacy of pour/spot-on acaricides[11]. In this study, a 1 % flumethrin solution applied in 3 equal volumes to the brisket/axillae, groin, and anogenital regions of Merino sheep pro-

Table 2: **Mean** (±SE) **number of ticks collected from Merino and Dorper sheep in the different treatment groups.**

Farm	Breed	Group	Mean (±SE) number of ticks per sheep at week: 1	2	3	4	5	6
Lemoenkloof	Dorper	1	4.4 (1.4)	11.4 (7.1)	13.8 (3.4)	12.5 (2.9)	12.1 (2.8)	18.3 (3.0)
		2	3.1 (1.8)	2.8 (1.2)	3.0 (1.3)	4.0 (2.1)	5.2 (1.5)	10.2 (4.0)
		3	0	0.3 (0.2)	1.1 (0.3)	2.0 (0.6)	3.2 (1.0)	7.9 (2.7)
Fanida	Dorper	1	5.8 (1.0)	4.5 (1.2)	4.7 (1.5)	4.8 (1.1)	11.1 (2.2)	8.0 (1.8)
		2	1.2 (0.4)	0.8 (0.3)	0.7 (0.5)	2.6 (0.7)	7.2 (1.7)	5.3 (1.3)
		3	0	0	0.2 (0.1)	0.6 (0.2)	2.9 (1.6)	4.5 (1.2)
Bergplaas	Merino	1	13.1 (2.5)	7.8 (1.7)	9.0 (2.0)	8.2 (1.2)	8.4 (20)	7.2 (2.2)
		2	1.2 (0.5)	0.9 (0.4)	1.5 (0.3)	1.6 (0.5)	2.9 (0.9)	1.6 (0.5)
		3	0.3 (0.2)	0.2 (0.1)	0.2 (0.2)	1.2 (0.4)	0.6 (0.3)	0.5 (0.2)
Lemoenkloof	Merino	1	6.2 (2.0)	5.3 (0.9)	3.9 (0.9)	4.9 (0.8)	4.8 (1.1)	7.3 (0.9)
		2	1.2 (0.5)	1.3 (0.7)	3.0 (0.9)	1.6 (0.5)	1.9 (0.9)	0.8 (0.4)
		3	0.1 (0.1)	0.4 (0.4)	0.6 (0.2)	0.1 (0.1)	0.6 (0.4)	0.5 (0.3)

Group 1 = untreated control
Group 2 = treated with 3 mℓ of a flumethrin 1 % m/v solution on the anogenital region
Group 3 = treated at 1 mℓ flumethrin (1 % m/v)/5 kg host body mass, equal volumes applied to brisket/axillae, groin and anogenital regions.

Table 3: **Efficacy** (%) **of control of a 1 % flumethrin solution on Merino and Dorper sheep.**

Farm	Breed	Group	Efficacy (%) of control at week: 1	2	3	4	5	6
Lemoenkloof	Dorper	2	29.5	75.4	78.3	68.0	57.0	44.3
		3	100.0	97.4	92.0	84.0	73.6	56.8
Fanida	Dorper	2	97.0	82.2	85.1	45.8	35.1	33.8
		3	100.0	100.0	95.7	87.5	73.9	43.8
Bergplaas	Merino	2	90.8	88.5	83.3	80.5	65.5	77.8
		3	97.7	97.4	97.8	85.4	92.9	93.1
Lemoenkloof	Merino	2	80.6	75.5	23.1	67.3	60.4	89.0
		3	98.4	92.5	84.6	98.0	87.5	93.2

vided a more prolonged (6 weeks) high level (>80 %) of control compared to Dorper sheep (>80 % for up to 4 weeks). This was also evident for those groups of sheep treated on the anogenital region alone, although efficacy of control was more variable. Hamel[5] suggested that sheep breed may influence overall acaricidal efficacy of a flumethrin pour-on formulation. In a study of differences in the efficacy of a 1 % deltamethrin pour-on formulation to protect small livestock against infestations with *I. rubicundus,* the compound afforded the best control on Merinos, followed by Dorpers and Angoras[11]. It was suggested that differences in the amount of sebum and sweat in the epidermis of the different breeds may be responsible for differences in the rate of spread and the level of dilution of the active compound in the epidermis[11]. It has been demonstrated that cypermethrin (or its metabolites) moves across the skin within the stratum corneum of the epidermis and that this effect is probably the result of the lateral movement of sebum and sweat through intercellular channels[9].

To optimise efficacy of control the pour-on or spot-on should be applied to the body regions where the ticks prefer to attach. Analysis of the distribution of flumethrin on the body surface of cattle following topical pour-on application has shown that the highest concentrations are found at the sites of application[15]. *Hyalomma* spp. and *R. e. evertsi* ticks commonly attach to the anogenital/inguinal and brisket regions of sheep [2,8]. In this study, application of flumethrin to the anogenital region only of sheep gave excellent and prolonged protection against ticks attaching in this area, especially in Merino sheep, but little protection against ticks attaching elsewhere on the body. Application of the acaricide to other appropriate body regions in this study resulted in high levels of efficacy. The application of a 1 % deltamethrin pour-on solution to the axillae and groins of Dorper and Merino sheep provided similar protection (>80 %) against *I. rubicundus* for 4–8 weeks[11]. *I. rubicundus* ticks mainly attach to the ventral body regions, above the knees, of small livestock[3]. Application of pour-on compounds to the dorsal midline of sheep to control *I. rubicundus* is not optimally effective (L J Fourie, unpubl. data, 1993).

Table 4: **Site-specific** (anogenital region) **efficacy** (%) **of control against ticks infesting Dorper and Merino sheep** (Group 2)**. The mean number of ticks collected from the anogenital region of control sheep is given in brackets.**

Week	Dorper		Merino	
	Lemoenkloof	Fanida	Lemoenkloof	Fanida
1	100.0 (3.9)	100.0 (3.5)	100.0 (5.0)	98.4 (12.4)
2	98.9 (8.8)	88.6 (2.6)	100.0 (3.7)	98.6 (7.1)
3	93.2 (10.3)	100.0 (3.9)	96.0 (2.5)	100.0 (7.7)
4	98.1 (10.6)	56.2 (3.3)	100.0 (3.9)	100.0 (6.4)
5	88.4 (9.7)	53.7 (9.5)	100.0 (4.3)	100.0 (7.7)
6	63.8 (14.9)	46.9 (6.4)	100.0 (6.3)	100.0 (6.6)

For those adult ticks that prefer to attach to the dorsal body regions (head, withers, back) of sheep, such as *Dermacentor marginatus* and *Ixodes ricinus,* application of pour-on compounds to the dorsal midline resulted in high levels of control [6,14].

Ticks feeding on the anogenital areas of sheep, especially Merinos, can potentially precipitate blowfly strike[12]. Application of 3 mℓ of a 1 % flumethrin compound will provide extended (6 weeks) protection against feeding ticks and thus also decrease the risk of blowfly strike. To prevent ticks from feeding elsewhere on the body, the compound should also be applied to the axillae/brisket and groin areas, especially to limit damage to the udders of ewes caused by feeding *Hyalomma* ticks.

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