Repellency effect of flumethrin pour-on formulation against vectors of Crimean–Congo haemorrhagic fever

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Abstract

Background: Ticks are able to transmit important diseases to humans, including Rocky Mountain spotted fever, Q fever, Crimean–Congo haemorrhagic fever, summer Russian encephalitis, and relapsing fever.

Aims: To determine the repellency effect of 1% flumethrin pour-on formulation against hard ticks.

Methods: The concentration of flumethrin pour-on formulation was 1 mg/10 kg body weight and was administered on the dorsal midline from the head to the base of the tail. The livestock included cows, goats, oxen and sheep in 2 villages in Ardabil Province, Islamic Republic of Iran.

Results: We studied 200 livestock comprising 5 age groups (< 2, 3–4, 5–6, 7–8 and >8 years). The main hard ticks identified were *Hyalomma* species (62.5%) and *Rhipicephalus bursa* (37.5%). In the treatment village, the maximum number of ticks per animal was 11.6 in oxen, 9.5 in sheep, 8.9 in goats and 8.6 in cattle. The repellency effect of flumethrin remained for 2 months.

Conclusion: Flumethrin provided 2 months protection against hard ticks. Therefore, it could be used in the livestock industry. Control of ticks is important for prevention of disease transmission.

Keywords: flumethrin, Islamic Republic of Iran, livestock, repellency, ticks

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Introduction

Ticks are important in human and veterinary medicine. Hard ticks include > 650 species. Diseases that are transmitted by ticks have a major economic impact on the livestock industry worldwide. Ticks are able to transmit several important diseases to humans, including Rocky Mountain spotted fever, Q fever, Crimean–Congo haemorrhagic fever (CCHF), summer Russian encephalitis, and relapsing fever (*1–4*). Control of ticks is important for prevention of disease transmission. Chemical methods are the most commonly used for control of ectoparasites.

Chemical insecticides, biological control, environmental management and repellent agents are the most important methods for tick control. However, the stability of some insecticides in nature and their adverse effects on humans and the environment are major concerns (*5*,*6*). For farmers and consumers, the important factors for insecticides are ease of application, low cost and long-term protection. Repellent compounds are derived from plant oils, smoke and tars, and they can be used for killing and repelling insects. Before World War II, there were 4 major repellents that had been in use for repellency of insects and animals for several years: Citronella oil was used for head lice; dimethyl phthalate was discovered in 1929; indole was invented in 1937; and Rutgers 612 was evaluated in 1939 (*7*). A total of 901 products are available: 872 synthetic oils and 29 plant oils. The United States Department of Agriculture tested some repellents against 4 types of cockroaches in Germany during 1953–1973 (*8*).

Flumethrin is a pyrethroid insecticide. It is used externally in veterinary medicine against parasitic insects and ticks on cattle, sheep, goats, horses and dogs, as well as for control of parasitic mites in honeybee colonies. Flumethrin is applied in a line from the base of the skull along both sides of the spine to the tail in cattle. The median lethal dose for rats by ingestion is 500–1000 mg/kg. Flumethrin is toxic to fish and aquatic animals (*9*). It acts on the nervous system of the target arthropods (*10–12*).

Methods

Study area

This study was conducted in 2014–2015 in Meshkinshahr County, which is located in the centre of Ardabil Province, Northwest Islamic Republic of Iran (Figure 1). This region has a cool climate (maximum 35°C) during the hot summer months. The winter is cold (minimum −25°C). A total of 25 000 people are involved with rearing livestock.

Study design

This was a case–control study of the repellency effect of 1% flumethrin pour-on against vectors of CCHF. The efficacy of flumethrin was evaluated in in 2 randomly selected villages with similar ecological features, Ur as treatment village and Majandeh as control village. One hundred livestock were selected randomly from each village, including cattle, sheep, oxen and goats, in 5 age groups (< 2, 3–4, 5–6, 7–8 and > 8 years). Tick survival rate was determined by examining the whole body of the animals at different times. In the treatment village, 50 livestock were sprayed with 1% flumethrin pour-on. The same number of livestock without flumethrin was checked as controls. The number of ticks on the livestock was counted prior to the experiment. At 1, 2, 3, 7, 14, 30 and 60 days after application, the tick density was determined. The control village was similar to the treatment village, in terms of lifestyle, livestock keeping, number and type of livestock and living conditions, and climate. Livestock in the control village were not treated with flumethrin. The results were analysed using the χ^2 test and *t* test.

Tick identification

All the collected ticks were identified according to the valid identification keys of Janbakhsh (1956), Hoogsteraal (1956) and Walker et al. (2007).

Results

Animal infestation

During the study period, 1975 ticks were collected and identified. In Ur, the maximum number of ticks per animal was 11.6 in oxen, 9.5 in sheep, 8.9 in goats and 8.6 in cattle (Table 1). The highest infestation rates were observed in age groups < 4 years.

Tick species

We identified 200 hard ticks morphologically: 80 *Hyalomma marginatum* (40%), 25 *Hyalomma anatolicum* (12.5%), 15 *Hyelomma dromedarii* (7.5%), 5 *Hyelomma detritum* (2.5%) and 75 *Rhipicephalus bursa* (37.5%).

Repellency of flumethrin

The repellency of flumethrin for up to 60 days is shown in Figure 2. The repellency of flumethrin according to age of livestock is shown in Table 2. This ranged from 100% for animals aged > 8 years to 91.2% for those aged 5–6 years. The repellency effect of flumethrin in different types of livestock is shown in Table 3. This ranged from 97.3% for goats to 90.5% for oxen.

Discussion

We studied the repellent effect of flumethrin insecticide. Tick infestation of cattle was related to the age of host animals, with old cattle having fewer ticks. We showed that there was a direct relationship between livestock age and efficacy of flumethrin. The repellency effect of 1% flumethrin pour-on showed a significant difference in oxen and sheep ($P < 0.01$). However, there was no significant difference between the number of ticks remaining on cows compared with other livestock ($P > 0.01$).

Other studies have shown that 1% flumethrin pour-on also provides long-term protection of livestock against ticks worldwide (*13*,*14*). In Jeddah, Saudi Arabia, 1% flumethrin pour-on was used to control *H. dromedarii* in dromedaries. For animals with high density of ticks, 2 ml/10 kg body weight was used, and 1 ml/10 kg for those with only mild contamination. In comparison with control animals, there was a high level of tick control with both doses (*15*). In another study in Riyadh, Saudi Arabia, 2 insecticides, 1% flumethrin pour-on formulation and 20% coumaphos WP formulation, were used topically against different stages of *H. dromedarii* on camels (*16*).

The toxicity of flumethrin was 8 times higher than that of coumaphos against ticks. Some studies have shown that 1% flumethrin pour-on has 95–100% lethality for ectoparasites (*17*). Flumethrin can prevent disease transmission by ticks, fleas, mites and other ectoparasites due to its repellent property (preventing blood feeding) (*17*). In the present study, the repellent property of flumethrin was evaluated against hard ticks on cows, sheep, water oxen and goats. Flumethrin repelled hard ticks of *Hyalomma* species and *Rhipicephalus bursa* from livestock for 2 months. In other studies, a combination of different toxicants increased the lethal and retention properties of this toxicant for a long time (*18*). A combination of flumethrin and imidacloprid was administered to dogs in a collar, and after 6 and 12 hours, the insecticides had 94–100% repellent and lethal effects on *Dermacentor variabilis* and *Amblyomma americanum* ticks. The protection time of these animals against ticks was estimated at 28–48 days. The repellent rate of flumethrin was estimated at > 2 months under field conditions (*19–22*). In a study in Namibia of sheep contaminated with *Hyalomma truncatum* treated with 1% flumethrin pour-on, ticks disappeared for 4 weeks and full protection was provided (*23*).

Flumethrin is effective against a broad range of ectoparasites. In endemic areas for visceral leishmaniasis it can have repellent and antinutritional properties against the sandfly vector *Phlebotomus* (Larrossius group). In a study from Southern Italy, 4.5% flumethrin and 10% imidacloprid achieved 90.5–100% prevention of dog leishmaniasis. It had a significant antinutritional effect on *Phlebotomus* and reduced *Leishmania infantum* in young dogs. This combination achieved 8 months of protection in comparison to 5 months with deltamethrin (*24*). Another study examined the effect of 1% flumethrin pour-on on visceral leishmaniasis in dogs. The ratio index of blood feeding by *Phlebotomus* in the dogs treated with flumethrin pour-on was 12.26–25%, compared with 53.8–58.7% in the control group. This difference was significant. Also, the index of preventing blood feeding by *Phlebotomus* was 75–87.74 and 41.29–46.45% in the treatment and control groups, respectively. Again, this difference was significant (*25*).

Conclusion

We recommend the use of 1% flumethrin pour-on formulation for livestock every 2 months in cold and mountainous climates (like Northwest Islamic Republic of Iran). Appropriate use of this insecticide at the recommended dose provides effective protection against important ticks on livestock.

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