Comparative efficacy of commercial preparation of deltamethrin and cypermethrin against *Ornithodoros* spp. of North Gujarat

Neelu Sharma¹ · Veer Singh¹ · K. P. Shyma¹ · H. R. Parsani¹

Received: 21 February 2016 / Accepted: 21 July 2017 / Published online: 29 July 2017
© Indian Society for Parasitology 2017

Abstract Ticks have massive capacity of acting as vectors of numerous pathogens that affect human, livestock and pets, which owes to their medical and veterinary importance. In animals, tick infestations are much more severe than in humans. Animals can be parasitized by hundreds or even thousands of ticks, which then proliferates the effect on the host. In almost all tropical and subtropical countries like India not only the hard ticks (Ixodidae) but also the soft ticks (Agrasidae) are responsible for economic losses either by direct injuries or disease transmission. Presently used control measure for ticks is only the use of commercially available acaricide compounds which are not much satisfactory and therefore a check on efficacy of these compounds is necessary for effective control. Commercially available preparations of deltamethrin (Butox, 1.25% E.C.) and cypermethrin (Ectomin, 10% E.C.) were compared for the acaricidal activity against soft ticks, *Ornithodoros moubata* by using Larval Packet Test. Larval mortality was higher with Butox as compared to Ectomin. Butox elicits 70% larval mortality, at the manufacturer's recommended dosage (25 ppm) while for Ectomin, larval mortality was 38.46% at the manufacturer's recommended dosage (200 ppm). This illustrates that deltamethrin (Butox) is more effective than cypermethrin (Ectomin).

Keywords *Ornithodoros* ticks · Cypermethrin · Deltamethrin

Introduction

Ticks are most competent and versatile arthropod vector for transmission of various pathogens in animals as well as humans (Shyma et al. 2015). Tick and Tick-borne diseases (TTBDs) are continuously on rise in tropics, posing serious world health problem and a major obstacle for animal health and production (Rajput et al. 2006). Soft ticks can transmit greater variety of pathogenic organisms including viruses, bacteria and blood protozoan's to livestock, humans and companion animals such as tick borne encephalitis, lyme disease, african swine fever virus, blue tongue virus, *Borrelia duttoni*, babesiosis and theileriosis (Jongejan and Uilenberg 2004; Matias et al. 2007; Bouwknegt et al. 2010). In addition to transmission of all these pathogenic organisms they also harm animals by sucking blood intermittently leading to anemia, general stress and irritation (Telmadarrai et al. 2007).

Presently control of ticks is mainly concerned with use of acaricides (Tolleson et al. 2007). Currently in North Gujarat, ticks are controlled by indiscriminate use of synthetic pyrethroids. However there is failure in control of ticks by this method due to development of resistance strains of ticks in environment (Shyma et al. 2015). Therefore it is important to investigate the efficacy of commonly used acaricides to control ticks so as to check their resistant or susceptible status and formulation of new control methods in case of treatment failure. There are lot of reports on development of resistance in hard ticks infesting livestock (Sharma et al. 2012; Shyma et al. 2012, 2013, 2015; Singh et al. 2014, 2015; Kumar et al. 2014), whereas, very little information is available on susceptibility/resistance status of soft ticks (Ghavami et al. 2015; Telmadarraiy et al. 2007). The present study was aimed for determination of acaricidal activity of commercial

✉ K. P. Shyma
dr.shymakpvet@gmail.com

¹ Department of Veterinary Parasitology, Sardarkrushinagar Dantiwada Agricultural University, Palanpur, India

formulations of acaricides (deltamethrin and cypermethrin) on soft ticks of Patan district of North Gujarat.

Materials and methods

Collection and identification of ticks

Live engorged adult female ticks were collected from dairy farms, cattle pens, and human dwellings. These were collected in vials, closed with muslin cloth to allow air and moisture exchange, brought to the Entomology Laboratory, Department of Veterinary Parasitology, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India. Ticks were then identified macroscopically and microscopically by using tick identification sources (Ruedisueli and Manship 2006; Telmadarraiy et al. 2004; Walker et al. 2003).

Laboratory maintenance of ticks

Ticks were then washed, cleaned, labeled, and kept at 28 ± 1 °C and $85 \pm 5\%$ relative humidity for egg laying. It took around two months for hatching of eggs into larvae and for experimental bioassay 12–14 day old larvae were used.

Acaricides

The commercial products, namely 10% EC cypermethrin and 1.25% EC deltamethrin at the concentrations of 100, 200, 400, 800 and 1600 ppm and 12.5, 25, 50, 100, and 200 ppm respectively were prepared in distilled water from the stock solution.

Larval packet test (LPT)

Larval packet test was conducted according to FAO (1971), guidelines with minor modifications (Shyma et al. 2012). Six hundred microliter of different concentrations of cypermethrin, and deltamethrin in distilled water were used to impregnate 3.75 cm by 8.5 cm filter paper rectangles (Whatman filter paper no. 1). The aqueous solution of acaricides was dried by keeping the filter paper for 30 min in incubator at 37 °C. The rectangles were folded in half and sealed on the sides with adhesive tapes, forming an open-ended packet to place tick larvae. Approximately 50 larvae were inserted and the packet was sealed with adhesive tape. The test was done in triplicate for each concentration of drugs. These packets were then placed in a desiccators in BOD incubator maintained at 28 ± 1 °C and $85 \pm 5\%$ RH. The packets were removed after 24 h, and larval mortality was calculated. Control packets impregnated with diluent only were also prepared for each series of concentration to be tested.

Statistical analysis

Dose response data were analyzed by probit method (Finney 1952) using Graph Pad Prism software. Regression curves of mortality of larva were also plotted against values of acaricide concentrations by log dosage probit mortality analysis for determination of LC_{50} and LC_{95} values of cypermethrin and deltamethrin.

Results

Important morphological features used in identification included size of tick, oval rounded body with tough, corrugated and dusty colored integument and integument with rounded tubercles (Fig. 1). These peculiar features revealed

Fig. 1 Microscopic view of the soft tick *Ornithodoros* spp.

Fig. 2 Comparative percentage mortality in larvae of *ornithodoros* spp. subjected to dose response LPT assay with deltamethrin and cypermethrin

Table 1 Mortality slope, LC₅₀ and LC₉₅ and coefficient of determinations of commercial formulations of deltamethrin and cypermethrin on larvae of *Ornithodoros* ticks

Active ingredient	Commercial preparation	LC ₅₀	LC ₉₅	Slope	R ²
Cypermethrin	Ectomin	365.23	17,058.59	0.71 ± 0.09	95.50
Deltamethrin	Butox	16.66	428.22	1.16 ± 0.35	78.38

that the ticks collected were soft ticks belonging to family *Ornithodoros* spp. (Ruedisueli and Manship 2006; Telmadarraiy et al. 2004; Walker et al. 2003). Graphs were plotted between log concentrations of acaricides and probit mortality for determination of LC₅₀, LC₉₅, slope and coefficient of determinations (R²) values (Fig. 2). For the determination of acaricidal activity of these drugs, percentage mortality of field tick was compared with the recommended dose of market formulated drug. Effects of commercial formulations of deltamethrin and cypermethrin on *Ornithodoros* ticks are shown in Table 1.

Results clearly depicts that *Ornithodoros* spp. ticks were susceptible for deltamethrin having high percentage mortality at the recommended as well as higher concentrations, hence it is effective for these ticks at its market formulated dose rate whereas, cypermethrin produced a lower level of mortality at its market recommended dose rate as well as at higher concentrations. A dose dependent increase in larval mortality was observed for both drugs. However, both preparations could not produce 100% mortality even at the highest concentration tested.

Discussion

Soft ticks are also equally important as hard ticks in spread of infectious diseases to animals and humans and also suck blood leading to anemic condition, loss of production and stress in animals. Selection for resistance in tick populations is a major consequence of extensive application of acaricides and a major threat to the efficacy of control programs against tick borne diseases. The present study revealed levels of susceptibility to commercially available deltamethrin and cypermethrin in *Ornithodoros* spp. of soft tick. There are only few studies related to susceptibility of various acaricides against *Ornithodoros* spp. ticks. This is first report which determines the efficacy of commercially available deltamethrin and cypermethrin for *Ornithodoros* spp. in India. A comparative study has been conducted by Telmadarraiy et al. (2007) for estimation of comparative susceptibility of cypermethrin in *Ornithodoros lahorensis* Neuman and *Argas persicus* Oken field populations in Iran. Ghavami et al. (2015) worked on susceptibility level of *Ornithodoros tholozani* to some pesticides in North West of Iran.

Both the drugs were not able to produce 100% mortality at the highest concentration used. Comparing the mortality % of both the drugs at different concentrations revealed that deltamethrin was relatively more effective and showed high % mortality at the recommended dose rate (25 ppm). At recommended dosage of deltamethrin, 70% of the mortality could be recorded however, cypermethrin could produce even lower percentage mortality at the recommended dose rate (200 ppm). The present study revealed deltamethrin to be more effective at its recommended dose rate as compared to cypermethrin suggesting that *Ornithodoros* ticks may have developed resistance against cypermethrin.

Conclusion

In the present study, commercial formulations of deltamethrin and cypermethrin were compared in vitro by LPT for their acaricidal activity against *Ornithodoros* spp. Based on the results obtained, it can be concluded that there is urgent need to revise the dose rate at which these synthetic pyrethroids are used by the livestock keepers in the area. Alternate control strategies have to be developed in due course to combat the development of resistance in tick population so as to control them (Shyma et al. 2014).

Acknowledgements The authors are thankful to the Director of Research and Dean, College of Veterinary Science and Animal Husbandry, Sardarkrushinagar Dantiwada Agricultural University, for providing facilities to carry out the research work.

References

- Bouwknegt C, Van Rijn PA, Schipper JJ, Hölzel D, Boonstra J, Nijhof AM, Van Rooij EM, Jongejan F (2010) Potential role of ticks as vectors of bluetongue virus. *Exp Appl Acarol* 52:183–192
- FAO (1971) Recommended methods for the detection and measurement of resistance of agricultural pests to pesticides—tentative method for larvae of cattle ticks, *Boophilus microplus* spp. FAO method No. 7. *FAO Plant Protect Bull* 19:15–18
- Finney DJ (1952) Probit analysis—a statistical treatment of the sigmoid response curve. Cambridge University press, Cambridge, pp 1–318
- Ghavami MB, Goli S, Mohammadi J, Vatandoost H (2015) Susceptibility level of *Ornithodoros tholozani* (Acari: Argasidae) to some pesticides in North West of Iran. *Persian J Acarol* 4:83–94

- Jongejan F, Uilenberg G (2004) The global importance of ticks. *Parasitology* 129:S3–S14
- Kumar S, Sharma AK, Ray DD, Ghosh S (2014) Determination of indiscriminating dose and evaluation of amitraz resistance status in different field isolates of *Rhipicephalus (Boophilus) microplus* in India. *Exp Appl Acarol*. doi:10.1007/s10493-014-9789-8
- Matias PJS, Marcio BC, Hernani GCR, Marcos VG, Karina CC, Adriano P, Viviani AV, Georgia MM, Jose Mauricio BD, Marcelo B (2007) *Labruna* species diversity and seasonality of free living ticks (Acari: Ixodidae) in the natural habitat of wild marsh deer (*Blastocerus dichotomus*) in southeastern Brazil. *Vet Parasitol* 143:147–154
- Rajput ZI, Hu SH, Chen WJ, Arijio AG, Xiao CW (2006) Importance of ticks and their chemical and immunological control in livestock. *J Zhejiang Univ Sci B* 7:912–921
- Ruedisueli FL, Manship B (2006) Tick identification key. University of Lincoln. <http://webpages.lincoln.ac.uk/fruedisueli/FR-webpages/Parasitology/Ticks/tik/tickkey/softticks-adult.Html>
- Sharma AK, Kumar R, Kumar S, Nagar G, Singh NK, Rawat SS, Dhakad ML, Rawat AKS, Ray DD, Ghosh S (2012) Deltamethrin and cypermethrin resistance status of *Rhipicephalus (Boophilus) microplus* collected from six agro-climatic regions of India. *Vet Parasitol* 188:337–345
- Shyma KP, Kumar S, Sharma AK, Ray DD, Ghosh S (2012) Acaricide resistance status in Indian isolates of *Hyalomma anatolicum*. *Exp Appl Acarol* 58:471–481
- Shyma KP, Kumar S, Sangwan AK, Ray DD, Ghosh S (2013) Acaricide resistance status of *Rhipicephalus (Boophilus) microplus* and *Hyalomma anatolicum* collected from Haryana. *Indian J Anim Sci* 83:591–594
- Shyma KP, Gupta JP, Ghosh S, Patel KK, Singh Veer (2014) Acaricidal effect of herbal extracts against cattle tick *Rhipicephalus (Boophilus) microplus* using in vitro studies. *Parasitol Res*. doi:10.1007/s00436-014-3839-3
- Shyma KP, Gupta JP, Singh Veer, Patel KK (2015) In vitro detection of acaricidal resistance status of *Rhipicephalus (Boophilus) microplus* against commercial preparation of deltamethrin, flumethrin, and fipronil from North Gujarat, India. *J Parsitol Res*. doi:10.1155/2015/506586
- Singh NK, Jyoti HaqueM, Singh H, Rath SS, Ghosh S (2014) A comparative study on cypermethrin resistance in *Rhipicephalus (Boophilus) microplus* and *Hyalomma anatolicum* from Punjab (India). *Ticks Tick-borne Dis* 5:90–94
- Singh NK, Gelot IS, Jyoti, Singh V, Rath SS (2015) Detection of amitraz resistance in *Rhipicephalus (Boophilus) microplus* from North Gujarat India. *J Parasit Dis* 39:49–52
- Telmadarraiy Z, Bahrami A, Vatandoost H (2004) A survey on fauna of ticks in west Arabian province Iran. *Iran J Publ Health* 3:65–69
- Telmadarraiy Z, Nasirian N, Vatandoost H, Abolhassani M, Tavakoli M, Zarei Z, Banafshi O, Rafinegad J, Salarilak SH, Faghihi F (2007) Comparative susceptibility of cypermethrin in *Ornithodoros lahorensis* and *Argas persicus* field populations. *Pak J Biol Sci* 10(23):4315–4318
- Tolleson DR, Teel PD, Stuth JW, Strey OF, Welsh TH, Carslens GE (2007) Fecal NIRS: detection of tick infestations in cattle and horses. *Vet Parasitol* 144:146–152
- Walker AR, Bouattour A, Camicas JL, Estrada-Pena A, Horak IG, Latif AA, Pengram RG, Preston PM (2003) Domestic animals in ticks of domestic animals in Africa: a guide to identification of species. The University of Edinburgh, UK