Bulgarian Journal of Veterinary Medicine, 2020 ONLINE FIRST
ISSN 1311-1477; DOI: 10.15547/bjvm.2358

Original article

TESTS ON THE EFFICACY OF AMITRAZ, IVERMECTIN AND EPRINOMECTIN FOR CONTROL OF LICE IN GOATS

P. PRELEZOV[1], N. NIZAMOV[1] & P. VELEVA[2]

[1]Department of Microbiology, Infectious and Parasitic Diseases, Faculty of Veterinary Medicine, Stara Zagora, Bulgaria; [2]Department of Computer Science and Mathematics, Faculty of Economy, Stara Zagora, Bulgaria

Summary

Prelezov, P., N. Nizamov & P. Veleva, 2020. Tests on the efficacy of amitraz, ivermectin and eprinomectin for control of lice in goats. *Bulg. J. Vet. Med.* (online first).

Ectoparasitic infestations with *Linognathus stenopsis* and *Bovicola caprae* are a serious concern in goat farms, especially during the winter and spring. This study tested the efficacy of three modern insecticide drugs (ivermectin, eprinomectin and amitraz) applied via different routes for control of sucking and chewing lice in naturally co-infected goats. Each of drugs was tested on 30 goats. The animals from the first flock were treated with a single dose of ivermectin, applied subcutaneously at 0.2 mg/kg, the second one received a single spot on treatment with 1 mg/kg eprinomectin and the third flock was treated twice with amitraz, through spraying at a dose of 4 mL/1 L water. The results were evaluated before the treatments and at post treatment days 3, 14 and 60. On post treatment day 60, the application of ivermectin resulted in reduction of *Bovicola caprae* population by 73.05%, and for that of *Linognathus stenopsis:* by 92.70%. Eprinomectin demonstrated 100% reduction of both lice. The reduction of *L. stenopsis* and *B. caprae* caused by amitraz was by 92.20% and by 98.61% respectively. The macrocyclic lactone eprinomectin showed the highest efficacy ($P<0.05$), was not toxic for goats and therefore, may be used as a treatment of choice for lice control.

Key words: amitraz, eprinomectin, goat, ivermectin, louse

INTRODUCTION

Goat farming is still a traditional branch of national livestock husbandry, especially in small private operations. This small ruminant species has a good potential for adaptation and is straightforwardly reared. Goats are high-yielding, yet not fastidious, and their milk is used for production of valuable dietetic foods.

Goats are infested with various stationary and temporary ectoparasites by reason of stable-pasture rearing and feeding. Thus, flocks become inevitably infected with lice without proper intervention from the part of the owner or veterinarian. Lice are stationary strictly host-specific ectoparasites from Order Phthiraptera, divided into sucking (Suborder Anoplura) and chewing lice (Suborders Ischnocera; Amblycera). In Bulgaria, similarly to global tendency, the commonest lice infecting

goats are the chewing lice (*Bovicola caprae*) and sucking lice (*Linognathus stenopsis*).

The animals are most commonly affected during the winter and early spring. At that time, rearing conditions are compromised due to increased population density and improper facilities, which are beneficial for the spread of entomosis. Goats with poor body condition become infected more easily and readily, the infection course is more severe compared to animals in good condition (Soulsby, 1986).

On one hand, lice could incur economic losses through induced pathophysiological alterations in hosts, e.g. weight loss, skin damage, mild to severe anaemia, hypoproteinaemia, nutritional deficiencies and decreased vitality (Otter *et al.*, 2003; Paul *et al.*, 2012). Furthermore, they could be responsible for transmission of pathogens (viruses, bacteria, fungi and protozoa) to susceptible hosts (Hornok *et al.*, 2010).

A lot of compounds, including chlorinated hydrocarbons, organophosphates, formamidines, carbamates, rotenone and pyrethroids are used for lice control. Until the appearance of the macrocyclic lactones (avermectin/milbemycin), the elimination of lice populations seemed impossible. The application of drugs through bathing and spraying during the seasons when lice populations are the most numerous is very difficult. A particular challenge is the treatment of lactating dairy animals. The appearance of ivermectin has increased the efficiency of treatment of ectoparasitic infestations (Bowman, 1995). The ease of application and high, almost 100% efficacy, allowed eliminating parasitic populations. Yet, ivermectin use is limited in lactating animals.

The mechanism of action of macrocyclic lactones is receptor-mediated. They impede the transmission of nerve impulses via competitive displacement of proteins bound to receptors for activation of chloride channels in postsynaptic membrane. They potentiate the inhibitory neurotransmitters of GABA receptors and thus, damage membrane functions, while activated GABA results in hyperpolarisation and placid paralysis (Vercruysse & Rew, 2002).

Shoop *et al.* (1996) reported the discovery of a novel molecule described as 4"-epi-acetylamino-4"-deoxy-avermectin B1, also known as eprinomectin. This novel molecule has a similar and better spectrum of antiparasitic activity that those reported for other avermectins or milbemycin, also because it is partitioned in the body in a way such to yield a low milk residue, hence is eligible for use during the lactation. Amitraz is a pharmacologically active substance with insecticidal and acaricidal properties, used worldwide for control of ectoparasites in animals (Yilmaz & Yildizdas, 2003). It is an alpha-2 adrenergic agonist acting through stimulation of alpha-2 adrenoceptors in the central nervous system and of alpha-1 and alpha-2 adrenoceptors in the peripheral nervous system. Furthermore, it inhibits the activity of monoaminooxidase and prostaglandin E_2 synthesis (Jones, 2002).

The purpose of the present study was to investigate some aspects of the therapy of natural phthirapteriasis in goats with modern insecticidal drugs.

MATERIALS AND METHODS

Animals

The experiments were carried out with 90 animals, 30 from each flock. Flocks had a similar intensity of infection and extensity

of infection. Goats were from a local Bulgarian breed, naturally infested and randomly chosen (with various colour and length of haircoat, body condition and body weight). The tests were performed in three privately owned farms: Mogila, Yambol district from 9 February to 13 April 2018 with 300 goats, in Sborishte, Sliven district from 5 October to 14 December with 100 goats and in Gorno Cherkovishte, Stara Zagora district, from 5 February to 10 April 2019 with 78 animals. The date of last treatment against ectoparasites was unknown. The goats were reared on pastures during most of the time, sharing common areas with other ruminant herds reared in the region. The preliminary examination of goats showed that their body condition was from medium to poor. They exhibited pruritus, parts of their skin was rougher, covered with loose hair.

Experiments were performed with naturally infected animals with the consent of owners in line with stipulation of Ordinance 20 of 1 November 2012 on minimum requirements for protection and welfare of experimental animals and requirements to facilities for their use, rearing and/or delivery. Used drugs are included in the Register of veterinary medicinal products licensed in the Republic of Bulgaria on the basis of art. 290, para 1 of the Veterinary Activities Act, in force by 30 July 2020.

Examination

Before treatment, goats were inspected with a magnifying glass for skin alterations including alopecia, flakes, crusts, nodules, as well as eggs and adult ectoparasites. Detected lice (preimaginal and imaginal life stages) were individually collected with tweezers and stored in containers with 70% ethanol. Collected insects were transported to the lab, immersed in xylene for 5 minutes for clearing and dehydration, then mounted on glass slides in Canada balsam with cover glasses to obtain permanent slides for microscopy. Lice were identified by morphological features described by Neveu Lemaire (1938). To determine the intensity of infection, all lice were counted in a total of 7 squares (area 10 cm^2) fixed with a paper template. Areas were from (1) shoulder, (2) brisket, (3) neck, (4) flank, (5) thigh, (6) groin and (7) abdomen from one side of the body (Brown, 2005). Observations and photographies were made on DMi1 S/M 424790 Leica® microscope (Leica Microsystems CMS GmbH), equipped with photocamera Leica MC120 HD.

Treatments

All goats from the flock in Mogila settlement were treated with ivermectin (Pandex™), applied subcutaneously at 0.2 mg/kg. The flock in Sborishte was treated with eprinomectin (Eprinex multi™), applied as a spot on, at 1 mg/kg, and goats from Gorno Cherkovishte were treated by spraying with 4 mL amitraz /1 L water (AMITRAZ 12.5%) twice at 14-day interval. The results from treatments were evaluated by four exams of the entire body of animals: prior to the treatment and on days 3, 14 and 60 after that.

Statistical analysis

To determine the presence of significant differences between different controlling days (days 0, 3, 14 and 60) after the treatment with ivermectin, eprinomectin or amitraz of animals infested with *Linognathus stenopsis* and *Bovicola caprae,* multivariate ANOVA with LSD post-hoc test was applied. The results were processed with SPSS Statistics 17.0.0 Win-

Wrap Basic, Copyright 1993–2007 software.

RESULTS

Morphological and microscopic identification confirmed that collected lice were imagines and nymphs of the sucking lice *L. stenopsis*, Burmeister (1838), from the family *Linognathidae*, suborder Anoplura, order Phthiraptera and of the chewing lice *B. caprae,* Gurlt (1843), from the family *Bovicoliidae*, suborder Ischnocera.

The efficacy of the three drugs against sucking lice *L. stenopsis* are presented in Table 1. Ivermectin application resulted in no live nymphs and imagines by the 3rd post treatment day, yet eggs were still found out on the haircoat of animals. The examination on day 14 was negative for imaginal and larval forms as well as for eggs, demonstrating 100% insecticidal activity of single ivermectin application against *L. stenopsis* in goats. Later, the protection offered by the drug weakened and by the 60th post treatment day, 1.10±1.2 lice on the average were found per goat, corresponding to percentage of reduction of 92.70%.

In goats treated with eprinomectin, no live insects were found out by the 3rd post treatment day, yet eggs were still present on the haircoat. The second examination (day 14) was negative both for adult lice and their eggs in all treated goats, the same was found out on the 60th day after the application, e.g. insecticidal activity of eprinomectin against *L. stenopsis* in goats was 100%.

The treatment with amitraz resulted in 92.20% reduction of initial lice population by the 60th day. On that day as well as on days 3 and 14, live imaginal forms were observed. Their total number from all 7 areas was 6–12 parasites per host.

The efficacy of tested preparations against chewing lice *B. caprae* (Table 2) showed that ivermectin had an effect only on the 14th post treatment day, and lice population was not completely abolished and live forms were found out. On the 60th day after the treatment, the reduction percentage was 73.05%.

The licicidal efficacy of eprinomectin against *B. caprae* was 100%, with no lice

Table 1. Insecticidal activity of tested preparations against *L. stenopsis* in goats. Data are presented as mean ± SD (n=30)

Insecticidal drug	Before treatment	Days after treatment			Reduction of initial lice population by day 60 (%)
		day 3	day 14	day 60	
Ivermectin (Pandex™)	15.07±6.72^{abc}	0^{a}	0^{b}	1.10±1.27^{c}	92.7%
Eprinomectin (Eprinex multi™)	29.43±24.3^{abc}	0 ^{a}	0 ^{b}	0 ^{c}	100.0%
Amitraz (AMITRAZ 12.5%)	52.2±24.86^{abc}	3.33±3.74 ^{a}	11.37±6.69 ^{b}	4.07±2.65 ^{c}	92.2%

Superscripts denote statistically significant (P<0.05) differences: $^{a-a}$ between day 0 and day 3; $^{b-b}$ between day 0 and day 14; $^{c-c}$ between day 0 and day 60.

Table 2. Insecticidal activity of tested preparations against *Bovicola caprae* in goats. Data are presented as mean ± SD (n=30)

Insecticidal drug	Before treatment	Days after treatment			Reduction of initial lice population by day 60 (%)
		day 3	day 14	day 60	
Ivermectin (Pandex™)	10.13±5.98[abc]	9.43±5.49	2.4±2.08 [b]	2.73±1.74 [c]	73.05%
Eprinomectin (Eprinex multi™)	8.43±8.05[abc]	0 [a]	0 [b]	0 [c]	100.00%
Amitraz (AMITRAZ 12.5%)	59.57±24.70[abc]	1.97±1.97 [a]	3.00±1.44 [b]	0.83±1.08 [c]	98.61%

Superscripts denote statistically significant (P<0.05) differences: [a-a] between day 0 and day 3; [b-b] between day 0 and day 14; [c-c] between day 0 and day 60.

present as early as the 3rd day after the treatment. This result was preserved until the 60th day.

The insecticidal activity of amitraz against *B. caprae* was higher than that against *L. stenopsis*. The reduction of lice by the 60th day was 98.61%.

As could be seen from Table 1, statistically significant differences (P≤0.05) were observed for all three tested drugs at the different period of examination vs pretreatment values. Ivermectin resulted in rapid and total extermination of sucking lice with only single individuals appearing on post treatment day 60. The efficacy pattern of amitraz was characterised with reduction of the population by the 3rd day, followed by increase by day 14 before the second treatment and another decrease by the 60th day. The treatment with eprinomectin demonstrated a rapid and long-lasting effect. Similar findings were obtained against *B. caprae* (Table 2): statistically significant differences (P≤0.05) at all treatment intervals with respect to initial populations. The group treated with ivermectin was slightly influenced by the 3rd post treatment day. The intensity of infection decreased substantially on the 14th day and remained almost unchanged on the 60th day. Amitraz showed a very good efficacy from the 3rd to the 60th day after the two applications. Eprinomectin, again, was 100% effective against this louse species.

DISCUSSION

The present investigation was performed in extensive production conditions due to the lack of data for treatment of pediculosis in goats with tested substances in Bulgaria.

The results of the study confirmed the conclusion of numerous researchers that drugs from the group of macrocyclic lactones were highly effective against infestation of goats with lice. Pal *et al.* (2001) monitored the efficacy of doramectin 1% (Dectomax™), applied s.c. at 1 mL/50 kg against *L. stenopsis* in goats and reported 100% effect on post treatment day 7. Again in goats infested with the same louse species, Yadav *et al.* (2004) used

moxidectin pour-on at 1 mL/10 kg and found out 100% efficacy by the 4th day. The authors have also treated animals with ivermectin at 0.2 mg/kg s.c. and reported again 100% on the 7th day post treatment. Shastri (1991) treated cattle, buffaloes, goats and dogs against sucking lice with s.c. ivermectin at 0.2 mg/kg with comparable results – 100% efficacy against nymphs and imagines by the 5th day with vital eggs which disappeared between days 10 and 15.

In Bulgaria, Nedelchev (1985) reported 100% efficacy of ivermectin (Ivomec™) against sucking lice infesting cattle by post treatment day 60 while the efficacy against the chewing species *B. bovis* attained 89.7%. The difference in the efficacy against sucking lice in our study was probably due to the fact that goats were reared on pastures almost throughout the entire year in contact with other infected goat flocks.

Logan *et al.* (1993) have applied s. c. doramectin (Dectomax™, Pfizer) at 0.2 mg/kg in cattle and observed 100% efficacy against sucking louse species (*Haematopinus eurysternus, Linognathus vituli* and *Solenopotes capillatus*) while the reduction of *Bovicola bovis* was 82% on the average. All these facts allowed concluding that the treatment with parenterally applied macrocyclic lactones was highly efficient against sucking lice, yet their short (moxidectin, doramectin) or insignificant (ivermectin) residual activity (O'Brien, 1999; Parker *et al.*, 1999) makes them little effective for prevention and control of chewing lice (Bates, 2004). On the other hand, Campbell *et al.* (2001) confirmed Eprinex®, Ivomec®, Dectomax® , and the other endectocides as very effective namely against the chewing species *Bovicola bovis*. The authors reported 100% efficacy preserved for 8 weeks even after a single application, applied as pour on. This is completely in line with results from our study about goats treated with eprinomectin.

In cattle, Titchener (1985) established that several *L. vituli* survived the treatment with amitraz as spray, without more details. Nedelchev (1985) has used the preparation Taktik in cattle infested with *L. vituli* and *B. bovis* and detected 95.8% intensefficacy (IE) and 96.9% extensefficacy (EE) against *B. bovis* as well as 96.1% IE and 96.3% EE against *L. vituli*. Our studies demonstrated higher efficacy against *B. caprae* – 98.61%, probably due to the greater hair length and density in goats compared to cows, which, along with the route of drug application, resulted in longer and better effect against this louse species feeding exclusively on animal haircoat. The efficacy against *L. stenopsis* was lower 92.20% ($P<0.05$), probably because of the reinfestation of animals after the residual effect of the preparation has vanished.

CONCLUSION

In these experiments, three insecticidal drugs applied by different routes have been tested. According to the results, drugs from the group of macrocyclic lactones (ivermectin and eprinomectin) were highly efficient, non-toxic for goats and therefore drugs of choice for control of phthirapteriasis in this animal species. Our findings, along with the lack of withdrawal period for milk, outlined eprinomectin as most preferred with this respect. The efficacy of amitraz was satisfactory and if necessary, could be also used for control of caprine phthirapteriasis regardless of its higher toxicity and strong smell.

REFERENCES

Bates, P. G., 2004. Therapies for ectoparasiticism in sheep. *Veterinary Practice*, **26**, 538–547.

Bowman, D. D., 1995. Georgi's Parasitology for Veterinarians, 6th edn, W.B. Saunder, Philadelphia, PA, pp. 32–34.

Brown, L., T. C. Linde, L. J. Fourie & I. G. Horak, 2005. Seasonal occurrence and production effects of the biting louse *Damalinia limbata* on Angora goats and 2 treatment options. *Journal of the South African Veterinary Association*, **76**, 74–78.

Campbell, J. B., D. J. Boxler & R. L. Davis, 2001. Comparative efficacy of several insecticides for control of cattle lice (Mallophaga: trichodectidae and Anoplura: haematopinidae). *Veterinary Parasitology*, **96**, 155–164.

Hornok, S., R. Hofmann-Lehmannb, I. G. Fernandez deMerac, M. L. Melib, V. Elekd, I. Hajtosd, A. Repasid, E. Gonczib, B. Tanczosa, R. Farkasa, H. Lutzb & J. de la Fuente, 2010. Survey on blood-sucking lice (Phthiraptera: Anoplura) of ruminants and pigs with molecular detection of *Anaplasma* and *Rickettsia spp*.. *Veterinary Parasitology*, **174**, 355–358.

Jones, R. D., 1990. Xylene/amitraz: A pharmacologic review and profile. *Veterinary and Human Toxicology*, **32**, 446–448.

Logan, N. B., A. J. Weatherley, F. E. Phillipsa, C. P. Wilkinsa & D. J. Shanksb, 1993. Spectum of activity of doramectin against cattle mites and lice. *Veterinary Parasitology*, **49**, 67–73.

Nedelchev, N. K.,1985. A study on the phthirapterosis of domestic ruminants. PhD Thesis, Sofia (BG).

Neveu-Lemaire, M., 1938. Traite d'éntomologie médicale et vétérinaire. Vigot Frères, Paris, pp. 569–621.

O'Brien, D. J., 1999. Treatment of psoroptic mange with reference to epidemiology and history. *Veterinary Parasitology*, **83**, 177–185.

Otter, A., D. F. Twomey, T. R. Crawshaw & P. Bates, 2003. Anaemia and mortality in calves infested with the long-nosed sucking louse (*Linognathus vituli*). *The Veterinary Record,* **153**, 176–179.

Pal, S., R. C. Ghosh, R. K. Nema & S. Roy, 2001. Efficacy of doramectin (Dectomax) against natural infestation of Linognathus stenopsis in goats. *Indian Veterinary Journal*, **78**, 941–942.

Parker, L. D., D. J. O'Brien & P. G. Bates, 1999. The use of moxidectin for the prevention and treatment of psoroptic mange (scab) in sheep. *Veterinary Parasitology*, **83**, 301–308.

Paul, A. K., M. Tanjim, S. Akter, M. A. Rahman & M. Talukder, M., 2012. Prevalence of ectoparasites in black bengal goat at the Gaibandha Districtof Bangladesh. *Bangladesh Journal of Progressive Science and Technology*, **10**, 005–008.

Shastri, U., 1991. Efficacy of ivermectin (MSD) against lice infestation in cattle, buffaloes, goats and dogs. *Indian Veterinary Journal*, **68**, 191.

Shoop, W. L., J. R. Egerton & P. DeMontigny, 1996. Efficacy in sheep and pharmacokinetics in cattle that led to the selection of eprinomectin as a topical endectocide for cattle. *International Journal for Parasitology*, **26**, 1227–1235.

Soulsby, E. J. L., 1986. Helminths, Arthropods and Protozoa of Domesticated Animals. Bailliere & Tindall, London, UK

Titchener, R. N., 1985. The control of lice on domestic livestock. *Veterinary Parasitology*, **18**, 281–288.

Vercruysse, J. & R. S. Rew, 2002. Macrocyclic Lactones in Antiparasitic Therapy, CABI, USA, pp. 1–13.

Yadav, C. L., P. S. Banerjee, V. Kumar & S. Vatsya, 2004. Comparative efficacy of pour-on moxidectin, flumethrin, and injectable ivermectin against louse infestation in goats. *Indian Vetetinary Journal*, **81**, 1325–1326.

Yilmaz, H. L. & D. R. Yildizdas, 2003. Amitraz poisoning, an emerging problem: Epidemiology, clinical features, management, and preventive strategies. *Archives of Disease in Childhood*, **88**, 130–134.

Paper received 24.06.2020; accepted for publication 18.09.2020

Correspondence:

Nikola Nizamov DVM
Department of Veterinary Microbiology,
Infectious and Parasitic Diseases,
Faculty of Veterinary Medicine,
Trakia University,
6015 Stara Zagora, Bulgaria,
email: nikola_nizamov@abv.bg