

## CLINICAL PATHOLOGICAL CHARACTERISTICS IN DOGS INFECTED WITH TICKS AND THEIR PREVENTIVE, TREATMENT MEASURES AT TAY HO DISTRICT - HANOI CITY

Nguyen Thi Ngan<sup>1\*</sup>, Pham Dieu Thuy<sup>1</sup>, Tran Nhat Thang<sup>1</sup>, Le Thi Thu Phuong<sup>2</sup>

<sup>1</sup>TNU - University of Agriculture and Forestry,

<sup>2</sup>Nam Tu Liem Animal husbandry and veterinary medicine station, Hanoi

### ABSTRACT

This study aimed to identify some clinical pathological characteristics of dogs infected with ticks at Tay Ho District - Hanoi city and apply effectively preventive and treatment measures on ticks, we examined and collected the ticks that parasitized on the body of 493 dogs raising in 4 wards which belong to Tay Ho district - Hanoi city, identifying clinical pathological manifestations and hematological changes in dogs infected with ticks at high prevalence; three drugs were used for tick treatment in infected dogs as follows: Bravecto drug, Fleadom collar, Hantox Spray. The results showed that there were 169 dogs infected in the total 493 dogs, accounted for 34.28%; infected dogs have a weak condition, pale mucous membranes, damaged skin, and some skin areas have purulent infection; dogs infected with many ticks have a decrease of red blood cells, an increase of white blood cells, hemoglobin and hematocrit reduced. The treatment effectiveness for infected dogs of Bravecto drug reached the highest proportion (97.56% - 100%); followed by Fleadom collar was also quite high (80.95% - 93.33%); and the effectiveness of Hantox Spray was low (39.02% - 53.33%).

**Keywords:** Dog; tick; pathology; treatment; Hanoi.

*Received: 04/02/2020; Revised: 21/02/2020; Published: 29/04/2020*

## MỘT SỐ ĐẶC ĐIỂM BỆNH LÝ LÂM SÀNG Ở CHÓ BỊ NHIỄM VE VÀ BIỆN PHÁP PHÒNG, TRỊ TẠI QUẬN TÂY HỒ - THÀNH PHỐ HÀ NỘI

Nguyễn Thị Ngân<sup>1\*</sup>, Phạm Diệu Thùy<sup>1</sup>, Trần Nhật Thăng<sup>1</sup>, Lê Thị Thu Phương<sup>2</sup>

<sup>1</sup>Trường Đại học Nông Lâm - ĐH Thái Nguyên,

<sup>2</sup>Trạm Chăn nuôi và Thú y quận Nam Từ Liêm - TP. Hà Nội

### TÓM TẮT

Để xác định một số đặc điểm bệnh lý lâm sàng ở chó bị nhiễm ve nuôi tại quận Tây Hồ - thành phố Hà Nội và áp dụng biện pháp phòng, trị ve có hiệu quả, chúng tôi đã khám và thu thập ve ký sinh trên cơ thể của 493 chó nuôi tại 4 phường của quận Tây Hồ - thành phố Hà Nội, xác định các biểu hiện bệnh lý lâm sàng và sự thay đổi một số chỉ tiêu máu ở những chó nhiễm nhiều ve; sử dụng 3 loại thuốc: Bravecto, Fleadom, Hantox Spray để điều trị ve cho chó. Kết quả cho thấy, trong 493 chó có 169 chó nhiễm ve, chiếm tỷ lệ 34,28%; ở những chó nhiễm nhiều ve thường có thể trạng gầy yếu, niêm mạc nhợt nhạt, da bị tổn thương, một số vùng da nhiễm trùng hóa mủ; chó nhiễm nhiều ve có số lượng hồng cầu giảm, số lượng bạch cầu tăng, hàm lượng huyết sắc tố giảm, tỷ khối hồng cầu giảm. Hiệu lực điều trị triệt để ve cho chó của thuốc Bravecto đạt tỷ lệ cao nhất (97,56% - 100%); hiệu lực điều trị triệt để ve cho chó của vòng Fleadom cũng đạt khá cao (80,95% - 93,33%); hiệu lực điều trị triệt để ve cho chó của thuốc Hantox Spray đạt tỷ lệ thấp (39,02% - 53,33%).

**Từ khóa:** Chó; ve; bệnh lý; điều trị; Hà Nội.

*Ngày nhận bài: 04/02/2020; Ngày hoàn thiện: 21/02/2020; Ngày đăng: 29/04/2020*

\* Corresponding author. Email: nguyenthingan@tuaf.edu.vn

DOI: <https://doi.org/10.34238/tnu-jst.2020.05.2587>

## 1. Introduction

Vietnam's climate tends to be hot and humid, which is a favorable condition for pathogen microorganisms to exist and develop, especially diseases caused by parasites. Ticks parasitize on dogs are one of the most common ectoparasitic diseases, which not only damage skin structure, but also reduce their immune system, growth and development. Parasitic ticks are a dangerous intermediate vector in transmitting diseases to livestock, thereby transmitting diseases to human, causing Crimean-Congo fever virus, Colorado fever, Q fever...; filariasis (*Dirofilaria*, *Dipetalonema*), *Borrelia*... [1], [2], [3]. The prevention and control of ticks is very complicated due to the lifecycle of this parasite that is constantly changing between the environment and the hosts, besides ticks are able to survive very long time in the natural environment. Therefore, from 2018 to 2019, we have conducted a study about ticks in dogs at Tay Ho district - Hanoi City and approved some treatment regimens, thereby recommending to dog owners to use effective measures to prevent and treat ticks in dogs, restricting tick-borne diseases to human and other animals.

## 2. Materials, contents and research methodology

### 2.1. Material

- Dogs breeding in 4 wards: Phu Thuong, Nhat Tan, Xuan La and Quang An at Tay Ho district, Ha Noi city.
- Parasitic ticks on dogs.
- Blood samples from healthy dogs and infected dogs.
- Treatment drugs for ticks:
  - + Bravecto drug (ingredient: fluralaner, manufactured by Intervet GesmbH - Austria).
  - + Fleadom ticking collar (the main component is amitraz made by Virbac - France).
  - + Hantox Spray (ingredient: pyrethroid, the active ingredient extracted from *Asteraceae* family), manufactured by Hanvet - Vietnam.
- Optical microscope; chemicals and other experimental equipments.

### 2.2. Research content

- The prevalence and infection intensity of ticks on dogs.
- Clinical symptoms of dogs infected with ticks.
- Changes of hematological indicators of dogs infected with severe tick infection.
- Determine the effectiveness of Bravecto drug, Fleadom collar, Hantox Spray in treating ticks for dogs.

### 2.3. Research methodology

- Parasitic ticks were collected from dogs breeding in localities by using cluster sampling in 4 wards: Phu Thuong, Nhat Tan, Xuan La, Quang An at Tay Ho district, Hanoi City.
- Infected dogs were observed by corporal conditions and clinical manifestations.
- Dog blood was collected from healthy and dogs infected with high infection intensity (3 ml per dog), stored in tube containing anticoagulant. Osmetech OPTI - CCA / Blood Gas Analyzer machine was used to analyze some hematological indicators of infected and healthy dogs at Tay Ho General Clinic as follows: red blood cells, white blood cells, leukogram formula and hemoglobin.
- Bravecto drug, Fleadom collar, Hantox Spray were used to prevent and treat ticks for dogs in the first trial, each of them was used for 15 infected dogs. After applying 15 days of treatment, re-examined to find out ticks. Since dog was considered as clean dog, the conclusion is that the drug is effective for radical treatment; if the dog is still infected but in the mild infection intensity, the drug has a therapeutic effect, but the treatment effectiveness was not thorough. Continue using Bravecto drug, Fleadom collar, Hantox Spray to treat the remaining dogs infected with ticks in 4 wards at Tay Ho district. After 15 days of treatment check again to find ticks and determine the treatment effectiveness.
- Data were processed by Excel 2010 and MINITAB 16 software.

### 3. Results and discussion

#### 3.1. The mainly clinical manifestations in infected dogs

**Table 1.** *The proportion and clinical manifestations in dogs infected with ticks*

Number of infected dogs	Number of dogs with clinical manifestations	Proportion (%)	Mainly clinical manifestations	Number of dogs with manifestations	Proportion (%)
169	82	48.52	Poor appetite, weak body, pale mucous membranes	13	15.85
			A lot of ticks stucked on the thin skin, ruffled hair, dogs licking and scratching on the itchy regions.	82	100
			Skin lesions, swollen skin areas with purulent infections	16	19.51

**Table 2.** *Changes in hematological indicators of healthy and infected dogs*

Hematological indicators	Healthy dogs $(\bar{x} \pm m_x)$ n =15	Infected dogs $(\bar{x} \pm m_x)$ n =15	P <sub>a</sub> value
Red blood cells (million/ mm <sup>3</sup> blood)	7.01 ± 0.17	5.16 ± 0.22	< 0.01
White blood cells (thousand/ mm <sup>3</sup> blood)	9.13 ± 0.11	13.91 ± 0.41	< 0.01
Hemoglobin (g%)	14.90 ± 0.58	10.50 ± 1.38	> 0.05
Hematocrit (%)	38.60 ± 0.50	32.10 ± 1.32	> 0.05
Mean corpuscular hemoglobin (g/l)	19.03 ± 0.52	24.02 ± 2.39	> 0.05

Table 1 showed that in the total 169 infected dogs, there were 82 dogs appeared clinical manifestations, accounted for 48.52%. The mainly clinical manifestations were as follows: anorexia, thin body, pale mucous membranes, many ticks on thin skin, ruffled fur, infected dogs licking and using feet scraping into the itchy regions. Some dogs showed signs of skin damage, swollen skin areas with purulent infections

These clinical manifestations resulted mechanical damage effects, nutrient appropriation and the effects of tick's toxins secreted. The combination of these effects made animals stunted, grow slowly, inflammation of the subcutaneous struture, inflammation of the skin pores and subsequent infections. Dogs exhibited poor appetite, anemia, pale mucous membranes, thin body, ruffled fur, dry and thickened skin, showing irritation, discomfort, frequent scratching, gnawing, licking areas parasitized by ticks.

#### 3.2. Changes in some hematological indicators of infected dogs

Table 2 showed that the red blood cells of healthy dogs were 7.01 million per mm<sup>3</sup> blood, the white blood cells were 9.13 thousand per mm<sup>3</sup> blood. According to Hoang Toan Thang and Cao Van [4], the red blood cells of healthy dog range from 6 to 8 million per mm<sup>3</sup> blood; the white blood cells are 9.4 thousand per mm<sup>3</sup> blood. Thus, our results of hematological indicators of healthy dogs vacillated in the physiological range as the authors described above. The average red blood cells of infected dogs were 5.16 thousand per mm<sup>3</sup> blood, with P value <0.01; the difference of this indicator was significantly between healthy and infected dogs. The average white blood cells of infected dogs were 13.91 thousand per mm<sup>3</sup> blood. Therefore, the average white blood cells of infected dogs were much higher than those of healthy dogs. This difference

was significant ( $P < 0.01$ ). The hemoglobin and hematocrit of healthy dogs were higher than those of infected dogs (14.90 g% and 38.60% versus 10.50 g% and 32.10%, respectively). However, with  $P > 0.05$ , this difference was not clearly significant. Average mean corpuscular hemoglobin of healthy dogs was lower than that of infected dogs (19.03 grams per liter versus 24.02 grams per liter). This difference also was not significant ( $P > 0.05$ ). In general, due to blood-sucking ticks, dogs infected with a lot of ticks reduced red blood cells significantly, but the white blood cells increased causing by ticks damaged skin structure, pus in some infected areas.

### 3.3. The leukogram formula of healthy dogs and infected dogs

The determination of leukogram formula is valuable in the diagnosis of diseases, especially the diagnosis of parasitic diseases. According to Hoang Thi Sen [5], the leukogram formula is the percentage (%) of different types of white blood cells. This formula varies depending on the age, species, physiologically corporal status. Compared with the leukogram formula of the healthy dog group (Table 3), we found that the proportion of leukocytes had a change, the

most obvious was the eosinophils: the eosinophils rate was from 5.77% (in healthy dogs) increased to 9.13% (in infected dogs). The difference was significant ( $P < 0.001$ ). This increase exceeded the upper limit of normal physiological fluctuations. The proportion of other types of white blood cells also changed: neutrophils were from 62.18% (in healthy dogs) decreased to 58.67% (in infected dogs) ( $P < 0.01$ ); Other types of white blood cells did not have significant changes ( $P > 0.05$ ).

According to Trinh Van Thinh *et al.* [6], cattle and poultry fight parasites by cellular reactions (inflammation, phagocytic function, eosinophilia, leukocytosis and neutropenia). Nguyen Xuan Hoat and Pham Duc Lo [7], Pham Duc Chuong *et al.* [8] reported that eosinophils participate in the process of protecting the body and preventing infection. Therefore, when the body infects by the parasite pathogen, eosinophils increases. According to Nguyen Thi Kim Lan [9], the host body responds to the parasite by two types of reactions: cellular and fluid reaction. Cellular reaction are inflammation and Eosinophil increase, leukocytosis and neutropenia.

**Table 3.** The leukogram formula of healthy dogs and infected dogs

Leukogram	Healthy dogs	Infected dogs	P <sub>a</sub> value
	$(\bar{x} \pm m_x)_{\%}$ n = 15	$(\bar{x} \pm m_x)_{\%}$ n = 15	
Neutrophils	62.18 ± 0.40	58.67 ± 0.59	< 0.01
Eosinophils	5.77 ± 0.26	9.13 ± 0.51	< 0.001
Basophils	1.25 ± 0.38	2.90 ± 0.73	> 0.05
Lymphocytes	26.20 ± 1.05	25.70 ± 0.79	> 0.05
Monocytes	4.60 ± 0.44	3.60 ± 0.19	> 0.05

### 3.4. Study on the preventive and treatment measures for infected dogs

#### 3.4.1. Determine the effectiveness of tick treatment drugs for dogs in the 1<sup>st</sup> trial at Phu Thuong ward

**Table 4.** *The effectiveness of Bravecto drug, Fleadom collar, Hantox Spray in treating ticks for infected dogs (1<sup>st</sup> trial)*

Treatment drugs	Locality (Group)	Number of treated dogs	Number of dogs without ticks	Proportion (%)
<b>Bravecto drug</b>	Group 2	5	5	100
	Group 3	5	5	100
	Group 5	5	5	100
	<b>Total</b>	<b>15</b>	<b>15</b>	<b>100</b>
<b>Fleadom collar</b>	Group 2	5	5	100
	Group 6	5	5	100
	Group 9	5	4	80,00
	<b>Total</b>	<b>15</b>	<b>14</b>	<b>93.33</b>
<b>Hantox Spray</b>	Group 3	5	3	60,00
	Group 5	5	2	40,00
	Group 9	5	3	60,00
	<b>Total</b>	<b>15</b>	<b>8</b>	<b>53.33</b>

**Table 5.** *The effectiveness of Bravecto drug, Fleadom collar, Hantox Spray in treating ticks for infected dogs (2<sup>nd</sup> trial)*

Treatment drugs	Locality (Group)	Number of treated dogs	Number of dogs without ticks	Proportion (%)
<b>Bravecto drug</b>	Phu Thuong	13	12	92.31
	Nhat Tan	8	8	100
	Xuan La	12	12	100
	Quang An	8	8	100
	<b>Total</b>	<b>41</b>	<b>40</b>	<b>97.56</b>
<b>Fleadom collar</b>	Phu Thuong	13	9	69.23
	Nhat Tan	8	7	87.5
	Xuan La	13	12	92.31
	Quang An	8	6	75.00
	<b>Total</b>	<b>42</b>	<b>34</b>	<b>80.95</b>
<b>Hantox Spray</b>	Phu Thuong	13	4	30.77
	Nhat Tan	7	4	57.14
	Xuan La	13	5	38.46
	Quang An	8	3	37.50
	<b>Total</b>	<b>41</b>	<b>16</b>	<b>39.02</b>

Table 4 showed that using Bravecto drug treated for 15 dogs infected with ticks; after 15 days of treatment, re-examined all treated dogs, ticks were removed in all 15 treated dogs. Thus, the effect of thorough treatment of Bravecto ticks reached 100%. Using Fleadom collar to treat 15 dogs infected with ticks; after 15 days of drug administration, re-examination of treated dogs found that 14/15 dogs without ticks, one was still infected with ticks but in small numbers (4 ticks). Thus, the treatment effectiveness of Fleadom collar

obtained 100% and the radical treatment effectiveness was 93.33%. Using Hantox Spray to treat 15 dogs infected with ticks; after 15 days of spraying, continued to spray the second application, re-examined dogs after 5 days of the second application, the number of ticks decreased in all 15 infected dogs but only 53.33% of these dogs were clean without ticks. Thus, the treatment effectiveness was only 53.33%. The Hantox Spray's effectiveness was low because this spray can not expose to the surface of the skin

in some hairy regions, where ticks are parasitized, so it did not have a radical treatment effect.

During the drug administration, all dogs treated with Bravecto drug, Fleadom collar and Hantox Spray were eating, moving normally and showing no abnormalities.

### 3.4.2. Determine the effectiveness of tick treatment drugs for infected dogs in the 2<sup>st</sup> trial in some wards of Tay Ho district

After approving the effectiveness of Bravecto drug in the treatment of first trial for dogs, there was found that the drug did not cause side effects and was safe for the treated dogs, we conducted treatment for the number of dogs infected with ticks investigated in the ward of Tây Hồ district. The results of table 5 showed that the radical treatment effectiveness in the second trial of Bravecto drug in the research wards was still high (ranging from 92.31 to 100%). Although the treatment effectiveness was not 100% as that in the first trial, but with 97.56% of the dogs have been found to be very effective in treating ticks in dogs. This result once again confirmed that Bravecto drug was very

effective in treating ticks in dogs. The radical treatment effectiveness of ticks for dogs of the 2nd round of Fleadom collar in the research wards also reached quite high (80.95%); Hantox Spray's radical treatment effectiveness of ticks for dogs was low (39.02%).

All dogs treated with Bravecto drug, Fleadom collar and Hantox Spray were safe and showed no abnormalities.

Dongus H. et al. [10] used fluralaner (the main active ingredient of Bravecto drug) to treat *Rhipicephalus sanguineus* ticks in 4 groups of dogs. The results showed that, after using the drug 24h, the radical treatment effect in 4 groups reached 99.3% to 100%. The research results of Burgio F. et al. [11] showed that using fluralaner to treat ticks for dogs were 100% effective after 12, 24 and 48 hours; Ranjan S. et al. [12] when used fluralaner to treat *Rhipicephalus sanguineus* ticks for dogs, the therapeutic effect reached 95.4 - 100%, the protection period lasted 12 weeks after treatment.

Thus, the tick treatment effectiveness given by Bravecto drug in our study was quite similar to the results of the authors above.

### 3.4.3. The comparison of the cost of using 3 tick treatment drugs for infected dogs

**Table 6.** The comparison of the cost of tick treatment drugs for infected dogs

Used drugs	Administration via	Cost	Treatment cost			
			Dogs weighed 2 kg	Dogs weighed 5 kg	Dogs weighed 10 kg	Dogs weighed over 10 kg
Bravecto drug	Oral use	-	485.000	550.000	807.000	807.000
Fleedom collar	Neck collar	140.000 per collar with 60cm of length	70.000	140.000	140.000	140.000
Hantox Spray	Spraying	25.000 per bottle 100ml 42.000 per bottle 300ml	25.000	25.000	42.000	42.000

To compare the cost of 3 types of Bravecto drug, Fleadom collar and Hantox Spray to treat ticks for dogs, we applied the treatment cost according to the market price. Dogs in 4 different weight groups 2 kg, 5 kg, 10 kg and over 10 kg respectively, were conducted to compare treatment costs, The results showed that: among the 3 drugs used to treat ticks, the Bravecto drug has a very high price, so the cost expended treating tick at all weight levels was the highest. Specifically:

- For Bravecto drug: The cost to treat ticks for dogs weighed 2 kg was 485,000VND

(Vietnamese dong), for dogs weighed 5 kg was 550,000 VND, dogs weighed over 10 kg was 807,000 VND. Bravecto was administered by oral via.

- For Fleadom collar: The treatment cost for dogs weighed 2 kg was 70,000 VND (due to the dog size and weight, it is possible to split the collar for 2 small dogs), dogs weighed over 5 kg used only one collar, thus, the treatment cost was 140,000 VND per dog. Fleadom collar are weared regularly for infected dogs.

- For Hantox Spray: 10-12 sprays per kg B.W; after 15 days of application, repeated spraying second time. Therefore, dogs weighed less than 10 kg used a 100 ml spray bottle, dogs weighed over 10 kg applied a 300 ml spray bottle. The treatment cost for dogs weighed less than 10 kg was 25,000 VND, and dogs weighed over 10 kg was 42,000 VND. Hantox Spray is used by topical spray on infected dogs.

Thus, the treatment cost of Bravecto drug was the highest, followed by Fleadom collar and the lowest was Hantox Spray.

Combined with the tick treatment effect of 3 drugs, the use of Fleadom collar was a relatively high treatment effect but obtained the most reasonable price, the usage is also relatively easy, protection period lasts from 4 to 6 months. Bravecto drug has a very high therapeutic effect, the oral drug can protect dogs from ticks within 12 weeks but the treatment was expensive. Hantox Spray has the lowest treatment cost but the actual therapeutic effect was also very low, and the usage was also quite complicated. Therefore, depending on economic conditions, users and owners can choose the appropriate medication to treat the dog tick.

#### *3.4.4. Propose measures to prevent tick disease for dogs*

Apply integrated control measures to eradicate the ticks:

- Eliminate ticks on dogs: Periodically using tick drugs for dogs. Use mechanical or chemical methods to eliminate ticks on the dog's body at all stages of tick development.

- Remove ticks in dog kennels: After sucking blood on the host, ticks will fall to the ground, then find the gap on the wall, wall of the cage to live and lay eggs. On the other hand, the larvae will follow the grass into the kennel. Therefore, smooth walls are recommended, and periodically spray pesticides inside the kennels.

- Eliminate ticks in the nature: Change the environment and living conditions of ticks by cleacollar the bushes around houses and dog sheds, using chemical spray to kill ticks on the garden yards.

- Regularly shower to dog to remove parasites.

#### **4. Conclusion**

- Ticks are relatively common parasites in dogs breeding in wards at Tay Ho district, Hanoi City.

Dogs infected with ticks manifested clinical symptoms including: anorexia, thinning, pale mucous membranes; a lot of ticks on thin skin, ruffled fur, infected dogs gnawing, licking, scratching on the itchy areas by their feet; skin lesions, rough skin with purulent infection.

- Infected dogs have a decrease in the red blood cells, while white blood cells increased; The proportion of lymphocytes and monocytes decreased, the rate of white blood cells increased significantly in comparison with those in healthy dogs.

- The radical treatment effectiveness for dogs of Bravecto drug reached the highest rate (97.56% - 100%); followed by Fleadom collar was also quite high (80.95% - 93.33%); Hantox Spray's effectiveness was low (39.02% - 53.33%).

- The cost of using Bravecto drug was the highest, followed by Fleadom collar and the lowest was Hantox Spray.

- Apply integrated preventive measures to eradicate ticks, regularly shower dogs to remove ticks and other parasites.

#### REFERENCES

- [1]. N. D. Wolfe, C. P. Dunavan, and J. Diamond, "Origins of major human infectious diseases," *Nature*, 447, pp. 279-283, 2007.
- [2]. J. Fuente, A. Estrada-Pena, J. M. Venzal, K. M. Kocan, and D. E. Sonenshine, "Overview: ticks as vectors of pathogens that cause disease in humans and animals," *Front Biosci.*, vol. 13, pp. 6938-6946, 2008.
- [3]. B. Mosallanejad, A. R. Alborzi, and N. Katvandi, "A survey on Ectoparasite infestations in companion dogs of Ahvaz district, South-west of Iran," *J. Arthropod Borne Dis.*, vol. 6(1), pp. 70-78, 2012.
- [4]. T. T. Hoang, and V. Cao, *Animal physiology*. Agriculture Publishing House, Hanoi, 2006, pp. 71-94.
- [5]. T. S. Hoang, *Human and animal physiology*. Thai Nguyen University of Education, 2005, pp. 6-10.
- [6]. V. T. Trinh, T. C. Phan, and V. K. Pham, *Veterinary Parasites*. Agriculture Publishing House, Hanoi, 1982.
- [7]. X. H. Nguyen, and D. L. Pham, *Organization of embryology*. University and High School Publishing House, Ha Noi, 1980, pp. 162, 172, 184 - 185.
- [8]. D. C. Pham, D. H. Nguyen, T. K. T. Luu, and T. T. Hoang, *Veterinary immunology*. Agriculture Publishing House, Hanoi, 2007.
- [9]. T. K. L. Nguyen, *Parasites and veterinary parasitic diseases*. Agriculture Publishing House, Hanoi, 2012, pp. 244 - 247.
- [10]. H. Dongus, L. Meyer, and R. Armstrong, "Water immersion of dogs close to the time of topical fluralaner treatment does not reduce effectiveness against a subsequent experimental challenge with *Rhipicephalus sanguineus* (sensu lato)," *Parasit Vectors.*, vol. 10(1), p. 441, 2017.
- [11]. F. Burgio, L. Meyer, and R. Armstrong, "A comparative laboratory trial evaluating the immediate effectiveness of fluralaner, afoxolaner, sarolaner and imidacloprid + permethrin against adult *Rhipicephalus sanguineus* (sensu lato) ticks attached to dogs," *Parasit Vectors.*, vol. 9(1), p. 626, 2016.
- [12]. S. Ranjan, D. Young, and F. Sun, "A single topical fluralaner application to cats and to dogs controls fleas for 12 weeks in a simulated home environment dogs," *Parasit Vectors.*, vol. 11(1), p. 385, 2018.