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STUDY ON EPIDEMIOLOGICAL, PATHOLOGICAL CHARACTERISTICS, PREVENTIVE AND TREATMENT MEASURES OF TRICHOCEPHALOSIS CAUSED BY *TRICHOCEPHALUS* SPP.

IN PORCINE IN THAI NGUYEN AND BAC KAN PROVINCE

Speciality: Veterinary parasitology and microbiology

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SUMMARY OF DOCTORAL DISSERTATION IN VETERINARY MEDICINE

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DOCUMENTS RELATE TO THE DISSERTATION

1. **Nguyen Thi Bich Nga**, Nguyen Thi Kim Lan, Đo Thi Van Giang, Truong Thi Tinh (2014), "Situation of *Trichocephalus suis* nematoda infection in porcine in Dong Hy district of Thai Nguyen province", *Thai Nguyen technology and science Journal,* 112 (12/2), pp 189 - 193.

2. **Nguyen Thi Bich Nga**, Nguyen Thi Kim Lan, Ha Thuy Hanh (2015), "Pathological characteristics of Trichocepholosis caused by *Trichocephalus suis* in experimentall infected porcines", *Thai Nguyen technology and science Journal,* 134 (4), pp. 75 - 80.

3. Nguyen Thi Kim Lan, **Nguyen Thi Bich Nga**, Ha Thuy Hanh, Truong Thi Tinh, Vu Minh Đuc, Nguyen Đinh Hai (2015), "Survey on the capacity of heat generation and deworming efficacy of Trichocephalosis by composting method", *Thai Nguyen technology and science Journal*, 118 (04), pp. 193 - 198.

INTRODUCTION

Trichocephalosis is the most popular nematode specie in the world, which causes by *Trichocephalus suis* nematode in porcine. In porcine, *Trichocephalus suis* parasitizes mainly in cecum, less in colon. According to Pham Sy Lang *et al.* (2006), *Trichocephalus suis* causes damages and secondary inflammation from bacteria invaded to internal organs, affecting to the growth process, specially, to the food consume, decreasing the diary average gain from 15 to 20% in comparison with no infected porcines.

Actually, the porcine husbandry is devenloping in Thai Nguyen and Bac Kan province. To the goal of increasing porcine volume in the agriculture production, both of these provinces have determined that porcine husbandry is the main road to devenlope husbandry in entire provinces. However, there has no systemic and sufficient research about *Trichocephalus* spp. in porcine in these provinces, therefore, there is not effectively existed in preventing processes.

To response of this real requirement and improve porcine husbandry in some provinces of Northern mountainous region, we began to realise the thesis ***''Study on the epidemiological, pathological characteristics, preventive and treatment measures of Trichocephalosis caused by Trichocephalus spp. in porcine in Thai Nguyen and Bac Kan province".***

Chapter 1
BIBLIOGRAPHIC REVISION

According to Skrjabin K. I. (1963), Nguyen Thi Le *et al*. (1996), the classification of *Trichocephalus suis* nematoda is mentioned as follows: Phylum *Nemathelminthes* (Schneider, 1873); clase *Nematoda* (Rudolphi, 1808); subclase *Enoplia* (Chitwood, 1933); Order *Trichocephalida* (Skrjabin et Schulz, 1928); Suborder *Trichocephalata* (Skrjabin et Schulz, 1928); Family *Trichocephalidae* (Baird, 1853); Subfamily *Trichocephalinae* (Ransom, 1911); Genus *Trichocephalus* (Schrank, 1788); Specie *Trichocephalus suis* Schrank, 1788.

Nguyen Thi Kim Lan (2012) informed that: *Trichocephalus suis* nematode has white colour. Its body divides clearly in two parts. The small head is like a hair, occupates 2/3 its body length, under of epidermal membrane is the trachea. The body size is short and big, inside of that, there is intestine and reproductive organ.

In the words of Phan Đich Lan *et al*. (2005), Pham Sy Lang *et al*. (2011), Nguyen Thi Kim Lan (2012), the necessary time to complete entire lifecycle of *Trichocephalus suis* nematode is 30 days.

Dwight Bowman D. (2013), Amanda Lee (2012), Nguyen Thi Kim Lan (2012); Skallerup P. *et al.* (2015) have reported: porcines infected with *Trichocephalus suis* nematode have clinical symtoms as: growth retardation, pallid mucous and diarrhea. The colon and cecum of these porcines have hemorrhage; commonly pathological disorders are inflammatory cells, increasing eosinophils, decreasing erythrocytes and hemoglobins in the serum.

In the opinion of Pham Van Khue and Phan Luc (1976), Đao Trong Đat and Phan Thanh Phuong (1986), Nguyen Thi Le *et al.*

(1996), Hagsten (2000), Nguyen Thi Kim Lan (2012), the best method of preventing and treating *Trichocephalosis* infection in livestocks is to intergrate all methods, it means depending on ecological regions, also treating on devenloped periods of *Trichocephalus suis* nematode in water and host.

Chapter 2
MATERIALS, CONTENTS AND METHODS

2.1. Object, time, and places

2.1.1. Object

- Porcines raised in Thai Nguyen and Bac Kan province.
- Nematode disease in porcines caused by *Trichocephalus* spp.

2.1.2. Time period

- From 2012 - 2015.

2.1.3. Places

- The thesis was carried out at porcine farms in Thai Nguyen and Bac Kan province.
- Laboratory of faculty of Veterinary Medicine and Animal Science, Thai Nguyen college of Agriculture and Forestry.
- Laboratory of ultrastructure - Institute of Hygiene and Epidemiology.

2.2. Materials

2.2.1. Animals and various types of study samples

**** Experimental animals:*** Porcines at different ages: healthy piglets at 1 month of age, severely infected porcines with *Trichocephalus* spp.

**** The study samples:*** Using samples of *Trichocephalus* spp. nematode, faeces, pigsty floors, superficial soils, samples of surrounding pigsty areas, blood samples of control and

Trichocephalus spp. experimental groups, samples from litter, ashes, lime, green manure crops, straw, grasses...

2.2.2. Instruments and chemicals: Optical microscopes, scanning electron microscope FE-SEM S4800, Laser automatic blood analising Machine Osmetech OPTI - CCA/Blood Gas Analfzen, Mc. Master counting chamber, saturated saline solution, Barbagallo solution, Hematoxylin– cosine staining system, *Trichocephalus* spp. anthelmintic medicine, disinfectants.

2.3. Contents

2.3.1. Nomeclature of parasitic nematode (Trichocephalus* spp.) in porcines in *Thai Nguyen and Bac Kan province.

2.3.2. Epidemiological characteristics of Trichocephalosis in porcines

2.3.2.1. Survey on present status in preventing and controlling of parasitic disease in porcines in two provinces.

2.3.2.2. The prevalence and infection intensity of Trichocephalus spp. *in porcines: determined by necropsy, feces examination, porcine age, season, breeding methods, veterinary hygienic situation, husbandry areas and planted areas of forage.*

2.3.3. Study on pathological characteristics of Trichocephalosis caused by Trichocephalus* spp. *in porcines

2.3.3.1. Study on pathological characteristics of Trichocephalosis in experimentally infected porcines.

2.3.3.2. Study on pathological characteristics of Trichocephalosis in naturally infected porcines.

2.3.4. Study on preventive and treatment measures of Trichocephalosis in porcines

2.3.4.1. Study on preventive measures of Trichocephalosis infection in porcines

2.3.4.2. Determine the affective and safe level of anthelmintic medicine for deworming Trichocephalus spp. *in porcines*

2.3.4.3. Approving preventive and treatment measures of Trichocephalosis in infected porcines

2.4. Methods

2.4.1. Necropsy, collecting and identifying of Trichocephalus* spp. nematode parasitized *in porcines in Thai Nguyen and Bac Kan provine

- Necropsy examination in porcines by using the method of not exhaustive dissection described by Skrjabin (1928). Identifying *Trichocephalus* spp. nematode is according to taxonomy keys described by Nguyen Thi Le *et al.* (1996), based on morphological characteristics, size and structure of adult nematode in combination with the observation of ultrastructure of *Trichocephalus* spp. under scanning electron microscope FE - SEM S4800.

2.4.2. Survey method of present status of parasitic prevention and control in two provinces

Formulating evaluation indicators, directly observing present status of porcine husbandry in studied regions. Interviewing and collecting the polls about the indicators designed.

2.4.3. Methods of epidemiological characteristics of Trichocephalosis

- Collecting samples by using stratified cluster sampling.

- Determining the prevalence of *Trichocephalus* spp. by using Fulleborn's method, infection intensity of *Trichocephalus* spp. Nematode by Mc. Master's counting technique.

2.4.4. Methods of pathological characteristics caused by Trichocephalus* spp. *in porcines

- Collecting of *Trichocephalus* eggs by using Darling method and putting into a recipient contained 20 ml of clean water, ensuring 2500 eggs in 1 ml (during the collection, counting the number of eggs in 1 ml to reach the desired eggs).

- Examining haematological indicators by using automatically hematological analyzer - Nihon Kohden Mek - 6420k (Japan). Leucocyte formular has determined by Tristova method. Studying microscopic lesions by using histological method, Hematoxylin - Eosin stain.

2.4.5. Determination methods for the effects of some disinfectants and processing techniques on Trichocephalus's eggs in feces.

- 4 experimental groups were designed by using 4 following disinfectants as: benkocid, povidine 10%, formades and QM - Supercide (most commonly used in pigstys) and a control group. Using Fulleborn's method to determine the *Trichocephalus*'s eggs able to survive or eliminate by the effect of these disinfectants.

2.4.6. Determination method of the efficacy and safety of Trichocephalus spp. anthelmintic medicine in porcine

- Using 3 anthelmintic medicines:

Levamisol, at dose of 7.5 mg/kg B.W.

Febendazol, at dose of 4 mg/kg B.W

Ivermectin, at dose of 0.3 mg/kg B.W.

- Evaluating of efficacy of these medicines in experimentally and naturally infected porcines. Determining of safety medicines by observing the response of porcines during 30 minutes to 1 hour.

2.4.7. Examination method in preventing and treating measures for Trichocephalus* spp. *infected porcines in close field.

Realized place: Tan Huong commune (Pho Yen district), Binh Thanh commune (Đinh Hoa district) - Thai Nguyen province.

Experimental object: Porcines infected only by *Trichocephalus* spp.

2.4.8. Proposing a preventive and treatment procedure of Trichocephalosis in porcines

Establishing the preventive and treatment procedure of Trichocephalosis in porcines based on studied results about

epidemiological characteristics and preventive, treatment measures of Trichocephalosis in porcines.

2.4.9. Data processing method

Data was collected and analised by biostatistical method according to Nguyen Van Thien (2008), Minitab 14.0 software and Microsoft Excel 2007.

Chapter 3
RESULTS AND DISCUSSION

3.1. Result of *Trichocephalus* nematode nomenclature in Thai Nguyen and Bac Kan province in porcines.

The results are presented in table 3.1 and 3.2.

Tables 3.1 and 3.2 show that: 250 parasitised worm in porcines in Thai Nguyen and 200 parasitised worms in Bac Kan were *Trichocephalus suis* specie (Schrank, 1788), phylum Nemathelminthes, genus *Trichocephalus* (Schrank, 1788), family *Trichocephalidae* (Ransom, 1911), sub-order Trichocephalata (Skrjabin et Schulz, 1928), *Trichocephalida* order (Skrjabin et Schulz, 1928), subclass Enoplia (Chitwood, 1933), class Nematoda (Rudolphi, 1808).

Table 3.1. Result of *Trichocephalus* nematode nomenclature in Thai Nguyen and Bac Kan province in porcines.

Places (provine /district)	Number of nomenclatured worms (worm)	Parasitic site (Caecum, colon)	Determined species	Percen tage (%)
Thai Nguyen	**250**	**Caecum, colon**	***Trichocephalus suis***	**100**
Vo Nhai	50	**Caecum, colon**	*Trichocephalus suis*	100
Dong Hy	50	**Caecum, colon**	*Trichocephalus suis*	100
Dịnh Hoa	50	**Caecum, colon**	*Trichocephalus suis*	100
Phu Binh	50	**Caecum, colon**	*Trichocephalus suis*	100
Pho Yen	50	**Caecum, colon**	*Trichocephalus suis*	100

Bac Kan	**200**	**Caecum, colon**	***Trichocephalus suis***	**100**
Ngan Son	50	**Caecum, colon**	*Trichocephalus suis*	100
Bach Thong	50	**Caecum, colon**	*Trichocephalus suis*	100
Ba Be	50	**Caecum, colon**	*Trichocephalus suis*	100
Cho Moi	50	**Caecum, colon**	*Trichocephalus suis*	100

Table 3.2. Size of *Trichocephalus suis* parasitic nematode in porcines in Thai Nguyen and Bac Kan province

Type of samples		Number of studied samples	Size	
			Length (mm) ($\bar{X} \pm m_{\bar{x}}$)	Width (mm) ($\bar{X} \pm m_{\bar{x}}$)
Trichocephalus suis female adult worms	Head	10	25.94 ± 0.93	0.19 ± 0.0011
	Body		15.06 ± 0.72	0.82 ± 0.04
Uterus		10	0.93 ± 0.03	0.29 ± 0.02
**Trichocephalus suis eggs*		10	0.05 ± 0.0023	0.05 ± 0.0023
Trichocephalus suis ma.le adult worms	Head	10	23.30 ± 0.47	0.15 ± 0.0011
	Body		13.23 ± 0.25	0.58 ± 0.01
Genital thorns		10	1.54 ± 0.02	1.54 ± 0.02

** Eggs have fully developed in uterus of Trichocephalus suis female adults.*

3.2.2. The prevalence and infection intensity of Trichocephalus suis nematode in porcines in Thai Nguyen and Bac Kan province

We have determined the prevalence and infection intensity of *Trichocephalus suis* nematode in porcines in Thai Nguyen and Bac Kan province by necropsy and stool examination .The results are performed in table 3.4 and 3.5.

Table 3.4. The prevalence and infection intensity of *Trichocephalus suis* nematode in porcines in 2 provinces by necropsy

Places (province /district)	Number of necropsy porcines	Infected number (pigs)	Prevalence (%)	worms /pig (min ÷ max)

	(pigs)			
Thai Nguyen	**219**	**69**	**31.51**	**6 - 1057**
Vo Nhai	46	17	36.96	6 - 811
Dong Hy	31	11	35.48	7 - 294
Dịnh Hoa	42	17	40.48	15 - 1057
Phu Binh	47	10	21.28	12 - 188
Pho Yen	53	14	26.42	9 - 493
Bac Kan	**197**	**72**	**36.55**	**18 - 1584**
Ngan Son	60	26	43.33	54 -1584
Bach Thong	49	17	34.69	34 - 892
Ba Be	52	16	30.77	18 - 391
Cho Moi	36	13	36.11	27 - 601
Total	**416**	**141**	**33.89**	**6 - 1584**

Table 3.4. shows that the prevalence of *Trichocephalus suis* nematode in porcines by necropsy was 33.89%, the infection intensity was from 6 to 1584 worms/pig. In Bac Kan province, the prevalence of Trichocephalus was 36.55% and infection intensity by necropsy vacillated from 18 to 1584 worms /pig higher than that in Thai Nguyen province (31.51% and 6 - 1057 worms / pig).

Table 3.5. Prevalence and infection intensity of *Trichocephalus suis* nematode in porcines in some places

Places (province /district)	Number of examined porcine (pig)	Number of infected porcine (pig)	Prevalence (%)	Infection intensity (eggs/gram of feces)					
				≤ 1000		> 1000 2000		> 2000	
				n	%	n	%	n	%
Thai Nguyen	2000	572	28.60[a]	344	60.14	159	27.80	69	12.06
Vo Nhai	400	131	32.75	72	54.96	41	31.30	18	13.74
Dong Hy	400	116	29.00	70	60.34	32	27.59	14	12.07
Dịnh Hoa	400	144	36.00	74	51.39	48	33.33	22	15.28
Phu Binh	400	82	20.50	61	74.39	15	18.29	6	7.32
Pho Yen	400	99	24.75	67	67.68	23	23.23	9	9.09
Bac Kan	**1600**	**562**	**35.13[b]**	**309**	**54.98**	**169**	**30.07**	**84**	**14.95**
Ngan Son	400	164	41.00	76	46.34	60	36.59	28	17.07
Bach Thong	400	137	34.25	80	58.39	38	27.74	19	13.87
Ba Be	400	118	29.50	74	62.71	29	24.58	15	12.71
Cho Moi	400	143	35.75	79	55.24	42	29.37	22	15.38
Total	**3600**	**1134**	**31.50**	**653**	**57.58**	**328**	**28.92**	**153**	**13.49**

Note:

In vertical line, the numbers carrying different letters are in statistically significant differences (P <0.001).

In general, in two provinces, the prevalence of *Trichocephalus suis* nematode in porcines was rather high (31.55%). Porcines in Thai Nguyen province, the prevalence was 28.60% (vacillating from 20.50% - 36.00%); in Bac Kan province was 35.13% (varying from 29.50% - 41.00%) higher than that in Thai Nguyen province.

The results of our study on prevalence of *Trichocephalus suis* nematode by examining feces in porcines in Thai Nguyen were lower than the results of Nguyen Van Huy *et al.* (2010) (28.60% compared with 34.92%). The prevalence of *Trichocephalus suis* nematode in both provinces (Thai Nguyen and Bac Kan) was higher than the result of Lai M. *et al.* (2011) in Trung Khanh province - China (10.13%), Nissen S. *et al.* (2011) in Uganda (17%) and Kagira J. M. *et al.* (2012) in Kenya (7%).

3.2.3. The prevalence and infection intensity of Trichocephalus suis nematode by age.

The results are shown in table 3.6.

Table 3.6. The prevalence and infection intensity of *Trichocephalus suis* nematode in porcine by age

Age of porcine (Month)	Number of examined pigs (pig)	Number of infected pigs (pig)	Prevalence (%)	Infection intensity (eggs /gram of feces)					
				≤ 1000		> 1000 - 2000		> 2000	
				n	%	n	%	n	%
≤ 2	450	104	23.11[a]	71	68.27	24	23.08	9	8.65
> 2 - 4	450	198	44.00[b]	92	46.46	70	35.35	36	18.18
> 4 - 6	450	167	37.11[c]	89	53.29	54	32.34	24	14.37
> 6	450	73	16.22[d]	52	71.23	21	28.77	0	0.00
Total	1800	542	**30.11**	304	**56.09**	169	**31.18**	69	**12.73**

Note: In vertical line, the numbers carrying different letters are in statistically significant differences (P <0.001).

Table 3.6 reports that porcines at different ages differed about prevalence and infection intensity of *Trichocephalus suis*. Piglets infected by *Trichocephalus suis* quite early, the prevalence and infection intensity were highest from 2 to 4 months of age. Pigs at 4 - 6 months of age infected by *Trichocephalus suis* with high prevalence and intensity. Sows and adult pigs infected by *Trichocephalus suis* nematode but in inoculated state (there were no pigs over 6 months of age severely infected). These results show that deworming *Trichocephalus suis* in pigs can be applied in any ages, but to prevent harmful effects of *Trichocephalus suis* in pigs, anthelmintic medicines should be used in pigs of 1-2 months of age (because of low prevalence at this age) .

3.2.7. Contamination of Trichocephalus suis eggs in husbandry area and forage area for porcines

Table 3.10. The contamination of *Trichocephalus suis* eggs in husbandry area and forage area for porcines.

Place (Province)	On the pigsty floor			Surrounding pigsty			Forage area for pigs		
	Number of examined samples	Number of infected samples	Percentage (%)	Number of examined samples	Number of infected samples	Percentage (%)	Number of examined samples	Number of infected samples	Percentage (%)
Thai Nguyen	87	87	100	87	64	73.56	87	32	45.98
Bac Kan	102	102	100	102	82	80.39	102	42	41.18
Total	189	189	**100**	189	146	**77.25**	189	82	**43.39**

The results in table 3.10 show that samples from pigsty floor, surrounding the pigsty and forage areas in 189 householders who have infected pigs with *Trichocephalus suis* nematode were contaminated with *Trichocephalus suis* eggs but in different contamination levels. Contamination rate of samples from pigsty

floor contaminated with *Trichocephalus suis* eggs was 100%, around the pigsty was 77.25% and in the forage area was 43.39%. This contamination rate warned that the environment of husbandry porcine was heavily contaminated with *Trichocephalus suis* eggs.

3.2. Study on pathological characteristics caused by *Trichocephalus suis* in porcines.

3.2.1. Study on pathological characteristics caused by *Trichocephalus suis* in experimental porcines.

3.2.1.1. The lifecycle time and excreting development of Trichocephalus suis eggs in experimental porcines.

Table 3.11. The lifecycle time and excreting development of *Trichocephalus suis* eggs in experimental porcines.

The number of experimental porcines	Number of eggs	Time to excrete eggs (days)	Number of eggs /gram of feces /days after being infected ($\overline{X} \pm m_{\overline{x}}$)			
			31 – 40 days	41 – 50 days	51 – 60 days	61 – 70 days
1	15000	31	3585 ± 111.28	4401 ± 69.45	3942 ± 142.69	2829 ± 151.81
2	12500	34	3258 ± 147.66	3963 ± 57.82	3228 ± 170.83	2127 ± 122.70
3	10000	33	2508 ± 116.54	3327 ± 103.65	2892 ± 159.18	1899 ± 93.70
4	7500	31	1929 ± 84.07	2820 ± 117.57	2436 ± 113.31	1566 ± 73.61
5	5000	35	1302 ± 96.86	2193 ± 114.74	1998 ± 125.27	1086 ± 85.61
*** Control (5 Pigs)**	**0**	**0**	**0**	**0**	**0**	**0**

Table 3.11 reports that: After 31-35 days of being infected *Trichocephalus suis* eggs, all 5 pigs excreted eggs to exterior through feces. Pig of number 1 and 4 were infected at respective dose: 15000 and 7500 *Trichocephalus suis* eggs beginning to excrete eggs at the 31th day. While pigs of number 2, number 3 and number 5 were infected at respective dose: 12500 and 10000 eggs and 5000 eggs beginning to excrete eggs at 34th, 33rd and 35th day.

According to Pham Van Khue and Phan Luc (1976), Phan Dich Lan *et al.* (2005), Pham Sy Lang *et al.* (2011), the time to complete lifecycle of *Trichocephalus suis* is 30 days. In our experiments, the time to

complete the lifecycle of *Trichocephalus suis* in pigs was longer than the data mentioned above by these authors (31-35 days).

3.2.1.2. Clinical manifestations of infected porcines with Trichocephalus suis nematode.

Table 3.12 shows that pigs infected with high number of *Trichocephalus suis* eggs with severely clinical signs more than the other pigs. Pigs of numbers 1 and 2 were emaciated, diarrhea in several days, pale eye mucous; pigs of number 3 and 4 have aqueous feces, pig of number 5 did not manifest with clearly clinical signs.

The average body weight of infected pigs was lower than weigh of control group.

The mainly clinical signs of infected pigs that we observed corresponding with the description of Phan Dich Lan *et al*. (2005), Nguyen Thi Kim Lan (2011): severely infected pigs with *Trichocephalus suis* eggs have diarrhea in many days, decreasing appetite, emaciated, pale eye mucous, dry skin,…

Bảng 3.12. Clinical manifestations of pigs infected with *Trichocephalus suis* after being infected

Experimental Pigs	Mainly clinical manifestation	Body weight of pigs (kg)			
		Prior to being infected	40 days after being infected	60 days after being infected	70 days after being infected
1	-Pasty feces from 35th day after being infected. - Aqueous feces from 41st day after being infected. . Pigs have diarrhea in many days. - Pigs were emaciated with dry skin, rough hair, pale mucous.	8.5	16.1	20.6	22.1
2	-Pasty feces from 36th day after being infected. - Aqueous feces from 40st day after being infected. . Pigs have diarrhea in many days. - Pigs were emaciated with dry skin, rough hair, pale mucous.	8.3	16.8	21.8	23.8
3	- Pasty feces from 40th day after being infected. - Aqueous feces from 46th day after being	8.6	17.9	23.5	26.7

	infected. . Pigs have diarrhea changing from pasty to aqueous. - Pigs were emaciated with dry skin, rough hair, pale mucous..				
4	- From 43rd day after being infected, in some days feces was not in shape. -Emaciated, pale eye mucous.	8.4	18.5	24.5	29.0
5	- Clinical signs were not apparent.	8.2	19.0	25.0	29.4
Average body weight of infected pigs		8,32 ± 0,07	8.32 ± 0.07	17.66^{a} ± 0.60	23.08^{e} ± 0.92
* CONTROL GROUP (5)	Average body weight of control pigs	8.38 ± 0.09	19.92^{b} ± 0.45	27.76^{d} ± 0.61	32.20^{f} ± 0.62
	No clinical signs				

In vertical line, the numbers carrying different letters are in statistically significant differences (P <0.001).

3.2.1.4.Macroscopic lesions in digestive organs of experimental porcines

Number of necropsy pigs	**Realised time to necropsy after being infected (day)**	**Macroscopic lesions**	**Number of *Trichocephalus suis* nematode/pig (worm)**
1	70	Cecal and colonic mucous have many ulcers, rough up the mucous, hemorrhage. In cecal lumen, it contents much mucus and dun – pink coloured.	1864
2	70	Cecal and colonic mucous have many ulcers, rough up the mucous, petechial hemorrhage. In cecal lumen, it contents much mucus and dun – pink coloured.	1543
3	70	Cecal and colonic mucous have petechial hemorrhage. In cecal lumen, it contents much mucus.	922
4	70	Cecal and colonic mucous have hemorrhage. In cecal lumen, it contents less mucus.	619
5	70	Cecal mucous have moderate hemorrhage.	205
* Control (2/5)	70	No lesions	0

Table 3.15 shows that: The most severe lesions were encountered in pig of number 1 and 2 with the number of *Trichocephalus suis* parasitic nematode was 1864 and 1543 worms, respectively. The lesions were seen: in cecal mucous and colonic lumen became rough up, many ulcers and petechials, in cecal lumen, it contents much mucus and dun – pink coloured.

Necropsy was realised in 2 pigs of control group to compare with infected pigs, in both pigs did not encounter lesions in large intestine and *Trichocephalus suis* parasite.

From the mentioned results, we evaluated as follows: Macroscopic lesions was observing in infected pigs which resulted from *Trichocephalus suis* nematode. The more nematode parasite in pigs, the more severe lesions in the cecum and colon of the host and vice versa.

3.2.2. Study on Trichocephalosis in naturally infected porcines

3.2.2.2. The prevalence and infection intensity of Trichocephalus suis nematode between pigs with diarrhea and normal pigs

Table 3.18. ***The prevalence and infection intensity of Trichocephalus suis nematode between pigs with diarrhea and normal pigs***

Places	Feces state	Number of examined pigs (pig)	Number of infected pigs (pig)	Prevalence (%)	Infection intensity (eggs/gram of feces)					
					≤ 1000		1000 – 2000		> 2000	
					n	%	n	%	n	%
Thai Nguyen	Diarhrea	349	113	32.38	20	17.70	24	21.24	69	61.06
	Normal	1651	459	27.80	324	70.59	135	29.41	0	0.00
Bac Kan	Diarhrea	274	109	39.78	11	10.09	14	12.84	84	77.06
	Normal	1326	453	34.16	298	65.78	155	34.22	0	0.00
Total	**Diarhrea**	623	222	**35.63**[a]	31	**13.96**	38	**17.12**	153	**68.92**
	Normal	2977	912	**30.63**[b]	622	**68.20**	290	**31.80**	0	**0.00**

Note: In vertical line, the numbers carrying different letters are in statistically significant differences.

In Thai Nguyen and Bac Kan province, pigs with diarrhea and normal pigs were infected with *Trichocephalus suis* nematode. However, the prevalence of pigs with diarrhea was higher and infection intensity was more severe in comparison with normal pigs. The results allowed us to evaluate that 68.92% of pigs with diarrhea severely infected with *Trichocephalus suis* nematode, it means *Trichocephalus suis* nematode play an important role in diarrhea syndrome in these pigs.

3.3. Study on preventive and treatment measures of Trichocephalosis in porcines

3.3.1. Determining the effect of some disinfectants and fecal processing techniques contained Trichocephalus suis eggs

3.3.1.1. Determining the effect of some disinfectants to *Trichocephalus suis* eggs

Table 3.20. The *effect of some disinfectants to Trichocephalus suis eggs* (in summer)

***Disinfectants*, Ingredient, dose**	**Observing time (day)**	**Mortality of *T. suis's* eggs (%)**	**Percentage of *T. suis*'s eggs able to cause disease (%)**
Povidine 10% (*1 litre/ 250 litres of water)*	1 - 30	1.27	0.00
	31 - 57	0.74 - 2.03	4.20 - 91.88
	58 - 60	1.65	98.35
Benkocid *(25ml/ 10 litres of water)*	1 - 30	1.35	0.00
	31 - 53	0.94 - 1.90	12.29 - 84.57
	54 - 56	1.21	97.18
Formades (10 ml/2.5 litres of water)	1 - 30	1.35	0.00
	31 - 60	1.27 - 2.39	2.36 - 91.52
	61 - 63	1.74	98.26
QM - Supercide (25 ml/10 litres of water)	1 - 30	1.55	0.00
	31 - 47	0.57 - 2.54	25.89 - 93.71
	48 - 50	2.40	97.60
CONTROL GROUP	1 - 30	1.43	0.00
	31 - 51	0.72 - 2.60	13.59 - 81.54
	52 - 54	2.60	97.40

Table 3.20 shows that all 4 disinfectants did not eliminate totally *Trichocephalus suis* eggs. The eggs still survived and able to be infected eggs. The development of *Trichocephalus suis* eggs between experimental and control group was similar. We consider that egg shells may be very thick which helped eggs not being destroyed by experimental disinfectants.

3.3.1.2. Determining the capacity of heat generation and effect in deworming Trichocephalus suis eggs in various composting formulas

Table 3.25. Capacity of heat generation and and effect in deworming *Trichocephalus suis* eggs through 4 composting formulas

Composting Formula	The highest time of heat generation (day)	Average temperature reached the highest degree ($\bar{X} \pm m_{\bar{X}}$) (^oC)	Existed time at high temperature degree (> 53 ^oC) (day)	Day on which *T. suis* eggs were total dead (day)
I	30	53.02 ± 0.35	5	37
II	32	58.50 ± 0.04	17	32
III	30	59.70 ± 0.21	20	26
IV	5	68.82 ± 1.26	31	6

Table 3.25 shows that:

About the capacity of heat generation: Formula IV demonstrated highest velocity in heat generation (after 5 days of composting), much faster than the formula I, II and III (30 - 32 days). The highest average temperature of formula IV was 68.82 ^oC, much higher than the formula I (53.02 ^oC), formula II (58.50 ^oC) and formula III (59.70 ^oC).

About the capacity in eliminating *Trichocephalus suis* eggs by 4 composting formulas: in formula IV, *Trichocephalus suis* eggs died totally on the 6th day of composting, much shorter than the formula I (37 days), the formula II (32 days) and formula III (26 days).

3.3.2. Determining the efficacy of anthelmintic medicines for deworming Trichocephalus suis nematode in porcines

By way of experimental results of 3 anthelmintic medicines of *Trichocephalus suis* nematode in porcines, we have found that levamisol, ivermectin and fenbendazole used for deworming *Trichocephalus suis* in pigs were highly effective and safe for pigs. However, ivermectin was more effective deworming *Trichocephalus suis* nematode than levamisol and fenbendazole (98.47%).

Table 3.27. The efficacy of antihelmitics used for deworming Trichocephalus suis nematode in pigs in the field

Name, ingredient, dose and use	Treatment round	Prior to deworming		15 days after deworming		Deworming efficacy	
		Number of infected pigs (pig)	Number of eggss/gram of feces ($\bar{X} \pm m_{\bar{x}}$)	Number of infected pigs(pig)	Number pf eggs /gram feces ($\bar{X} \pm m_{\bar{x}}$)	Number of pigs being clear of worm eggs (pig)	Deworming efficacy (%)
Levasol 7.5 % (levamizol. 7.5 mg /kg B.W. I.M)	1	38	1808.68 ± 159.23	2	225 ± 63.64	36	94.74
	2	32	1744.69 ± 180.90	1	90	31	96.88
	3	41	1036.10 ± 74.72	3	230 ± 68.19	38	92.68
Total	**-**	**111**	**-**	**6**	**-**	**105**	**94.59**
Bendazol (fenbendazol. 4 mg /kg B.W. Mixe to food)	1	33	1790 ± 180.98	2	135 ± 56.12	31	93.94
	2	42	1582.78 ± 146.25	1	120 ± 42.43	41	97.62
	3	45	1212.67 ± 107.25	2	105 ± 64.00	43	95.56
Total	**-**	**120**	**-**	**5**	**-**	**115**	**95.83**
Ivermectin 0.3mg/kg B..W. I.M)	1	37	1550.27± 59.77	1	180	36	97.30
	2	50	1711.2 ± 133.32	0	0	50	100
	3	44	1437.21 ± 114.64	1	90	43	97.73

Total	**-**	**131**	**-**	**2**	**-**	**129**	**98.47**

3.3.4. Approving preventive and treatment measures of Trichocephalosis in porcines

Table 3.29. Prevalence and infection intensity of *Trichocephalus suis* nematode in porcines before being experienced

Group	Number of examined pigs (pig)	Number of infected pigs (pig)	Prevalence (%)	Infection intensity (eggs/gram of feces)					
				≤ 1000		> 1000 -2000		> 2000	
				n	%	n	%	n	%
Experimental	39	39	100	18	46.15	14	35.90	7	17.95
Control	36	36	100	19	52.78	12	33.33	5	13.89

Table 3.30. Prevalence and infection intensity of *Trichocephalus suis* nematode in porcines after 1 experienced month

Group	Number of examined pigs (pig)	Number of infected pigs (pig)	Prevalence (%)	Infection intensity (eggs/gram of feces)					
				≤ 1000		> 1000 -2000		> 2000	
				n	%	n	%	n	%
Experimental	39	0	0,00	0	0	0	0,00	0	0,00
Control	36	36	100	17	47.22	13	36.11	6	16.67

Table 3.31. . Prevalence and infection intensity of *Trichocephalus suis* nematode in porcines after 2 experienced month

Group	Number of examined pigs (pig)	Number of infected pigs (pig)	Prevalence (%)	Infection intensity (eggs/gram of feces)					
				≤ 1000		> 1000 - 2000		> 2000	
				n	%	n	%	n	%
Experimental	39	5	12.82	5	100	0	0.00	0	0.00
Control	36	36	100	21	58.33	11	30.56	4	11.11

Table 3.29, 3.30, 3.31 show that there were no infected pigs of *Trichocephalus suis* nematode after 1 month. However, after two months of applying preventive and treatment measures, infected pigs with *Trichocephalus suis* nematode were accounted 12.82%. In the control group, prevalence of *Trichocephalus suis* in pigs after 1 and 2 experienced months was 100%. However, the

infection intensity was decreasing gradually after 1 and 2 experienced months.

Table 3.32. Porcine body weight in experimental and control group at various experimental periods

Experimental Periods	Porcine body weight (kg)		Comparison (%)	
	Control group ($\bar{X} \pm m_{\bar{x}}$)	Experimental group ($\bar{X} \pm m_{\bar{x}}$)	Control group	Experimental group
Benning of experiment	23.86 ± 2.68	23.60 ± 2.70	100	98.90
After 1 experienced month.	36.95 ± 4.83	39.95 ± 5.06	100	108.12
After 2 experienced month.	51.90 ± 3.58	58.50 ± 3.90	100	112.72
Totally increased body weight during the experiment	28.04	32.01	100	114.16

The results in table 3.32 show that integral measures of *Trichocephalosis* prevention and control applied in the experimental pigs were effective: reduced the prevalence and infection intensity of *Trichocephalus suis* nematode, increased porcine body weight 14.16% faster than the control group.

3.3.5. Designing preventive and control procedure of Trichocephalosis in porcines

Combining all results of the thesis with preventive and control principle for parasitic disease, we recommend that the preventive and control procedure of Trichocephalosis in porcines as follows:

1. Deworm *Trichocephalus suis* nematode in pigs: three antihelmitic medicines: levamisol (7.5 mg / kg B.W), fenbendazol (4 mg / kg B.W) and ivermectin (0.3mg / kg B.W) that were approved for deworming *Trichocephalus suis* nematode and showed good results. Depends on each locality and specific case, one of 3 medicines can be chosen for deworming *Trichocephalus suis* in pigs. However, ivermectin is recommended due to its efficacy.

Deworming procedure as follows:

- Firstly, deworming to severely infected or clinical manifestation pigs of Trichocephalosis.

- Periodic deworming *Trichocephalus suis* nematode to whole porcine herd (3 - 4 times/year) or when clinical manifestations in pigs are encountered.

- To sows and fattening pigs, *Trichocephalus suis* nematode need to be dewormed before being incorporated, to boars be dewormed every 3 months and at 1-2 months of age to the fattening pigs.

After being dewormed *Trichocephalus suis* nematode in pigs, Pigsty must be daily cleaned, feces need to be collected for composting, to avoid spreading disease germs into the environment.

2. Fecal treatment by aerobic composting technique to eliminate Trichocephalus suis eggs

Fecal treatment is daily collected from the pigstys, carried into a place where is made composting pit. Applying composting technique to eliminate *Trichocephalus suis* eggs with a ratio of raw materials and feces is 1: 1. The steps are as follows:

- Lay a material stratum (green plants and other grass crops, cut off 15-25 cm) with 25-30 cm of dense on the ground, then putting a fecal stratum with 10 cm of thickness on the a material stratum.

- Continue to do next steps as above until the composting pit reach approximately 1 - 1.5 m of diameter, 1.5 - 2 m of height, the canvas will be enveloped. Two days after composting, the temperature will increase to 70 ^{o}C - 71 ^{o}C. Under the effect of such high temperature, *Trichocephalus suis* eggs will be eliminated.

* Residual water in porcine husbandry process should be treated in biogas tanks to eliminate entire *Trichocephalus suis* eggs and other parasites.

3. Realizing hygiene into the pigtys and their surrounding areas

Pigtys and their surrounding areas must be ventilated in summer and warmly in winter; always be dry and clean because it is easy for pigs to expose germs. Areas around the pigsty should be cleaned to

avoid spreading and resisting *Trichocephalus suis* eggs in the environment.

4. Strengthening care and manage porcine herd

Be attended to **c**are and manage in porcine herd, especially, in the piggy and fast growth period to improve the immune against diseases, including Trichocephalosis.

CONCLUSION AND RECOMMENDATION

Conclusion

1. Nomenclature of *Trichocephalus* spp. nematode

Trichocephalus suis has been identified as a parasitic nematode and caused Trichocephalosis in porcines in Thai Nguyen and Bac Kan province.

2. About the epidemiological characteristics:

- The preventive and control measures of parasitic diseases in porcines in 2 provinces were poor, especially Trichocephalosis preventive measures.

- Prevalence of *Trichocephalus suis* nematode in porcines through necropsy was 33.89% (ranging from 21.28% - 43.33%), by feces examination was 31.50% (varying from 20.50- 41%).

- The prevalence and infection intensity of *Trichocephalus suis* in porcines decreased according to ages. Porcines infected with *Trichocephalus suis* much number and severe at 4 months of age.

- Seasons, husbandry methods and veterinary hygienic situation were significantly affected to the prevalence and infection intensity of *Trichocephalus suis* in porcines. Porcines infected with *Trichocephalus suis* much number and severe in summer, in traditional husbandry method and in a poorly veterinary hygiene.

- The ambient medium around the pigstys were contaminated *Trichocephalus suis* eggs.

3. About the pathological characteristics of Trichocephalosis:

- Time period for *Trichocephalus suis* to complete lifecycle in porcine was 31- 35 days.

- Experimentally and naturally infected porcines have typically clinical manifestations as follows: diarrhea, emaciation, anemia and retardation.

- blood cell count, hemoglobin concentration and average volume of red blood cells decreased in experimental porcines; whereas number of lymphocyte and platelet increased, the proportion of neutrophils decreased, the proportion of eosinophils increased, the proportion of lymphocytes and monocytes was increased in comparison with control porcines.

- Experimentally and naturally infected porcines have lesions as follows: congestion and hemorrhage in cecal, colonic mucous, ulcers, eosinophil proliferation.

4. Preventive and treatment measures of Trichocephalosis

- The common disinfectants used in Thai Nguyen and Bac Kan: (povidine 10%, benkocid, fomandes and QM - supercide) could not eliminate *Trichocephalus suis* eggs.

- Composting was the good measure for eliminating *Trichocephalus suis* eggs. In particular, aerobic composting technique was the best technique of generating heat and eliminating *Trichocephalus suis* eggs in 4 composting fomulas.

- Levamizole, fenbendazole, ivermectin were effective and safe for deworming Trichocephalus suis nematode in porcines, ivermectin was the highest effectiveness among them (98.47%).

- Integral preventive and treatment measures of Trichocephalosis for experimental porcines reached a good effectiveness: reduced the prevalence and infection intensity of *Trichocephalus suis* nematode, increased porcine body weight in comparison with control porcines.

2. RECOMMENDATION

Widely applying preventive and control procedure of Trichocephalosis in porcines in Thai Nguyen, Bac Kan province and other mountainous provinces in order to reduce economic losses cause by this disease, contributing to improve husbandry productivity and promote sustainable development in porcine husbandry.