

EFFICACY OF NEEM DECOCTION, NEEM LEAVES AND JACARANDA LEAVES EXTRACTION ON GASTRO – INTESTINAL NEMATODES IN GOATS

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ABSTRACT. Natural herbal remedies have been long used to control common parasitic infections in livestock. The effectiveness of two plant products was tested on goats with helminthiasis. A study was carried out in a commercial goat farm near Sg. Siput, whereby *Azadirachta indica* (neem) decoction and leaf extract as well as *Jacaranda filicifolia* (Jacaranda) leaf extract were fed orally to 3 groups of goats that previously with strongyle egg counts range from 587 to 1650 egg per gram (EPG) for a period of 5 weeks. In this study, the Jacaranda Leaves Water Extract (JLWE) showed the highest number of fecal egg count with 2585 EPG at the end of study. All treatments showed reduced percentage of packed cell volume from 23% to 21%, which was not significant. However, there was no difference in the composition of strongyle larvae in the goats. The results show that neem decoction was effective in reducing faecal egg count but the Jacaranda leaf extract and neem leaf extract were not effective in reducing faecal egg counts in goats. Further work is required to assess the efficacy of these herbal products for worm control in goats.

Keywords: Neem Decoction, Neem Leaves, Jacaranda Leaves, Gastro Intestinal Nemaode

1.0 INTRODUCTION

Malaysia's livestock industries, especially the pig and poultry sectors, contributes significantly to the gross national income, and is also one of the main sources meat products for the nation. The livestock industries especially ruminant are projected to grow bigger due to higher demand of halal meat or livestock based products especially from Islamic countries. At the moment, Malaysia is dependent on imports of meat products from ruminants, from other countries such as India, Australia, New Zealand, Indonesia, South Africa and Thailand (Anonymous, 2011).

One of the main reasons for the slow pace of growth of the ruminant industry is the limitations caused by gastrointestinal parasites, mainly nematodes infection also known as helminthiasis. Helminthiasis is considered as one of the main causes of economic losses through weight loss and high mortality in small ruminants

(Norakmar *et al.*, 2010). Helminthiasis is mainly caused by parasitic nematodes from the family of Strongylidae such as *Haemonchus* spp., *Bunostomum* spp., *Cooperia* spp., *Oesophagostomum* spp., and *Trichostrongylus* spp. *Haemonchus contortus* are important blood sucking nematodes in grazing animals that causes severe anemia with heavy infections. Anemia, emaciation, edema, and intestinal disturbances caused by these parasites result principally from loss of blood and also the injection of hemolytic proteins into the host's system (Schmidt *et al.*, 2009). Heavy infections can lead to host fatality. Besides that, poor growth could lead to poorer meat and milk production and also death would cause major losses to these small holder farmers.

The adaptation of gastrointestinal nematodes especially in their host will enable it to adjust or circumvent the immune response of the host for their survival (Chandrawathani *et al.*, 2013a). As a result, anthelmintic treatments can be given to control these helminthes. Today, broad-spectrum anthelmintics that are commonly used to treat these infections are Benzimidazoles (BZ), Levamisole (LEV) or Ivermectin (IVM) (Wahab *et al.*, 2007). Nirophenols and Salicylanilides are also regularly used in husbandry systems (Chandrawathani *et al.*, 2013a) to reduce the worm infections. However, resistance of helminths to common anthelmintics have been reported all over the world due to the selective pressure of chemotherapeutics (Wahab *et al.*, 2007). In Malaysia, frequent usage of anthelmintics

can deem it ineffective towards target species (Chandrawathani *et al.*, 2013b).

An alternative method of controlling the gastrointestinal nematode infection is by using indigenous medicinal plants. *Azadirachta indica* is one of the local medicinal plants that has received some research attention. It belongs to Meliaceae family and it also known as Neem or "Mambu" by the locals in Malaysia. Azadirachtin, meliantol and salanin were the active constituents reported in neem (Chandrawathani *et al.*, 2013a).

Another interesting medicinal plant, seen from both biological and chemical perspectives is *Jacaranda filicifolia* or Jacaranda and also known as "Jambul Merak" from the family of Bignoniaceae. During large scale screening to study anthelmintic effects of herbal plants, involving multiple plants extract, Jacaranda was found to be active against specific biological targets (Gachet *et al.*, 2009). The disposition of the leaves, type of inflorescence and the characteristics of the fruits, helps in identification of its species (Gachet *et al.*, 2009). Constituents of the *Jacaranda filicifolia* stem include b-sitosterol, ursolic acid, 2a, 3a dihydroxyurs-12en-28-oic acid, and 2-(-4-hydroxyphenyl) ethyl 1-dodecyloctadecanoate (triacontanoic acid) (Rahmatullah *et al.*, 2010).

The low awareness of drug resistance of common helminths and availability of common herbal plants as remedy, among farmers and general public leads to research of medicinal plants such as Jacaranda and neem, for the specific

use in combatting parasites. Its foliage is non-toxic, eco-friendly, economical and palatable (Chandrawathani *et al.*, 2013b). Local herbal remedies are easily available, cheap and most important it will reduce the use of anthelmintic drugs on food animals such as goats, sheep and cattle as well as profitable to the farmers with production of disease and chemical free meat of high quality and safe food supply for public.

Therefore, the aim of this project is to determine the effectiveness of *Azadirachta indica* (neem) leaves extract, *A. indica* (neem) decoction and *Jacaranda filicifolia* (Jacaranda) leaves extract against the gastrointestinal worm parasite infection in local goats. In addition, the effect of extracts on the animals blood parameters were also studied. Results from this study will provide useful information on the effect of Jacaranda leaves water extract (JLWE), neem leaves water extract (NLWE) and neem decoction (NDEC) on gastrointestinal nematodes and reduction of parasite infection symptoms. This will provide economical options to enable farmers to use the most appropriate worm control methods to suit their management system.

2.0 MATERIALS & METHODS

2.1 Study Area

This study was conducted from January to February 2014, for a total of 6 weeks, at a private goat farm located in Sungai Siput, Perak, under supervision of Veterinary Research Institute (VRI) Ipoh.

2.1.1 Background of the Farm

This farm is located in an oil palm plantation and has a population of about 200 goats. The wooden goat shed was raised with several compartments for goats of various ages and individual pens for pregnant animals. The surrounding area was muddy, and unkempt with goat dung and wild grass. They were allowed to graze under oil palm trees during the day for 5 to 6 hours daily and housed at night. In the pen, they were fed concentrates and oil palm fronds. Animals were observed to be healthy clinically and were chosen for this study.

2.2 Experimental Animals

This study involved 32 adults, local Katjang cross goats between the ages of 1 year to 2 years based on dentition. The average weight of the goats is 20 kg. The experimental animals were grouped randomly into four (4) groups, with eight animals each, namely, Group 1 (un-treated controls), Group 2 (Neem Leaf Water Extract-NLWE), Group 3 (Jacaranda Leaf Water Extract - JLWE), Group 4 (Neem Leaf Decoction – NLDEC) and treated orally twice on week 1 and week 3 only. They were ear tagged for identification and faecal samples were collected weekly per recta for 6 consecutive weeks. The control group was not given any treatment but was observed for clinical helminthiasis in case of necessity for salvage treatment.

2.3 Preparation of Leaf Extracts: Neem Extract (*A. indica*) and Jacaranda Extracts (*J. filicifolia*)

The mature leaves from the trees on the grounds of Universiti Sains Malaysia, Penang, were harvested freshly, washed and cleaned by using running tap water. After that, the leaves were air-dried under the shade for two days. By using a mill electrical grinding, the dried leaves were ground to a powder form and the resulting powder was stored at room temperature in air-tight containers until usage.

An amount of 720 grams of the powder was mixed with 3600 ml of sterile distilled water in 2000 ml conical flask. This mixture was heated using water bath (Stuart, waterbath-RE300B, UK) for 6 hours at 70 °C. The resulting extract was filtered through filter paper (Whatman No.1, USA) and was concentrated later by using a rotary vacuum evaporator (Heidolph Rotary Evaporator) at 40 °C before being left to dry in the oven at 40 °C for 48 hours. Sterile universal bottles were used to store the sediment at 4 °C until used.

Twenty-two point six four (22.64) grams of leaves paste extract was diluted with 400 ml distilled water producing a liquid extract. A volume of 50 ml of liquid extract is equivalent to 2830 mg of leaves extract and was fed to each respective group in week 1 and week 3. The extract was given orally using a syringe. The animals swallowed the liquid with no problems.

2.4 Neem (*Azadirachta indica*) Decoction preparations

Fresh mature neem leaves were collected from the neem tree on the grounds of the Veterinary Research Institute, washed and cleaned by using tap water. A total of 200 grams of fresh leaves were weighed and soaked into 1000 ml of distilled water for three (3) days. The leaves were removed, and the remaining decoction fluid was fed at 50 ml equivalent to 10 grams of neem leaves per goat in week 1 and week 3 before grazing or feeding.

2.5 Specimen Collection and Laboratory Techniques.

2.5.1 Faecal Egg Count (FEC)

Fresh faecal samples were collected from the rectum of each goat once a week and analyzed immediately to avoid any contamination of larvae from older faecal on the floor. The McMaster egg counting method (MAFF, 1986) was applied for faecal egg counts (FEC) from the faecal samples collected weekly in order to estimate the number of helminth eggs in a gram of goat faeces. This method was conducted in the Parasitology Section of Veterinary Research Institute (VRI).

Three (3) grams of faeces were weighed into a jar filled with 45 ml saturated salt solution up to 45ml (dilution ratio of 1:15). The sample was crushed by using pestle and mortar. Then, the faecal suspension was filtered through a strainer before it was filled up both of the counting chambers of McMaster slide in order to estimate the faecal egg count (EPG), with

$$\begin{aligned} \text{Number of EPG} &= \frac{\text{Number of eggs counted} \times \text{Total volume (45ml)}}{\text{Volume of counted chamber (0.15ml)} \times \text{Weight of faeces (3g)}} \\ &= \text{Number of eggs actually counted} \times 100 \end{aligned}$$

a sensitivity of egg counted representing 50 eggs per gram of faeces in this modified McMaster method (Chandrawathani *et al.*, 2013a).

2.5.2 Faecal Culture for L₃ Larvae

Faecal culture was performed by using standard methods (MAFF, 1986) to identify the third stage larvae by providing suitable conditions for hatching of eggs and larval development of the ineffective third stage. The faecal sample was crushed manually and the consistency of faeces should be moist and crumbly by the addition of water but not wet. This mixture was then placed into half of the culture jar. The mouth and inside of the jar were wiped clean and the jar was capped loosely before left to incubate at room temperature for 7 days.

After a week, water was added to the culture jar up to the brim for harvesting of larvae. The mouth jar was closed with a petri dish before it was turned upside down. After 30 minutes, larvae were collected by using pipette and will be placed into universal bottle, followed by a drop of Lugol's iodine. The larvae identification was carried out by morphological observations under microscopes using 40 X magnification using keys from MAFF (1986).

2.5.3 FAMACHA Method

The Faffa Malan Chart (FAMACHA) technique was used to estimate any anemia cases among the experimental goats which may be caused by *Haemonchus contortus*. The colour of lower eyelid was ranked with a score of 1 to 5 (normal to severe anemia) according to the redness observed. It was carried out twice in week 1 and week 6 (pre- and post-treatment).

2.5.4 Percentage Packed Cell Volume (% PCV)

Blood samples collected in EDTA tube of all 32 goats for pre- and post – treatment (week 1 and week 6) for Packed Cell Volume (PCV) by using micro-haematocrit method. Measured values obtained from centrifuging blood in a haematocrit centrifuge at 1200 rotation per minute for 5 minutes. A higher than normal percentage of PCV is an indication of dehydration, while lowered percentage of PCV showed anemia caused by acute infection, bleeding, blood parasite, or poor nutrition. The normal value of PCV for goats is between 19 and 38%.

2.5 Statistical Analysis

Both descriptive statistics and graphs were generated using data analysis tools such as Microsoft Excel 2007 and IBM SPSS Statistic 20. The differences in

average of FEC were determined using One way Anova with Post Hoc Multiple Comparison (Tukey test). The significant level for statistical tests were set at $P < 0.05$.

3.0 RESULT

3.1 Faecal Egg Counts (FEC)

During the study, faecal egg counts (FEC) were conducted for 6 consecutive weeks. Figure 3.1 showed the mean of egg per gram (EPG) readings against week obtained for each group during pre- and post-treatment. At the beginning of the study, the average FEC starts around 587 to 1650 EPG. The average FEC for Control group steadily increased from week 1 until week 3 but showed declining readings of 1266 to 575 EPG from week 4 to week 6. In the Neem Leaves Water Extract (NLWE) treatment group the EPG showed inconsistent fluctuation and increased drastically after the second treatment (3rd week) to 4212 EPG before declining back in week 5 and week 6. Unfortunately, Jacaranda Leaves Water Extract (JLWE) failed to reduce EPG readings since the amount kept increasing from week 1 until the end of the study period. The JLWE showed the highest number of FEC at the end of study, which was 2585 EPG compared to Control and NLWE, 575 EPG and 2562 EPG, respectively. While, Neem Decoction (DEC) showed increasing values during week 2 from 1275 EPG to 2912 EPG and the value declined to 1687 EPG before consistently increasing from week 4 until week 6.

3.2 Prevalence Of Parasite Species In The Experimental Animals

According to mean composition of larvae (L_3) in the goats from all groups (Table 3.2), four species of L_3 stage nematodes were identified from the culture, namely *Haemonchus* spp., *Trichostrongylus* spp., *Cooperia* spp. and *Oesophagostomum* spp. The most abundant species present was *Haemonchus* spp. following by *Trichostrongylus* spp. . *Cooperia* spp. was present at an average of 5.5% in all groups (Control, NLWE, JLWE and NDEC). While the lowest species recorded was *Oesophagostomum* spp.

In all groups, the percentage of L_3 larvae of *Cooperia* declined to 0% towards the end of the study. In contrast, the *Oesophagostomum* was seen during post-treatment in 5% in goats treated with NLWE, 7% in goats treated with NDEC and 10% for both control goats and goats treated with JLWE. In the Control experimental animals (Figure 3.2a), the percentage of *Haemonchus* L_3 larvae increased from 68% during pre-treatment to 79% during post-treatment. While, *Trichostrongylus* showed a decreasing value of 11% at the end of the study.

The effectiveness of each treatment according to the mean EPG of pre- and post-treatments (Table 3.2) shows that all treatment groups; NDEC, JLWE and NLWE had an increase in faecal egg counts, with the Control group showing a drop in faecal egg counts (49.45%). Figure 3.2b shows the percentage L_3 larvae in goats treated with NLWE for pre- and post-treatment. There is an increase in *Haemonchus*

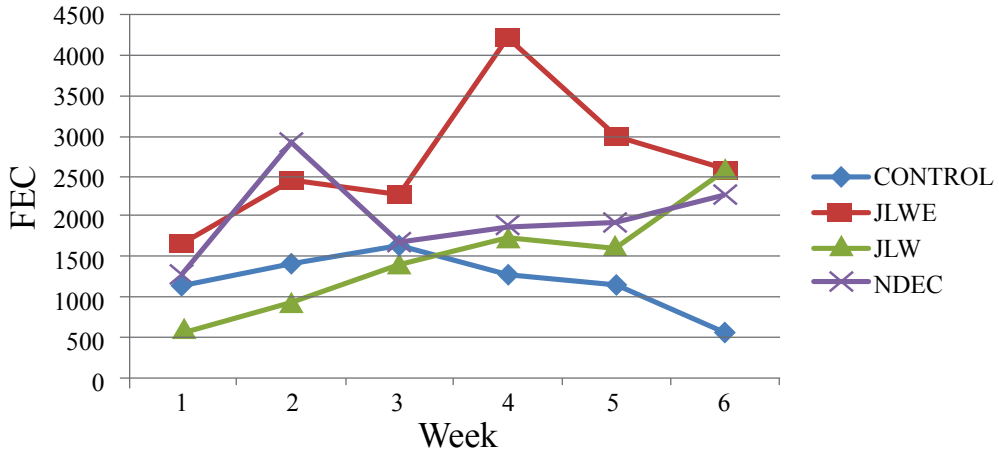


Figure 3.1. Mean Faecal Egg per Gram (EPG) for 6 weeks for all control and experimental groups

Table 3.1. Mean Faecal egg count with standard error for all control and experimental groups

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
CONTROL	1137.5 ± 380.8	1400 ± 537.5	1637.5 ± 375.6	1266.7 ± 514.9	1150 ± 359.4	575 ± 194.3
NLWE	1650 ± 301.8	2457.1 ± 508.4	2275 ± 253.4	4212.5 ± 1352.2	2985.7 ± 944.5	2562.5 ± 990.3
JLWE	587.5 ± 134.2	937.5 ± 390.9	1412.5 ± 449.0	1737.5 ± 483.3	1612.5 ± 333.5	2585.7 ± 748.5
NDEC	1275 ± 186.8	2912.5 ± 1225.1	1687.5 ± 439.7	1887.5 ± 375.8	1912.5 ± 438.1	2250 ± 409.3

Table 3.2. The efficacy of each treatment according to the mean epg of pre- and post-treatments.

Treatment	Mean epg		% drop in FEC
	Pre-treatment	Post-treatment	
Control	1137.5	575	49.45
NLWE	1650	2562.5	0
JMLWE	587.5	2585.7	0
NDEC	1275	2250	0

and *Trichostrongylus* by 2% and 4% respectively. A different trend showed in Figure 3.2c for percentage of L₃ larvae in goats treated with JMLWE. *Haemonchus* reduced by 4% but *Trichostrongylus* spp. increase by 5% from 21% to 26% with a 24% reduction of *Haemonchus* spp. occurring in the neem decoction treatment group (Figure 3.2d).

3.3 FAMACHA scores

Average FAMACHA (Figure 3.3) for Control and all treatment groups during pre – treatment showed higher score since all groups score above 3 which indicates medium anemia. All three plant remedies treatment, NDEC, NLWE and JLWE showed slightly higher score of FAMACHA in the post-treatment (6th week) compare to pre-treatment(1st week) score. This indicates that the animals were less anaemic after 6 weeks of treatment.

Table 3.3. Percentage of mean larvae composition in control and treatment group

Mean Composition Larvae (%)				
	Control	NLWE	JLWE	NDEC
Haemonchus	73.5	69.0	66.0	48.5
Trichostrongylus	16.0	23.0	23.5	29.3
Cooperia	5.5	5.5	5.5	5.0
Oesophagostomum	5.0	2.5	5.0	2.5

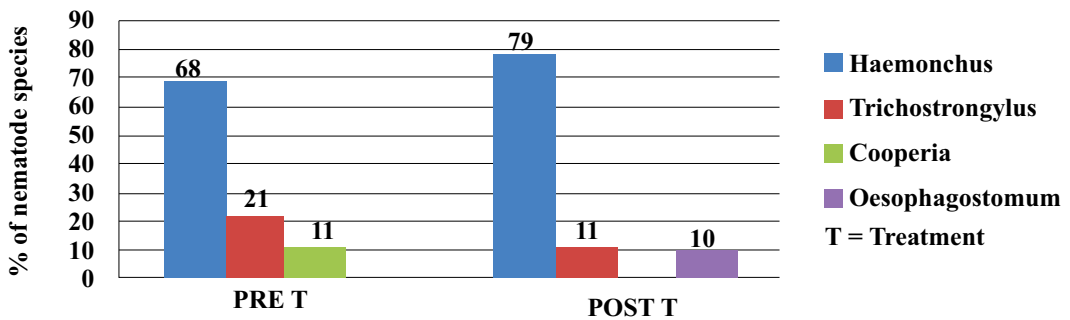


Figure 3.2a. Percentage of L₃ species in control goat for pre- and post-treatments.

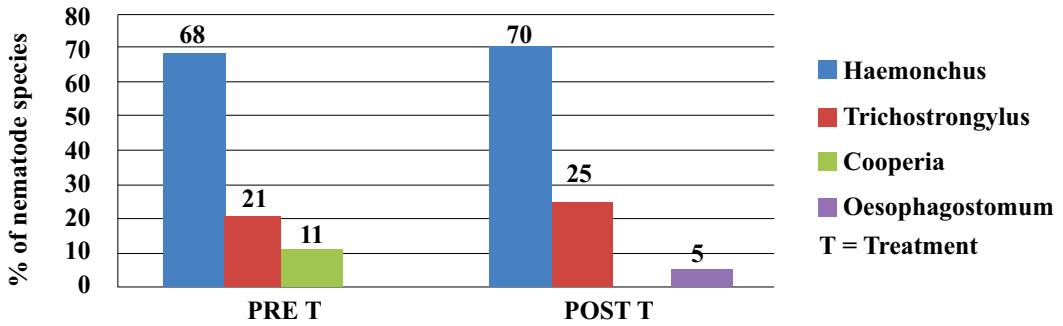


Figure 3.2b. Percentage of L₃ species in goats treated with Neem (*A. indica*) leaves water extracts for pre- and post-treatments.

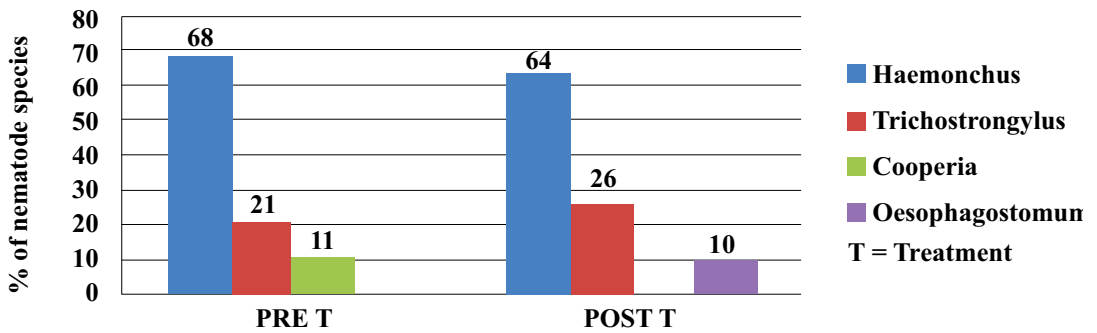


Figure 3.2c. Percentage of L₃ species in goats treated with Jacaranda (*J. filicifolia*) leaves water extract for pre- and post-treatments.

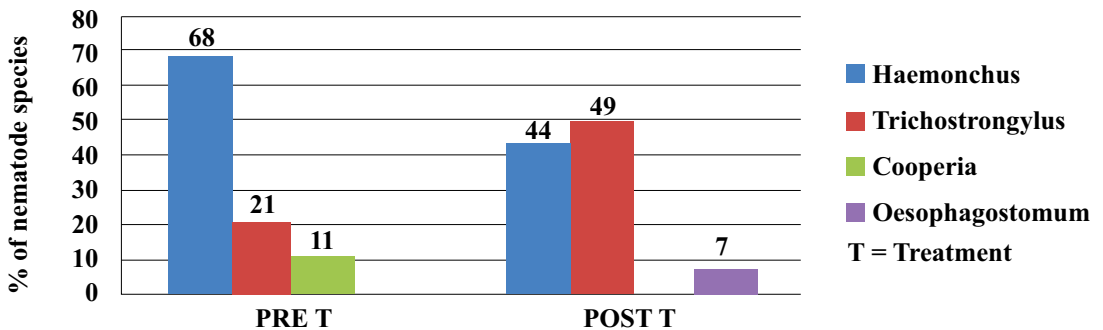


Figure 3.2d. Percentage of L₃ species in goats treated with Neem Deccoction (*A. indica*) for pre- and post-treatments.

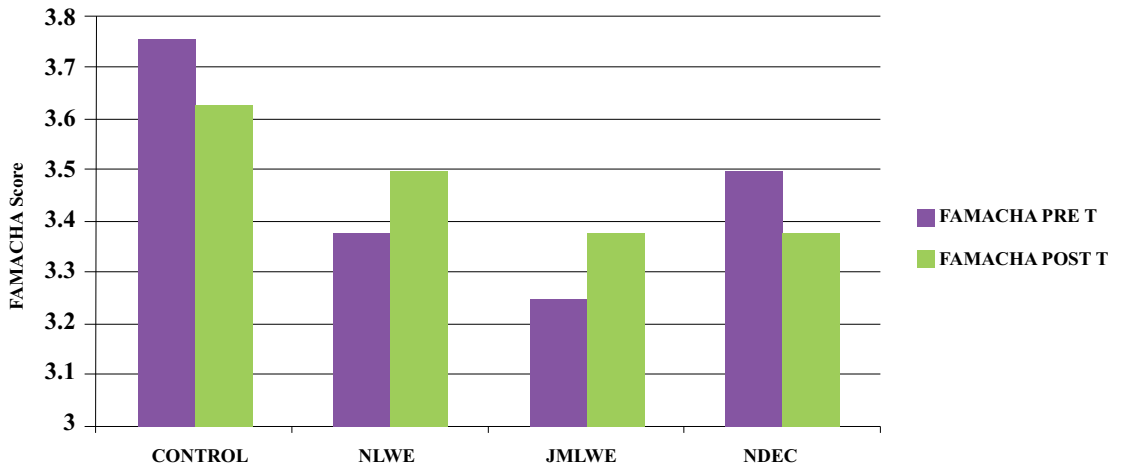


Figure 3.3. Average FAMACHA according to control and experimental groups

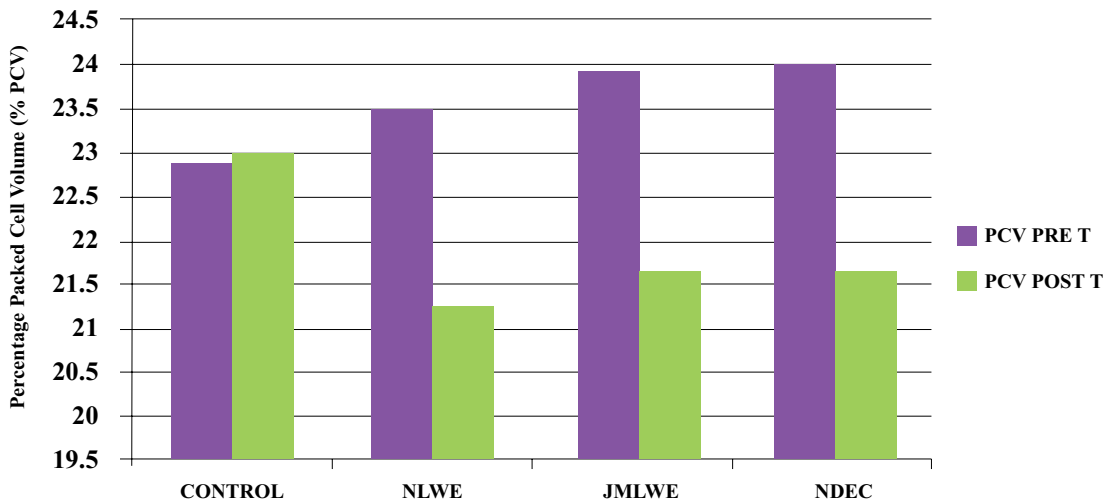


Figure 3.4. Average Percentage Packed Cell Volume (% PCV) for all control and experimental groups.

3.4 Percentage Packed Cell Volume

As shown in Figure 3.4, the percentage of Packed Cell Volume (% PCV) for all treatment groups (NDEC, NLWE and JLWE) drastically declined for the post-treatment to 21% compared to the value during pre-treatment, which was 23%. While for Control group, the value slightly increased to 23% in post-treatment.

3.5 Statistical Analysis

Based on One-Way Anova test, there was a significant difference between the mean number of FEC for all group tested at the significant value of 0.04 ($P < 0.05$). While, by looking at Post Hoc Multiple Comparison data analysis, NLWE and Control groups were significantly different in terms of FEC at 0.03 ($P < 0.05$). However, the JLWE and NDEC showed no significantly different at 0.869 and 0.177 ($P > 0.05$) respectively.

4.0 DISCUSSION

The severity of infection in animals is greatly influenced by climate, management factors, nutrition given and the immunity of the host (Stear *et al.*, 2007). Warm and humid weather all year round in Malaysia is perfect for development of various species of gastro-intestinal nematodes. According to Cheah *et al.* (1997), the swift development of the pre – infective larval stages are most favorable to higher temperatures with adequate moisture. This project was carried out within January to February 2014 which falls in between the northeast monsoon (November – April).

According to the data, several states in Peninsular Malaysia including Perak received reduction of rainfall between 20% - 40% (January – March 2014) which is below the average (Jabatan Meteorologi Malaysia, 2014).

Due to the higher temperatures in Malaysia, the survival rates of L_3 on pasture are shorter because of rapid metabolic rates to utilize stored energy (Cheah *et al.*, 1997). Climatic changes have influencing the development of several species, for example *Haemonchus contortus* in wet tropics will disappear from pasture within a month due to its short survival rate (Waller, 2004). Chances of host acquiring high numbers of infective stage larvae are high during heavy rain, since the contaminated faeces get washed thus concentrating the L_3 stage.

As the study took place in a private farm with routine management conditions, there are limitations that cannot be avoided such as the free pasture grazing practice. Grazing on contaminated pastures promotes rampant infection or auto re-infection of the L_3 infective larvae (Chandrawathani *et al.*, 2009). During certain time frame with moderate light intensity, the *Trichostrongylus* spp. and *Haemonchus* spp. will move upwards on vegetation and easily be consumed by goats (Gordon, 1948). This explains the higher prevalence of *Trichostrongylus* spp. and *Haemonchus* spp. during pre- and post – treatment in experimental animals (Figure 3.2a, Figure 3.2b and Figure 3.2c). While, the existence of *Oesophagostomum* spp. in post – treatment explained that this species might be from infested pasture

from other small ruminants.

By implementing the rotational grazing and zero-grazing through cut-and-carry method, it could help to reduce the helminth burden in local goats. According to Waller (1999), integrated control through rotational grazing with less than one week of grazing period was found to be effective in Malaysia for worm control, since this grazing system was designed to cut the life cycle of nematode infective stages. Having the same role as rotational grazing, Waller (2004) suggested the pasture selected for cut-and-carry method must be taken from an area that are uncontaminated by any small ruminants within two months.

Intensity of infections is closely related to hygiene level (Jittapalapong *et al.*, 2012). During the study, this private farm did not have a proper sanitation management system including the drainage system, manure management and sanitation inside goat shed (Plate 4.1) as well as surrounding area. This environment is perfect habitat for free living stage larvae to develop. Basic facilities including animal care, food and water supplies must be a major priority to overcome this problem.

The severity of infection depends on the host immunity which is strongly related to genetic factors, age, nutrition and historic exposure (Stear *et al.*, 2007). Since, the experimental animals were randomly picked; the only factor taking into account in this study is nutritional status on current diet. Higher plan of nutrition helps them to withstand parasite infection, for example by introducing mineral feed blocks medicated

with fenbendazole (FBZ) for one grazing cycle every six months (Waller, 2004). Protein energy malnutrition (PEM) in small ruminants with prolonged parasitism burden can be altered by providing well – nourished protein supplements. According to Koski & Scott. (2001), lambs with high – protein diets developed immunity against several types of gastrointestinal nematodes including the “barber’s pole” worms which also abundance in goats. It is suggested that these supplementary foods are serve together with the medicinal plants such as neem leaves to increase effectiveness of worm control.

The burdens of parasite infection in all experimental goats were not at the same level due to limitation of farm management and period of study taken. Since this study was done in a private farm, it was not possible to drench all animals with anthelmintic before proceeding with the herbal treatments. If it is possible in the first place, the experiment would have been initiated with the control and treatment group having the same average EPG during prescribed period. The different levels of worm burdens affected the faecal egg counts readings during the study especially with the common strongyle *Haemonchus contortus*, which is known for fluctuating egg production.

From observation in the field, extracts delivery method, dosage of extracts given and palatability of goats towards certain types of treatments does affect the effectiveness of treatment given. Both plant extracts are given by using syringe and this technique needed more

labour while delivering. It was also not practical, since goats showed favourable behavior towards different plants extracts. The experimental goats treated with neem (NLWE and NDEC) found it unpalatable by spitting out a portion of it but the JLWE treated goats favoured the taste of the extract solution. This behavior might have affected the dosage consumed by each treatment goat although care was taken to give the correct dose.

According to a previous study, 50 ml of NLWE extract dilution which is equivalent to 2830 mg of leaves extract was given only once for one month (Chandrawathani *et al.*, 2013a). Despite giving treatment once a month, an initiative taken by feeding plant extracts twice a month (1st week and 3rd week) to increase the dosage, showed no significant difference as is the case with JLWE also with the faecal egg count readings showing a continuously increasing value over the study period (Figure 4.1). The reduction of EPG only occurred two weeks after NLWE treatment was given to the respective group. While, NDEC showed no significant difference even though there were reduction of EPG value in certain weeks of study.

The second objectives is to determine the effect of extracts on the experimental animals in terms of blood parameter and reduction of parasite infection symptoms were achieved by FAMACHA scores and percentage of PCV readings. The pale colour of eyelid (rank 3 to 5) demonstrated an early sign of parasitic infection. Both treatment groups

showed scores above 3, indicating that herbal dewormer failed to prevent anaemic condition among the treated animals. This is only applicable to barber's pole worm; *Haemonchus contortus* (Waller, 1999). In addition, the study period may have been too short to elucidate an effect on the FAMACHA scores.

With respect to percentage of PCV readings, it was noted that the average was between 20 – 25 % revealing normal PCV values. The current scenario was consistent with previous study, indicating the declining of % PCV in post treatment due to constant challenge of blood sucking parasite consumed from contaminated pastures (Chandrawathani *et al.*, 2013a). Thus, both blood parameters illustrated the herbal remedies only failed to control the blood sucking activity of the worm infection. A study with a longer time is important to evaluate how the actions of plant extracts under different management conditions and also to optimize the dose (Chandrawathani *et al.*, 2013)

From the course of the study, the effectiveness of plant extracts was determined by insufficient amount of treatments dosage to reduce the egg per gram. A prolonged study with is important to evaluate the mode of action of plant extracts under different management conditions as well as to optimise the dose rate (Chandrawathani *et al.*, 2013a). It is noteworthy that more research on alternatives solution to chemical anthelmintic be made by exploring economical yet eco-friendly herbal anthelmintic found in Malaysia.

5.0 CONCLUSION

Haemonchus spp., *Trichostrongylus* spp., *Cooperia* spp., and *Oesophagostomum* spp. are the four main species of gastrointestinal parasite infecting the local goats in this private farm. Based on the data collected and statistical analysis done, neem leaves water extract (NLWE) was found to have the capability to prevent the infection of nematodes at certain periods after the treatment was given. Although NLWE appeared to act in low efficacy against this gastrointestinal parasite, it is more effective compared to neem decoction (NDEC) and Jacaranda leaves water extract (JLWE) which failed to prove any anthelmintic effect during 6 weeks of study. Combination of several good farming management practices will help to reduce the infection and reinfection among ruminants. Therefore, further research is urgently needed, in order to come out with appropriate and reliable principle of herbal remedies as an alternative to anthelmintic drugs usage.

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ACKNOWLEDGEMENTS

The authors would like to thank Universiti Sains Malaysia [Grant : 305/PBIOLOGI 613509 (Science Fund)] and USM Fellowship for funding this project. A special thank to the farmer for his kind cooperation during the course of this study as well as all technical staff and field staff for their support and help.

