J. Trop. Agric. and Fd. Sc. 53 (1)(2025): 51 – 57

Detection of internal parasite infestation in the lactating Boer does using FAMACHA© method

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Abstract

This study was conducted at Koperasi Pembangunan Desa Goat Farm, Papar, Sabah, to detect internal parasite infestation in the lactating Boer does using the FAMACHA© method. One hundred female pure Boer goats aged 2 to 3 years were randomly selected. The farmer's data was used to determine the stages of lactation and the type of birth. All does were examined for their ocular mucous membrane using the FAMACHA© method and body condition score (BCS). Five does from each category of the FAMACHA© method were randomly selected for faecal egg count and identification of helminth. The result shows that 55% of does are in early lactation, 39% are in mid lactation and 5% are in late lactation. The birth data indicated that 92% of births were single, while 8% were twins. Only 20% of the does in categories 1 and 2 (FAMACHA© method) were healthy and non-anaemic. The remaining 80% (categories 3, 4 and 5) were anaemic. Under this, 18.8% is severely anaemic. Only 47% of the does in categories 1, 2 and 3 had a good body (BCS of 3), while 53% of the does in categories 4 and 5 had thin bodies (BCS of 2). For eggs/g (EPG), only 20% of the does (categories 1 and 2) had a low infestation, whereas 80% of the does (categories 3, 4 and 5) had severe infestations. The larvae culture shows that 92% of the population is *Haemonchus contortus,* and 8% is *Monezia* spp. A strong correlation (P <0.01) existed between the FAMACHA© method, EPG and BCS. This study revealed that the majority of female pure Boer goats at early lactation and mid lactation stages in this farm were infested with an internal parasite, particularly *Haemonchus contortus.*

Keywords: *internal parasite, FAMACHA© method, pure Boer does, lactation*

Introduction

Small ruminants, including goats, are widely reared in Malaysia. The highest goat populations were found raised in the state of Kedah (50,849 heads), Pahang (40,649 heads), and Johor (35,731 heads) (DVS 2021). However, the goat population in Malaysia declined from 479,444 heads in 2011 to 323,994 heads in 2021, based on the DVS (2021) report. This decline may be due to several factors, such as breed, nutrition, management, and health (Wong and Sargison, 2017; Shahudin et al. 2018).

Internal parasite infestation is one of Malaysia's main restriction on goat production, causing slow growth, mortality and economic loss to the farmers (Chandrawathani et al. 2013a; Khadijah et al. 2014). In addition, the existing cost of treatment and losses would be higher due to the current extensive internal parasite resistance in Malaysia (Chandrawathani et al. 2013a; Paul et al. 2020). The primary concern of the internal parasite species is *Haemonchus contortus,* a blood-sucking parasite known as wireworm or barber's pole worm. *Haemonchus contortus* is approximately 60 to 100% of the total helminth population in the digestive tract of goats in Malaysia (Chandrawathani et al. 2013b; Khadijah et al. 2014; Zainalabidin et al. 2015). The other helminth species commonly found in goats are *Trichostrogylus* spp., *Cooperia* spp., *Strongyloides papillosus, Oesophagostomum* spp., *Moniezia* spp, *Trichuris* spp., or *Bunostomum* spp. (Chandrawathani et al. 2013a). The general clinical signs of goats succumbing

Article history
Received: 2.9.24
Accepted: 22.1.25

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to internal parasites are anaemia, weight loss, diarrhoea and reduced productivity, leading to death in heavily infected animals (Paul et al. 2020).

Since anaemia is the primary clinical sign of internal parasite infestation, FAMACHA© is an effective tool for identifying animals with visible anaemia due to internal parasite infestation, requiring immediate treatment (Sunder et al. 2022). The Faffa Malan Chart (FAMACHA©) method was created by Dr. Faffa Malan, designed for sheep and acceptable for goats (Nabukenya et al. 2014). The FAMACHA© method is based on a colour chart with five colour categories depicting varying degrees of anaemia that are comparable with the colour of the mucous membranes of the eyes of animals (Nabukenya et al. 2014; Sunder et al. 2022). A previous study revealed that using the FAMACHA© method, animals can be treated early, resulting in faster health recovery, and farmers can save up to 76% on anthelmintic treatment costs (Vanessa et al. 2014). This method has become widely accepted (Sunder et al. 2022). Therefore, this study aimed to detect internal parasite infestation in lactating Boer does at Koperasi Pembangunan Desa Goat Farm, Papar, Sabah, Malaysia, using the FAMACHA© method.

Materials and method

Experimental site and animals

The study was conducted at Koperasi Pembangunan Desa Goat Farm, Papar, Sabah. Malaysia. This farm was created in 2005 after importing 597 pure Boer goats from Australia. The farm is located at latitude 5º 63' N and longitude 115º 95' E. The surrounding temperature was 29ºC, with 79% humidity. A total of 100 female pure Boer goats aged from 2 to 3 years old were randomly selected for this study. All does were in the various lactation stages. The does were managed under semi-intensive and allowed to graze from 1100 to 1600 in the open grazing area. When returned to the pens, does were given commercial concentrate (300 to 500 g/goat/day). Drinking water was provided *ad libitum.* The does were not dewormed before and after the study.

Assessment of lactation stages

Does (n=100) in the lactation stages were categorised as early lactation (first day to 80 days of lactation), middle lactation (80 to 140 days of lactation), and late lactation (more than 140 days of lactation) according to El-Tarabany et al. (2018). The type of birth was also recorded. The lactation stages and type of birth were gathered from data recorded by the farmer.

Assessment of anaemia using the FAMACHA© method

All does were restrained in a standing position to allow examination of the ocular mucous membrane. Using the FAMACHA© method, the mucous membrane of each does was scored and categorised according to colour as described by Sunder et al. (2022) where red (non-anaemic) = 1; red - pink (non-anaemic) = 2; pink (mildly anaemic) = 3; pink - white (anaemic) =4; and white (severely anaemic) = 5. The does categorised as having scores 3, 4, and 5 require immediate action.

Assessment of body condition score (BCS)

The does were assessed for BCS. The doe was allowed to stand, after which several palpations were done at the lumbar area (loin eye), sternum, and rib cage area. Assignment of a body score for a goat is based on a 5-point scale with a 0.5 increment. The BCS scale describe as: 1 = very thin; 2 = thin; 3 = average; 4 = fat; and 5 = obese (Ghosh et al. 2019).

Assessment of faecal egg count (FEC) and identification of helminth species

After scoring, five does from each category were randomly selected for faecal collection using a grab sampling method directly from the rectum to determine FEC and internal parasite identification. The faecal samples were transported to the laboratory in a cool box to prevent egg hatching. The FEC was calculated using the McMaster counting technique. Approximately 3 g of faeces were grounded and mixed with 45 ml of flotation fluid, a saturated salt solution. The subsample was then transferred to both chambers of the McMaster counting chamber and let stand for 5 minutes after being filtered. At a magnification of 10 X 10, the parasite load was counted. Eggs/g (EPG) was used to express each doe's FEC. Total EPG was determined based on the following formula:

$$\text{Total EPG} = \frac{(\text{Number of eggs in both chambers X 45})}{0.15 \text{ X } 3}$$

The level of internal parasite infestation based on the total EPG is described as low (EPG <500), moderate (EPG 500-1000), and severe (EPG >1000) (Panadi et al. 2018).

Later, the balance of faecal samples from each category was pooled for larvae cultures to identify the internal parasite species. Third-stage larvae were identified under a microscope based on the identification keys provided in the Manual of Veterinary Parasitological Laboratory Techniques (1986). The main criteria for identifying the helminth species are the larva's head form and tail length (Olivas et al. 2019).

Statistical analysis

Data were analysed using IBM SPSS Statistics version 29 (2022). The EPG data were checked for normality using the Shapiro-Wilk test. There is a normal distribution of EPG data. Therefore, EPG was analysed using one-way ANOVA based on FAMACHA© scores. The data were compared using the Duncan Multiple Range Test if there were significant differences. The BCS is ordinal data. Thus, a non-parametric Kruskal-Wallis test was used. The pairwise comparisons were used as post-hoc. Since FAMACHA© scores are ordinal, Spearman's rank correlation was used to analyse the relationship between FAMACHA© scores, EPG and BCS.

Results and discussion

A total of 100 female pure Boer goats from Koperasi Pembangunan Desa Goat Farm, Papar, Sabah were successfully examined. Based on the data collected from the farmer, it was found that 55% of does are in early lactation (from the first day to 80 days of lactation), 39% are in mid lactation (from 80 to 140 days of lactation), and 5% are in late lactation (more than 140 days of lactation). The birth data indicated that 92% of births were single, while 8% were twins (*Table 1*).

The number of does and BCS categorised according to the FAMACHA© method are shown in *Table 2*. The result shows that only 20% of the does were in categories 1 and 2, which were considered healthy and non-anaemic. The remaining 80% of the does were in categories 3, 4 and 5, where they were in anaemia condition. In these categories, 18.8% are in severe anaemia. The effects of a heavy parasite burden in non-resilient does will be visible when a low ratio of red blood cells and mucous membranes is observed in the eyes (Sunder et al. 2022). The increased anaemia condition in this study may be attributable to 77% of does in the early and middle lactation stages (*Table 1*). Milk production reaches its peak during the early and middle lactation stage, which results in increased physiological stress and reduced immune responses (El-Tarabany et al. 2018; Idamokoro et al. 2017). Consequently, does become more vulnerable to high infection (Paul et al. 2020). However, the present study did not determine packed cell volume (PCV) to confirm anaemia status. Further research is needed to determine the PCV to confirm anaemia status and its correlation with the FAMACHA© method in lactation does on this farm.

A Kruskal-Wallis test revealed that the BCS in categories 1, 2, and 3 of the FAMACHA© method were significantly higher than BCS in categories 4 and 5 (*Table 2*). It was found that 47% of the does in categories 1, 2, and 3 had better body condition with a BCS of 3. Meanwhile, 53% of the does in categories 4 and 5 had

Table 1. The number of Boer does, lactation stages, and type of birth categorised according to the FAMACHA© method

Category of FAMACHA© method	Does (n)	Lactation stage (n)			Type of birth (n)	
		Early	Mid	Late	Single	Twin
1	6	0	5	1	6	0
2	14	2	11	1	14	0
3	27	16	10	1	23	4
4	38	28	9	1	36	2
5	15	10	4	1	13	2
Total (%)	100	56	39	5	92	8

Note:
The lactation stages and type of birth were determined using data recorded by the farmer

Table 2. The number of Boer does, and BCS categorised according to the FAMACHA© method using the Kruskal-Wallis test

Category of FAMACHA© method	Does (n=100)	Median BCS (IQR)	Kruskal-Wallis Statistic (H) (df)	P value
1	6	3.75 (1.13) *	38.91(4)	<0.001
2	14	3.25 (1.00) *		
3	27	3.00 (1.00) *		
4	38	2.25 (1.00)		
5	15	2.00 (0.50)		

Notes:
*- significantly different (p <0.05) using pairwise comparisons, n= number of animals, BCS= body condition score, IQR=Interquartile Range, df=degree of freedom.

thin bodies, with a BCS of 2. The low BCS observed in this study may be attributed to the fact that 77% of the does were in the early and mid lactation stages, as seen in *Table 1*. The peak of milk production is observed between two and four months in the early and mid lactation stage (El-Tarabany et al. 2018; Idamokoro et al. 2017). When does experience high milk production, they undergo a negative energy balance and must utilise their bodily reserves, mostly fat (Castro et al. 2023). This frequently leads to decreased body weight and low BCS during lactation (Paul et al. 2020).

The low BCS in this study also could be caused by high parasite burdens in the digestive tract, indicated by their EPG ranging from 2100 to 3700 (*Table 3*). The EPG indicates the internal parasite load and pasture contamination levels (Besier et al. 2016). The low BCS also could be associated with the increased population (92%) of *Haemonchus contortus* in this study (*Figure 1*). Each matured Haemonchus contortus can suck approximately 0.05 ml of blood/day/goat, resulting in severe blood loss, which leads to anaemia and a high FAMACHA© score (Alim et al. 2016; Dutta et al. 2017). Due to rapid sucking by *Haemonchus contortus*, chronic intestinal bleeding also occurred, causing protein loss from the intestines, resulting in loss of body weight and low BCS score (Paul et al. 2020). In another internal parasite study, adult Boer had BCS at 3 (Wong and Sargison, 2017). The good body condition in that study may be due to their mean EPG (842.00) being lower than EPG in this study. Furthermore, the Boer does were kept intensive. Hence zero grazing minimised the chance of parasite transmission from the grazing area (Chandrawathani et al. 2015).

The one-way ANOVA test showed that the EPG in the category 3, 4 and 5 of the FAMACHA© method were significantly higher than those in categories 1 and 2 (*Table 3*). Only 20% (20/100) of the does (categories 1 and 2) had a low infestation, whereas 80% (80/100) of the animals in categories 3, 4 and 5 had severe infestations. The EPG (3740.00) in this study was higher than the total EPG (3240.00) in other Boer does reported earlier (Chandrawathani et al. 2011). Apart from lactation stress and non-anthelmintic practices, the higher EPG in the present study could be due to longer grazing time (> 4 hours) in the grazing area. Grazing for more than 4 hours in a grazing area was reported to increase the chance of infections by ingesting larvae with grass (Yusof and Isa, 2016). Furthermore, under open grazing, faeces with parasite eggs from the infected does will be passed onto the same grazing area (Panadi et al. 2018). Thus, grazing in contaminated areas will promote widespread infection or reinfection (Paul et al. 2020). In different studies, adult Boer crosses under semi-intensive had low parasite infections with EPG between 520.00 to 1010.00 (Azlan et al. 2019; Chandrawathani et al. 2013b) compared to this study where the Boer does are pure breed. Lower EPG from those studies may be due to the mixed breed between Boer and Asiatic Tropical goats, such as Katjang and Jamnapari, making them more resistant to parasite infections (Azlan et al. 2019). Katjang and Jamnapari goats are well known to have adapted to the critical local environment, including resistance to parasite infections (Ariff et al. 2010).

Table 3. The number of Boer does, and EPG categorised according to the FAMACHA© method (±SEM) using one-way ANOVA

Category of FAMACHA© method	Does (n=100)	EPG (±SEM) (n=5)
1	6	140.00±24.49^{a}
2	14	480.00±37.42^{a}
3	27	1440.00±112.25^{b}
4	38	2100.00±154.92^{c}
5	15	3740.00±218.17^{d}
P value		<0.001

Notes:
^{a,b,c,d} means in the same column with different superscripts are significantly different (p <0.05), SEM–standard error of the mean, n= number of animals, EPG= eggs/g

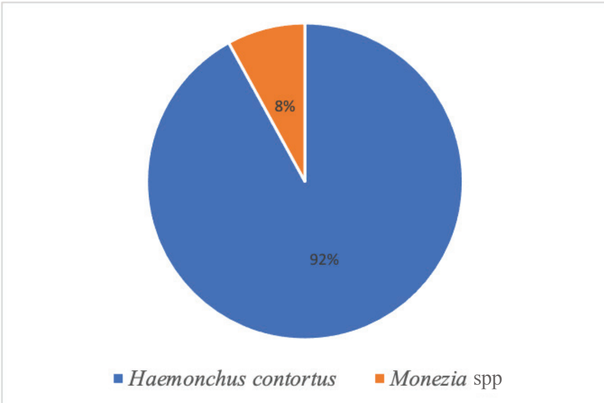

Figure 1: The percentage of different species of helminth larvae identified from the faecal culture of lactating Boer does

The helminth larvae culture shows that 92% of the larvae population is *Haemonchus contortus* and 8% is *Monezia* spp (*Figure 1*). This result agrees with the previous study where *Haemonchus contortus* was the primary internal parasite species (97% to 100%) that infected the adult Boer (Chandrawathani et al., 2013b; Wong and Sargison, 2017). *Haemonchus contortus* was also the dominant internal parasite that affected the adult Boer crosses. However, its population percentage was between 71% – 73% (Chandrawathani et al. 2013a; Thongsahuan et al. 2014). Indigenous Katjang goats were also affected by *Haemonchus contortus* as dominant internal parasites, with a population of 64% – 68% (Khadijah et al. 2014; Chandrawathani et al. 2015). The higher population of *Haemonchus contortus* in the pure Boer in this study could be related to a genetic factor in which this breed has less adapted to the local environment, leading to high infection compared with Boer cross or indigenous Katjang (Azlan et al. 2019). Pure Boer goats in another study were also significantly affected (100%) with internal parasites compared to Saanen goats (79%) (Paul et al. 2020). The higher population of *Haemonchus* *contortus* in this study could also be due to the prolific ability of this species. The matured *Haemonchus contortus* can lay 5000 – 7000 eggs/day compared to another strongyle helminth, such as *Trichostrongylus spp.,* which can only lay between 100 – 200 eggs/day, while *Oesophagostomum spp.* lay eggs at intervals of 45 days (Mohammed et al. 2016). The presence of *Monezia spp.* known as a tapeworm in this study, which could be due to Malaysia having multiple species of mites that can be intermediate hosts that complete the life cycle of *Monezia* spp in goats (Khadijah et al. 2014). *Monezia spp.*, which is a minor population, was also found in other Boer and Saanen goats (Paul et al. 2020).

The Spearman's rank correlation between the FAMACHA© method, EPG, and BCS in lactating Boer does is shown in *Table 4*. The high correlation between the FAMACHA© method and EPG in this study may be due to the progressive increase of EPG as the category of the FAMACHA© method is increased from 1 – 5 (*Table 3*). It could be due to *Haemonchus contortus*, the main internal parasite species found in this study, sucking blood and leading to severe anaemia (*Figure 1*). The finding in this study was similar to earlier studies carried out in several tropical countries where the FAMACHA© method and EPG were significantly correlated in goats (Nabukenya et al. 2014; Cloete et al. 2016; Olivas et al. 2019). However, in local sheep, the FAMACHA© method and EPG were not correlated (Mohammed et al. 2016). It may be attributed to the mild infection in the sheep where EPG was less than 500, leading to non-visible anaemia.

The higher correlation between the FAMACHA method and BCS may reflect the pathogenic effects of *Haemonchus contortus*, as BCS decreased as the FAMACHA method category increased from 1 – 5 (*Table 2*). Infection with *Haemonchus contortus* causes gastroenteritis, protein-losing enteropathy, poor weight gain, and poor body condition in goats (Paul et al. 2020). Significant correlations between the FAMACHA© method and BCS were reported in goats in other tropical countries (Thomas and Syamala, 2016; Olivas et al. 2019).

The significant correlation between EPG and BCS in this study was comparable to Paul et al. (2020), who reported a significant correlation in local pure Boer and Saanen goats. The does use in this study at the adult stage also contributed to increased EPG and decreased BCS. The does were reported to be 3.2 times more affected by internal parasites than the bucks (Paul et al. 2020), while the adults were 5 times more affected than the young goats (Vanessa et al. 2014). Furthermore, lactating does were 46.7 times more at risk of parasite infection (Paul et al. 2024).

Table 4. Correlation between FAMACHA© method, EPG, and BCS in lactating Boer does using Spearman's rank correlation

Parameters	r
FAMACHA© method and EPG	0.981**
FAMACHA© method and BCS	-0.753**
EPG and BCS	-0.733**

Notes:
** Significant at (P <0.01), r -value for correlation. EPG= eggs/g, BCS= body condition score. The number of replicates for each parameter was n=25

The root cause and recommendations for the farm

The root cause of the high internal parasite infestation in the Koperasi Pembangunan Desa Goat Farm may be poor farm management at the lactation stages. They did not practice routine anthelmintics. The previous studies revealed that most private and small goat farms in Malaysia did not practice routine anthelmintics (Khadijah et al. 2014; Shahudin et al. 2018; Paul et al. 2020). This problem may be due to the farmers' lack of proper goat rearing and reliance on traditional knowledge to raise their goats (Shahudin et al. 2018). The other poor management practiced by this farm is they used open grazing rather than rotational grazing (Chandrawathani et al. 2013a). It may be due to the restricted availability of pastureland in Malaysia (Zayadi 2021). Open grazing will continue the life cycle of internal parasites due to pasture contamination by infected animals (Panadi et al. 2018; Paul et al. 2020). Thus, the parasite can create a huge number of eggs and reinfection in animals (Paul et al. 2020). The hot and humid climate over the year in Malaysia is also conducive to the outbreak of internal parasites (Khadijah et al. 2014; Shahudin et al. 2018). Another poor management practice on this farm is poor hygiene. The floor of the pens and feeder were discovered to be unclean. The feed is easily polluted by animal faeces, which allows the animals to be infested with internal parasites (Paul et al. 2020). Poor nutrition can also create fewer immune responses and lead to high internal parasite infestation in lactating does (Panadi et al. 2018; Jesse et al. 2019). Further study should be conducted to determine the correlation between nutrition, parasite load and the FAMACHA© method on lactating does of this farm.

This farm recommends practicing routine anthelmintics, rotational grazing, routine hygiene, and improved nutrition, especially in lactating does (Dutta et al. 2017; Paul et al. 2020). The other recommendation is a hybrid breed where cross-breeding between female pure Boer and Asiatic Tropical goats, Katjang buck, to increase their resistance to parasite infestations (Azlan et al. 2019; Rosali et al. 2019). The farm is also recommended to routinely examine the animals with the FAMACHA© method goats (Cloete et al. 2016). The infected animals need immediate action, such as separating the infection from the healthy goats and treating them. The advantages of using the FAMACHA© method are animals can be treated early, inexpensive, reducing the amount and frequency of anthelmintic treatment by only selected animals showing signs of infection were treated, leading to decreased anthelmintic treatment costs, delaying the emergence of anthelmintic resistance, and allowing for earlier detection of other issues that may have gone undiscovered because animals are inspected more regularly (Vanessa et al. 2014; Carlo et al. 2018). Further research is needed to determine the reduced anthelmintic treatment costs after using the FAMACHA© method on lactating does of this farm.

Conclusion

This study revealed that the majority of female pure Boer goats at the early lactation and middle lactation stages in this farm were infested with an internal parasite, particularly *Haemonchus contortus*. This study also demonstrated that the FAMACHA© method can be used to identify the severity of infestation of internal parasites on the farm and will allow the farmer to take immediate action or prevention. It can reduce the requirement for anthelmintics by treating only selected animals showing signs of infection while also delaying the anthelmintics resistance.

Acknowledgment

The authors would like to thank the staff at Koperasi Pembangunan Desa Goat Farm, Papar, Sabah, for their assistance and help throughout this study. The study was a part of project "Peningkatan Skala Teknologi Pengeluaran Kumpulan Pengganda Baka Kambing Boer Secara Komersial (bersama dengan Koperasi Pembangunan Desa)" (P-TP104-1303) under the Malaysian Agricultural Research and Development Institute (MARDI) grant.

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