EFFICACY OF COMMONLY USED ON-FARM ANT-HELMINTICS AMONG DORPER SHEEP FARMS IN KAJIADO COUNTY, KENYA

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ABSTRACT

Ineffective anthelmintics continues to reduce productivity in livestock due to increased worm burdens in dewormed animals. This in-effectiveness has been majorly noted in small ruminants causing serious health and productivity constraints. Widespread resistance towards available anthelmintics is the main cause of in-effectiveness. This study sought to determine the efficacy of the most commonly used on-farm anthelmintic for Dorper sheep in Kajiado and also identify factors associated with the rising cases of their resistance. Questionnaire surveys targeting different farms were used to assess the community's knowledge and attitudes on these infections. Animals not treated within the last three months and with faecal egg counts of ≥ 150 egg per gram were selected for the study. They were divided into 4 groups of 18 animals each. Group A was treated with Albendazole orally, Group B with Oxyclozanide/levamisole orally, Group C with Ivermectin injection subcutaneously while Group D served as the untreated control group. Faecal egg counts and cultures were done on day 0 (pre-treatment) and on day 14 (post-treatment). Faecal cultures were used to identify the principal nematode genera present in the pre- and post-treatment phases. Anthelmintic efficacy was established using the faecal egg count reduction test (FECRT). The mean faecal egg counts (FECs) between groups (treated and control) was not significantly different ($P > 0.05$) before treatment. However, on $D_{14.}$ FECs of Group C were significantly different ($P < 0.05$) from the rest of the treated groups. All anthelmintics exerted a reduction ($P < 0.05$) on nematode egg counts post-treatment. Faecal egg count egg reduction results revealed 86%, 76% and 17% for levamisole, albendazole and ivermectin respectively. In the case of pre-treatment cultures, *Haemonchus*, *Oesophagostomum*, *Cooperia*, *Trichostrongilus* and *Strongiloides* were present indicating multiple parasitic infections. Post-treatment faecal cultures showed that *Haemonchus, Oesophagostomum* and *Trichostrongilus* had escaped the treatments. However, *Haemonchus* were the predominant genera present. Based on these findings, it can be concluded that multiple drug resistance has been confirmed in Kajiado County and this has negative effects on the productivity of these animals. However, the level of resistance observed was apparently very high in ivermectin. It is therefore, recommended that animal health extension services in the County should be deployed to create awareness on the emerging threat of anthelmintic resistance and how to manage it.

Keywords: Anthelmintic resistance, EPG, Faecal egg counts, FECRT, Gastrointestinal nematode,

INTRODUCTION

Kajiado county is largely dominated by the Maasai community that rely heavily on their livestock for food and economic investment. Among the livestock being kept, small ruminants including sheep and goats form a significant composition of the herd. Small ruminants form an integral and important component of animal production among pastoral communities in Kenya, providing food and nutritional security for thousands of residents in arid and semi-arid regions (Molina-flores *et al*., 2020). Goats and sheep are mostly reared in marginal environments with scarce grazing and unfavorable climatic conditions. They are considered as the dairy animals of the poor because of the lower capital investment, production cost required, rapid generation turn over, shorter pregnancy periods and milk supplies in quantities that are suitable for immediate household consumption (Herrero *et al*., 2013)sometimes complex, value chains. They are a crucial asset and safety net for the poor, especially for women and pastoralist groups, and they provide an important source of nourishment for billions of rural

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and urban households. These socio-economic roles and others are increasing in importance as the sector grows because of increasing human populations, incomes and urbanisation rates. To provide these benefits, the sector uses a significant amount of land, water, biomass and other resources and emits a considerable quantity of greenhouse gases. There is concern on how to manage the sector's growth, so that these benefits can be attained at a lower environmental cost. Livestock and environment interactions in developing countries can be both positive and negative. On the one hand, manures from ruminant systems can be a valuable source of nutrients for smallholder crops, whereas in more industrial systems, or where there are large concentrations of animals, they can pollute water sources. On the other hand, ruminant systems in developing countries can be considered relatively resource-use inefficient. Because of the high yield gaps in most of these production systems, increasing the efficiency of the livestock sector through sustainable intensification practices presents a real opportunity where research and development can contribute to provide more sustainable solutions. In order to achieve this, it is necessary that production systems become market-orientated, better regulated in cases, and socially acceptable so that the right mix of incentives exists for the systems to intensify. Managing the required intensification and the shifts to new value chains is also essential to avoid a potential increase in zoonotic, food-borne and other diseases. New diversification options and improved safety nets will also be essential when intensification is not the primary avenue for developing the livestock sector. These processes will need to be supported by agile and effective public and private institutions. © 2011 The Animal Consortium.","author":[{"dropping-particle":"","family":"Herrero","given":"M.","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Grace","given":"D.","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Njuki","given":"J.","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Johnson","given":"N.","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Enahoro","given":"D.","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Silvestri","given":"S.","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Rufino","given":"M.C.","non-dropping-particle":"","parse-names":false,"suffix":""}],"container-title":"Animal","id":"ITEM-1","issue":"SUPPL.1","issued":{"date-parts":[["2013"]]},"page":"3-18","title":"The roles of livestock in developing countries","type":"article-journal","volume":"7"},"uris":["http://www.mendeley.com/documents/?uuid=56acabd2-bdcd-4695-b0e7-364495e73cd9"]}],"mendeley":{"formattedCitation":"(Herrero *et al.*, 2013. An important sheep breed, the dorper has over the years become a sensation to the local farmers because it is hardy and offers more returns. Farmers in every part of the country have been replacing their local breeds with this sheep breed to earn. It is the breed that was developed to thrive in arid and semi-arid areas and provide excellent meat on sparse vegetation. The dorper sheep are in high demand right now because they have an extremely beefy carcass and they are able to convert forage into a lot of meet per animal (Zonabend König *et al*., 2017).

However, the production rate of this important sheep breed has significantly reduced over the years due to rise of helminthic infections (Sazmand *et al*., 2020)there is a lack of information about levels of knowledge, attitudes and practices among livestock farmers in Iran regarding the concept of parasite control and AR. This study aimed to evaluate the knowledge, attitudes and practices of livestock farmers of Hamedan, Iran, regarding parasitic diseases and AR by interviewing 150 farmers using a structured questionnaire. Most of farmers had some knowledge of the clinical signs associated with helminth parasitism, but more than half were unaware of the existence of zoonotic parasites. More than half of the participants had never heard about AR, but were interested to learn about it through their veterinarians. Those who were aware of the problem considered non-prescribed anthelmintic drugs to play a role in its emergence, while several of the participants believed that "more expensive" and "foreign-branded" drugs worked best. Almost all of the farmers reported that they frequently consulted with a veterinarian about anthelmintic treatments, but very few adhered to recognized principles of responsible and sustainable drug use. About half of the participating farmers treated their sheepdogs for helminth parasites, despite the common practice of regularly feeding likely infected livestock offal. Education had a significantly positive association with farmers' knowledge, attitudes, and best practice scores, while knowledge was significantly associated with both attitudes and practices. Based on these results, we recommend that regular country-wide classes should

be held to educate farmers on the evidence-based principles of sustainable helminth control and prevention of zoonotic helminth diseases.",",author":[{"dropping-particle":"","family":"Sazmand","given":"Alireza","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Alipoor","given":"Golnaz","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Zafari","given":"Salman","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Zolhavarieh","given":"Seyed Masoud","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Alanazi","given":"Abdullah D.","non-dropping-particle":"","parse-names":false,"suffix":""},{"dropping-particle":"","family":"Sargison","given":"Neil D.","non-dropping-particle":"","parse-names":false,"suffix":""}],"container-title":"Frontiers in Veterinary Science","id":"ITEM-1","issue":"October","issued":{"date-parts":[["2020"]]},"page":"1-9","title":"Assessment of Knowledge, Attitudes and Practices Relating to Parasitic Diseases and Anthelmintic Resistance Among Livestock Farmers in Hamedan, Iran","type":"article-journal","volume":"7"},"uris":["http://www.mendeley.com/documents/?uuid=4e281512-daf1-4469-bd69-91f1b25fd601"]}],"mendeley":{"formattedCitation":"(Sazmand et al., 2020. Gastrointestinal nematodes (GIN) infections are the main impediments that limit the productivity of small ruminants, globally. These infections increasingly threaten the profitability of small ruminants among livestock farmers (Velde *et al*., 2018). Within the pastoralist communities particularly the Maasai where extensive management is practiced helminthic infestations continue to be a major blow to their goat and sheep production (Obanda *et al*., 2019). Anthelmintic treatment serves the primary control measure for worm infections in small ruminants. However, there have been rising cases of helminthic infestations in de-wormed animals as reported by farmers (Hurisa *et al*., 2021). The unresponsive infestations have therefore become a serious health and productivity constraint. Effective management of these infestations relies on the use of quality anthelmintics. However, widespread resistance towards available anthelmintics is threatening the potential utilization of this strategy. Efficacy of the anthelmintic is influenced by the several factors including the dosing rate, dosing route, dosing volume and formulation of the drug. Different veterinary anthelmintics available in Kenya are benzimidazoles, imidazothiazoles and avermectins. The need to carry out the present study was informed by the fact that the efficacy of these anthelmintics among Dorper sheep farms in the southern rangelands of Kenya is unknown. The objectives of the present study were to (a) assess the perception of Dorper sheep farmers about their anthelmintic utilization and (b) to evaluate the efficacy of the most commonly used anthelmintics against GINs in naturally infected sheep in Kajiado county.

MATERIALS AND METHODS

Study Area

This study was conducted in Dalalekutuk ward of Kajiado county located in the southern rangelands of Kenya (Figure 1). This is an area known for rearing thousands of the Dorper sheep. Kajiado receives minimal rainfall and is characterized by cyclical episodes of prolonged drought that exacerbate the effects of helminthes in livestock. Rainfall is seasonal with the short rainy season occurring in October to December and long rains falling between March and May. The coolest period is between July and August, while the hottest months are from November to April. Kajiado county is 1710m above sea level and is located at1.85° S 36.78° E. The selected study area is about 90 kilometers from Nairobi and majority of the population relies on livestock. Communal grazing is practiced in the area.

Data Collection

Questionnaire survey

A sociological inquiry in the form of a survey was used, with structured set of questions (open and closed-ended) supported by Open Data Kit (ODK) being employed as the primary data collection instrument. A total of 100 household heads were included based on the recommendations by Arsham (2007) for survey studies. The questionnaire was to obtain information on anthelmintic utilization and their knowledge and attitudes on the rising cases of helminth infections in the area. Community leaders and extension officers were also involved in the selection of sheep owners to be interviewed. The collected information during the actual interview was supported by farm observations and discussions. Farmer's demographics, anthelmintic utilization, knowledge and practices on the rising cases of helminth infections were captured in the questionnaire. The respondents were asked to rank the

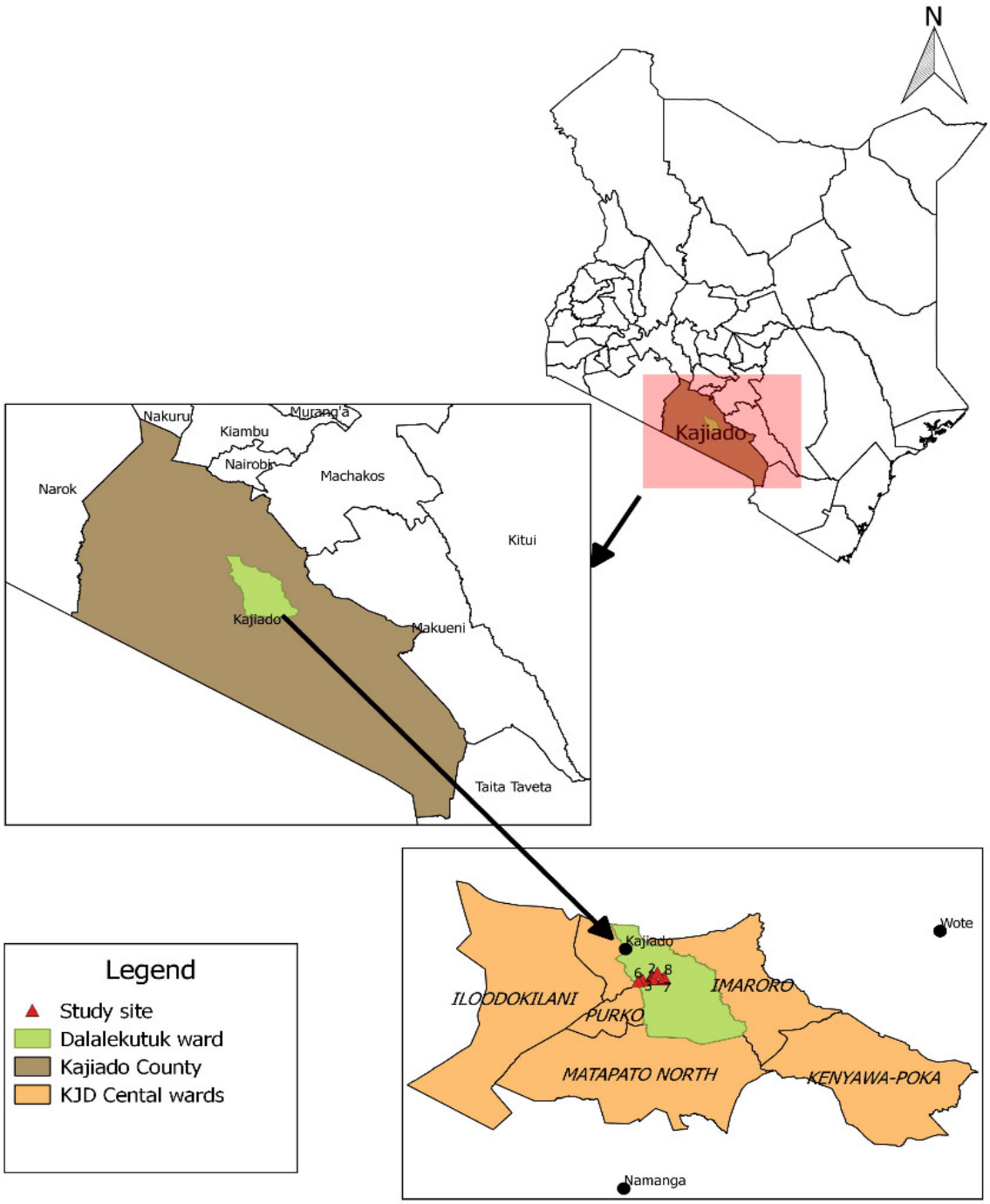

Figure 1: Location of the study site in Kajiado County, Kenya

different anthelmintic brands based on their preference and indicate their criteria for the selection of the anthelmintic.

Study animals

A total number of 92 animals (Dorper sheep and their crosses) were first sampled from eight farms in the study area. The experimental sheep were identified after screening all the sheep aged at least three months and above for their FECs with those whose FECs ≥ 150 being included in the study. Those animals with the age of less than one year were considered as young while those greater than one year were considered to be adults according to the classification of age groups (Coles *et al.*, 2018). A total of 54 animals were then selected based on their faecal egg counts. The study animals were both pure Dorper and cross breeds, kept under traditional extensive management system on communal land with access to the same watering points. The body condition score were determined according to Pant *et al*. (2016) and were grouped as poor, medium or good. At night the animals were kept in pens at their owner's respective homes.

Study design and treatment

The experiment was conducted in three stages namely, the pre-treatment FEC screening stage, treatment of the selected animals and post-treatment phase. Within the selected flocks based on purposive sampling, a baseline survey was undertaken prior to the commencement of the study to establish which animals were to be included in the study. Those that had received anthelmintic treatment in the last 28 days were excluded. After the screening stage, those with the faecal egg count (EPG) of (≥ 150 eggs per gram of faeces) from the general herd were ear-tagged and included in the study. These animals were then divided into four groups of 18 animals each using a complete randomized design. The anthelmintics that were chosen for testing were based on the frequency of utilization in the area. Group A was treated with 10% albendazole orally, Group B with levamisole orally, Group C with ivermectin injection subcutaneously and Group D served as the untreated control group. These drugs were acquired from a local veterinary store located in the study area. Faecal samples were then collected on D_0 (pre-treatment phase) and on D_{14} (post treatment phase) for analysis. The collected faecal samples were divided into two portions, for the evaluation of efficacy of the used anthelmintic and identification of the principal nematode genera present before and after treatments.

The details of the drugs used in the test are summarized in Table I**.**

Faecal sample collection and handling

Faecal samples from the rectum of experimental animals were collected and analyzed for helminth eggs during the pre- and post-treatment phases. Post-treatment faecal sampling and FECs were conducted 14 days after treatment to allow for comparison in FECs before and after treatment to measure the effect of the drugs on helminth egg shedding. About 10 grams of faeces were collected from each selected animal using gloved fingers and placed immediately in a clean plastic bag. The bags were then closed as tightly as possible to keep off air. For identification purposes, each collected faecal sample was labeled with the details of the ear tag number of each animal, date of collection and its herd before being placed in a cool box. The collected samples were then transported to the Laboratory at the Kajiado County Veterinary offices for processing and examination. The FECs were carried out using the modified McMaster counting technique (Sultan *et al*., 2010) in order to determine the number of eggs per egg of faeces.

The remaining portion of the samples were then transported to the Helminthology Laboratory, Veterinary Science Research Institute, Kenya Agricultural and

TABLE I- EXPERIMENTAL TREATMENTS

Group	Drug Used	Dose(mg/kgBW)	Dosage route	Sample size
A	Levamisole	10	Oral	18
B	Albendazole	7.5	Oral	18
C	Ivermectin	0.2	Sub-cutis	18
D	Control	------	Untreated	18

Livestock Research Organization (KALRO) for culture. Upon arrival at the laboratory, the samples were kept at 4ºC in the refrigerator until processing. Pre- and post-treatment larval cultures were performed on pooled faecal samples in plastic culture plates and partially covered. The pooled faecal samples were mixed with water, ensuring they remained moist and crumby but not really wet and incubated at room temperature for ten days.

Evaluation of anthelmintic efficacy

To establish the efficacy of the used anthelmintic, faecal egg count reduction test (FECRT) was performed in accordance with (Rinaldi *et al.,* 2019). The mean FEC of each treatment group expressed as eggs per gram of faeces (EPG) was calculated and compared to that of the control group. Percent reduction (R) was determined using the following formula:

$$\% \text{ Reduction} = 100\ (1-(X_t/X_c))$$

In which X_t and X_c are the mean faecal egg counts for the treated and control groups, respectively after treatment (D_{14}).

Efficacy of each anthelmintic was tested and interpreted according to the World Association for Advancement of Veterinary Parasitology (WAAVP) recommendations (Coles *et a*l., (1992). Resistance was considered to be present if only one of the following criteria was met:

- The percentage reduction in faecal egg counts was <95% or
- The lower 95% confidence level was <90%

Identification of the third stage nematode larvae

Using the Baermann technique, third stage larvae (L_3) were recovered in accordance with Hernández-Chavaría and Avendaño-, (2001). The recovered larvae were then identified using key morphological features and counted under a compound microscope (Miller, 1997).

Data management and analysis

The collected data from the field and laboratory investigation were coded to appropriate variables and entered into MS Excel work sheet. Questionnaire survey results were compared using chi-square statistics and levels of significance was determined at $P<0.05$.

The efficacy of anthelmintics was assessed in accordance with World Association for the Advancement of Veterinary Parasitology (W.A.A.V.P) as described by Coles *et al.-* , (1992). Faecal egg count reduction test (FECRT) was used where arithmetic means, variances, percentage reduction and 95% confidence interval were calculated. The percentage reduction **(R)** is 100 (1 - $\bar{x}t/\bar{x}c$) where $\bar{x}$ is the arithmetic mean of the FEC; t is the; treatment groups, at day 14 and c is the control group at day 14. The 95% confidence interval was calculated by applying the formula $100[1 - \bar{x}t/\bar{x}c \exp(- 2.048\sqrt{Y^2})]$ for the lower limit and $100[1 - \bar{x}t/\bar{x}c \exp(+ 2.048\sqrt{Y^2})]$ for the upper limit. Y^2, the variance of reduction was calculated as;

Y^2=Variance of treatment group / (n, for treatment group* $\bar{x}^2$t) + Variance of control group/ (n, for control group* $\bar{x}^2$c).

The interpretation of the FECR test results was made according to the World Association for Advancement of Veterinary Parasitology (WAAVP) recommendations (Coles *et al*., (-1992). Resistance was declared where the percentage reduction in the FECs was < 95% and where the lower 95% confidence interval was < 90%. Where only one of the above conditions was met, emerging resistance was suspected.

RESULTS AND DISCUSSION

Farmers knowledge and attitudes on the rising cases of helminth infections

Anthelmintic treatment has been serving as the most effective means for the control of helminth infections in small ruminants but the indiscriminate use of anthelmintics has led to the emergence of anthelmintic resistance, which is a major constraint for nematode control throughout the world (Buttar *et al.,* 2012) levamisole, morantel and fenbendazole. A questionnaire was administered to assess the anthelmintics usage in the study area, factors associated with the rising cases of helminthic infestations in Kajiado County and the farmers' knowledge, attitude and practice on anthelmintic resistance.

It was noted that farmers in Kajiado relied entirely (100%) on the use of anthelmintics in the control and management of helminth infestations in their flocks. They did not practice any traditional therapy with respect to this. The survey indicated that majority of the respondents (80%) could not

read and understand the information on the drug's leaflets (TableII). This could indicate that the farmers could not get the right dose rate and expiry date indicated on the leaflets. The most commonly used anthelmintics in Kajiado County as reported by farmers are ivermectin, levamisole and albendazole. Price (80%) was the main factor that influenced the choice of these drugs by farmers. Most of the residents acquired these drugs from open markets and private drug vendors in the area. This is because of lack or inaccessibility of government clinics in the area. Majority of the respondents indicated that they did not have any idea on anthelmintic rotation therefore they did not rotate between the different classes of anthelmintics. All the respondents indicated that the dose they used on a given animal was entirely dependent on the visual estimation of the animal as either young or mature.

Most of the interviewed farmers relied on clinical manifestation of the disease such as diarrhea, nasal discharge, and loss of body condition as the primary reason for treatment. However, a small portion (20%) of the farmers treated their animals purposely for fattening. Based on the information obtained from this study, it is worth noting that anthelmintics are prone to misuse and the likelihood of development of resistance to the available anthelmintic drugs is high (Terefe *et al.*, 2014)tetramisole and ivermectin against gastrointestinal nematode parasites prevailing in sheep. Fecal culture and postmortem examination techniques were used to identify the species of nematode parasites prevalent before and after treatment. The results show that: 1.

It was also noted that these flocks were heavily infested with these worms as compared to other regions owing to the hot and humid climate in this region (Obanda *et al.,* 2019). This is very favorable for the development and survival of pre-parasitic stages of nematodes and infective larvae are available on the pasture (Arsenopoulos *et al*., 2021)adversely affecting the health and productivity of animals. The first challenge is the uneven distribution of the infection globally, this being more prevalent in tropical and subtropical and warm temperate and summer rainfall regions than in cool and cold temperate and arid regions; hence, this leads in differences in the approaches required for its control. Another challenge is the widespread presence of Haemonchus strains resistant to the various anthelmintics available: Benzimidazoles, imidazothiazoles, macrocyclic lactones, closantel and monepantel, which makes the control of the infection difficult. The third challenge refers to the difficulty of diagnosing the disease, given that field evidence can provide suspicion about the infection, which needs to be subsequently confirmed by laboratory tests through parasitological or molecular techniques. The final challenge relates to the difficulties in the control of the infection and the necessity to use pharmaceutical products cautiously and with a planned approach, to avoid further development of anthelmintic resistance, also given that use of a recently licenced vaccine is not widespread. In conclusion, at the moment, we should be concerned, but not worried, about this infection, and apply correctly the appropriate health management plans (Arsenopoulos *et al.*, 2021). However, it was noted that although these animals were heavily infested, they looked very healthy. This could be attributed to good nutritional and management of these flocks by these residents.

Faecal egg counts

The mean pre- and post-treatment faecal egg counts and the percentage of faecal egg count reduction and the lower and upper 95% confidence limit for each group of anthelmintic drugs tested are summarized in Table III.

The mean FEC between groups (treated and control non-treated) was not significantly different before treatment (day zero). However, on the 14th day, post-treatment faecal egg counts of Group C were significantly different ($P < 0.05$) from the rest of the treated groups. All anthelmintics exerted a significant ($P < 0.05$) reduction effect on nematode egg counts post-treatment as illustrated in Figure 2.

Efficacy evaluation

The anthelmintic efficacy was evaluated using the faecal egg count reduction test (FECRT) method and the interpretation carried out according to the World Association for Advancement of Veterinary Parasitology (WAAVP) recommendations (Coles *et al*., (1992).

The FECR below 95% or the 95% confidence interval is <90% indicates the presence of anthelmintic resistance. The findings from this study illustrated that levamisole brought about 86% reduction of the FEC while albendazole and Ivermectin caused 76% and 17% reduction in the FEC respectively as illustrated in Table III.

Thus the study revealed that there is suspected resistance to levamisole and albendazole. However, it can be

TABLE II- FARMER'S KNOWLEDGE AND ATTITUDES ON RISING HELMINTH INFECTIONS

Questionnaire focus	Responses
Do you use anthelmintics?	Yes (100%)
Commonly used anthelmintics:	Ivermectin, Levamisole, Albendazole
Reason of anthelmintic choice:	Price (70%), Color (20%), Recommendation (10%)
Sources of the drug:	Open air markets, private vet pharmacies, government clinic
Frequency of treatment:	Average thrice per year
Response to treatment:	Improvement in body condition,
Do you practice drug rotation?	No (70%), Yes (30%)
Level of education	None (80%), Primary (20%)

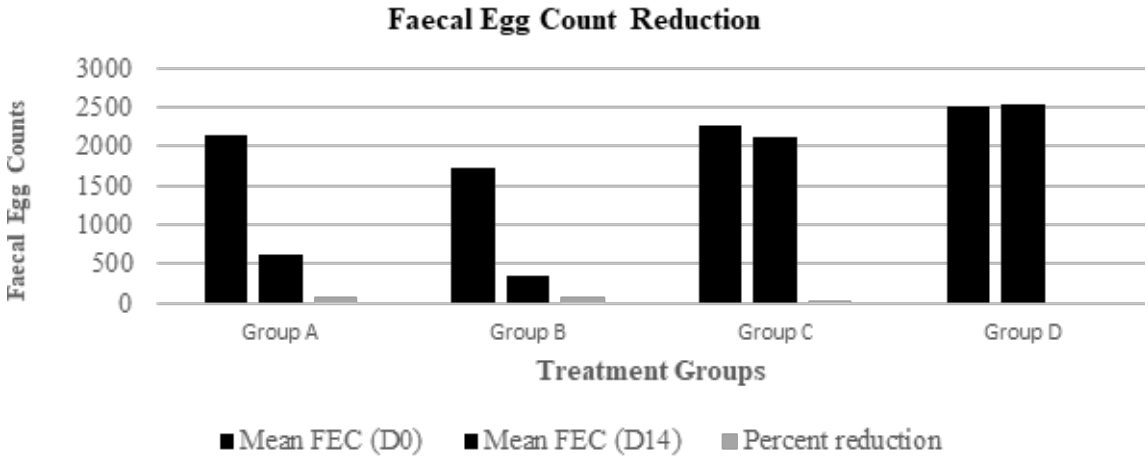

Figure 2: Faecal egg count reduction in the experimental groups

TABLE III- RESULTS OF THE FAECAL EGG COUNT REDUCTION TEST FOR THE DIFFERENT TREATMENT GROUPS

Parameters	Group A	Group B	Group C	Group D
Sample size	18	18	18	18
Mean FEC (D_0)	2133	1728	2278	2521
Mean FEC(D_{14})	628	356	2130	2539
Percent reduction	76	86	17	0
95% LL CI	-13	29	-288	-----
95% UP CI	98	99	94	-----
Interpretation	resistant	resistant	resistant	-----

FECs = Faecal egg counts, LL = Lower limit of the 95% confidence interval and UP=Upper limit of the 95% confidence, D_0 = Day zero, D_{14} = Day 14

concluded that ivermectin had developed high level of resistance to different nematode species in Kajiado County. Overall, the resistance to ivermectin could be attributed to the prolonged and intensive use of the drug over the years (Arsenopoulos *et al.*, 2021)adversely affecting the health and productivity of animals. The first challenge is the uneven distribution of the infection globally, this being more prevalent in tropical and subtropical and warm temperate and summer rainfall regions than in cool and cold temperate and arid regions; hence, this

leads in differences in the approaches required for its control. Another challenge is the widespread presence of Haemonchus strains resistant to the various anthelmintics available: Benzimidazoles, imidazothiazoles, macrocyclic lactones, closantel and monepantel, which makes the control of the infection difficult. The third challenge refers to the difficulty of diagnosing the disease, given that field evidence can provide suspicion about the infection, which needs to be subsequently confirmed by laboratory tests through parasitological or molecular techniques. The final challenge relates to the difficulties in the control of the infection and the necessity to use pharmaceutical products cautiously and with a planned approach, to avoid further development of anthelmintic resistance, also given that use of a recently licenced vaccine is not widespread. In conclusion, at the moment, we should be concerned, but not worried, about this infection, and apply correctly the appropriate health management plans (Arsenopoulos *et al.*, 2021). The drug is being widely used by the farmers for deworming their livestock even without proper veterinary advice, often leading to under dosing. It could also be attributed to failure in delivering the drug subcutaneously during injection which was clearly noted during the study.

Third stage larva identification

Based on morphological features, nematodes of genera *Haemonchus*, *Oesophagostomum*, Cooperia, *Trichostrongilus* and *Strongiloides* were recovered from pre-treatment cultures indicating multiple parasitic infections in the area (Table III)

Post-treatment faecal cultures showed that *Haemonchus, Oesophagostomum* and *Trichostrongilus* did not respond to treatments as such were not sensitive to the drug doses used. However, *Haemonchus* were the most predominant species present.

CONCLUSIONS AND RECOMMENDATIONS

The present study concluded that the community in the study area had no knowledge on anthelmintic resistance. There were numerous nematode genera isolated from the faecal samples of the examined animals before and after treatment and they included *Haemonchus*, *Oesophagostomum*, Cooperia, *Trichostrongilus* and *Strongiloides*. The study concluded that the commonly used anthelmintics in the area have lower efficacy in the management of the veterinary helminthosis. The study established that risk factors associated with the rise of these parasitic worm infection in Kajiado included high stocking density, frequent and inappropriate use of drugs and community's lack of knowledge on parasitic worm infections

The National and County Government needs to put up measures of educating the local community on the

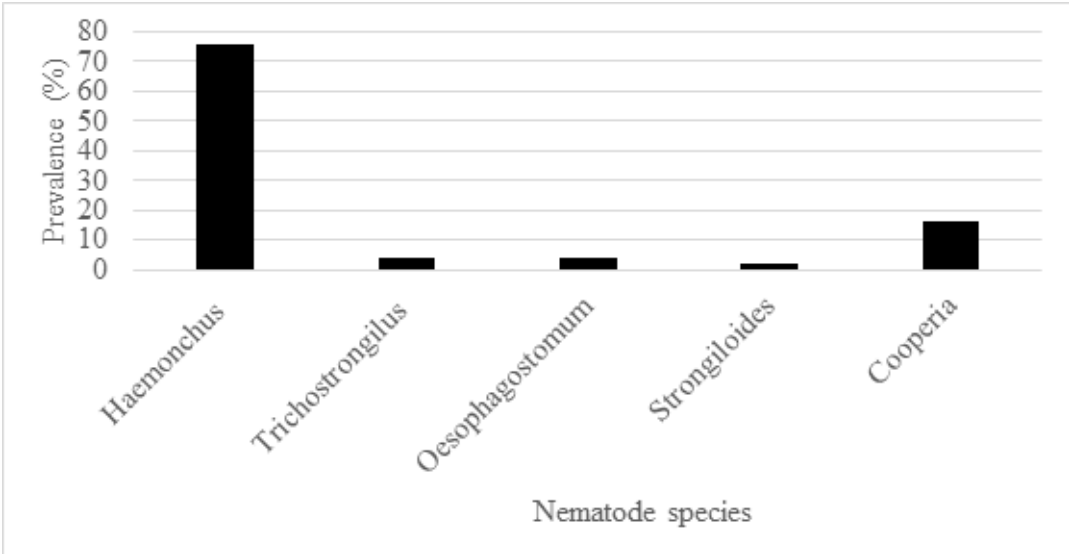

Figure 3: Pre-treatment larval cultures showing the different nematode genera prevalent in Kajiado

emerging threat of anthelmintic resistance with the aim of controlling the infections. Appropriate management measures should be put in place to tackle the spread and emergence of parasitic nematode genera in farms.. Farmers should be advised to lower the frequency of treatment of these flocks, practice anthelmintic rotation and ensure proper administration of the drug.

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