Vol. 16(1), pp. 18-23, January-March 2024
DOI: 10.5897/JEN2022.0277
Article Number: E9C4DAC71981
ISSN 2006-9855

http://www.academicjournals.org/JEN

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Journal of Entomology and Nematology

Full Length Research Paper

Comparative efficacy and cost analysis of albendazole, levamisole, and ivermectin on West African dwarf sheep in Makurdi Benue state Nigeria

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Received 22 February, 2022 Accepted 29 June 2022

Helminthosis and helminths resistance to anthelmintic is a great concern in the management of sheep. The efficacy of three different anthelminthics was studied in sheep. Three groups of sheep comprising seven animals each were treated with three different anthelmintics (albendazole, ivermectin and levamisole). Faecal samples were collected from each group before and after treatment. The faecal egg count (FEC) was monitored for 20 weeks using the Modified McMaster Technique. Baseline FEC indicates that all animals used for this study were heavily infected with (mean FEC of 1,779, 1,186 and 1,457 epg for groups A, B and C respectively) high worm burden before treatment. Following treatment, there was reduction in the mean FEC in groups A and C which lasted for three weeks and in group B which lasted for twelve weeks before re-infestation. An increase in FEC in group A (albendazole) treated sheep necessitated the need for re-treatment on week eight. Likewise, the increasing number of FEC in group C (levamisole) treated sheep also led to re-treatment on week nine. Group B (ivermectin) received no second treatment as there was a reduction in the FEC. This showed that the gastrointestinal nematode in the sheep within the study area was more susceptible to ivermectin over time when compared to the albendazole and levamisole treatment. This study also showed the ability of the sheep to mount immune response leading to the fluctuation in FEC observed in the study. A cost-benefit analysis conducted, showed that the cost of treatment of one group of sheep annually using albendazole, ivermectin and levamisole is ₦50,310, ₦19,762.5 and ₦48,750 respectively. This shows that ivermectin is more efficacious and cheaper for the treatment and control of gastrointestinal nematodes of sheep compared to albendazole or levamisole in the study area.

Key words: Albendazole, cost-analysis, efficacy, ivermectin, levamisole, sheep.

INTRODUCTION

Small ruminants are important livestock species in developing countries due to their ability to convert forages, crops and household residues into meat, fibre, skin and milk (FAO, 1981). Gastrointestinal parasite infection is the most important limiting factor to sheep productivity due to associated morbidity, mortality, cost of treatment and other control measures (Jones, 2001; Nwosu et al., 2007), thus causing severe economic

losses in the sheep industry (Davies et al., 2005). The most commonly used rapid and easy method of quantitative analysis of nematode egg counts in the field and an epidemiological survey is the McMaster technique (Lughano and Dominic, 1996). Anthelmintics are drugs that reduce parasite burdens in animals to a tolerable level, by either killing the parasite (vermicide) or inhibiting their growth or paralysing them (vermifuge). They also reduce the build-up of infective worm larva on pasture or eggs in the environment (Aliu, 2007) but the use of anthelmintics is limited by high cost, unavailability and poor quality of drugs (Monteiro et al., 1998). Although anthelmintics medication remains the most important means of combating helminth infection, the use, abuse and misuse of this anthelmintics have led to drug resistance development to almost all known anthelmintics except for the new anthelmintic Monepantel (Adamu et al., 2013). This problem of resistance has gradually grown from the early 1960's to the current status, which at present, occurs in several genera and classes of helminthes including all three groups of commercially available anthelmintics (benzimidazoles, imidazothiazoles and macrocyclic lactones), except in newer drugs such as Monepantel (Kaminsky et al., 2008). Thus, the efficacy and cost of using ivermectin, albendazole and levamisole in the treatment of helminthosis in sheep were calculated. The effects of these drugs on the onset of re-infection after the treatment were also evaluated.

METHODOLOGY

Experimental animals

A total of twenty-one (21) West African Dwarf breed of sheep belonging to different individuals within the vicinity of the Veterinary Teaching Hospital, University of Agriculture, Annex, North Bank Makurdi, Benue State were used for this study. These sheep comprise of sixteen (16) ewes and five (5) rams, with an average weight of 22 kg within the age range of 10-32 months. The sheep were kept under a semi-intensive system of management, with no records of medications.

Experimental design

Seven days before anthelmintic treatment of the 21 sheep, a baseline faecal examination was carried out to determine the faecal egg count (FEC) of individual sheep using the Modified McMaster technique and faecal floatation procedure. The faecal egg count was done and the sheep were randomly allocated to the groups based on the faecal egg counted. The sheep were weighed individually using a Camry weighing scale and randomly divided into three (3) groups A, B and C of seven (7) sheep each; with the groups A, B and C receiving albendazole at 10 mg/kg, orally, ivermectin at 0.3 mg/kg, subcutaneously, and levamisole at 5 mg/kg, intramuscularly respectively.

Sampling and determination of faecal egg counts

Following treatment, faecal samples were collected from the rectum and examined for helminth eggs weekly through the course of the experiment in all the sheep. The faecal egg count was immediately determined in the lab using the Modified McMaster Technique while using saturated sodium chloride solution as the floatation medium (Soulsby, 1982; Jørgan and Perry, 1990).

Data collection and analysis

For the pre-treatment FEC and post-treatment FEC, the mean and standard error of the mean (SEM) were calculated and recorded for each group. The FEC of each sheep in the three groups was determined once every week. The mean FEC for each group and the SEM was similarly calculated for each group weekly. The time interval between the week of the first treatment and the re-treatment (steady increase in FEC of over 2 weeks) week was regarded as the "duration of action" of the drug and it was noted for each group. The varying changes in FEC over the weeks were also presented in percentage (%).

RESULTS

Comparative anthelmintic efficacy of albendazole, ivermectin and levamisol in sheep

All sheep used for this study showed the presence of faecal helminthes egg with mean FEC of 1779, 1186, and 1457epg for groups A, B and C respectively (Table 1) prior to treatment. Following treatment, there was reduction in FEC afterward, in group A (which lasted till day 35), group B (which lasted till day 84) and group C (which lasted till day 35) respectively (Table 1). These indicate that albendazole and levamisole are efficacious within the first three weeks (21 days) of administration before an increase in FEC while ivermectin showed a longer efficacy which lasted for over two months. The increased FEC after these weeks, indicated the need for retreatment on day 49 (week 8) in group A, using albendazole, and the retreatment of group C on day 56 (week 9) using levamisole. The study equally showed that the gastrointestinal parasites infecting sheep in the study area are susceptible to ivermectin and not as much to albendazole and levamisole for a very long time. In groups A, B and C, mean FEC peaked on day 49, 84 and 42 post-treatment with mean FEC of 7729, 1243 and

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Table 1. Comparative anthelmintic effect of albendazole (A), ivermectin (B) and levamisole (C) in sheep (real count/% variations).

Days	Albendazole	Ivermectin	Levamisole
	Real count (% variation)	Real count (% variation)	Real count (% variation)
0	**1779'**	**1186'**	**1457'**
7	2114* 0 (treatment)	943* 0 (treatment)	571* 000 (treatment)
14	207 (90.2)	150 (84.1)	1079 (-89.0)
21	286 (86.5)	643 (31.8)	93 (83.7)
28	150 (92.9)	86 (90.9)	293 (48.7)
35	3679 (-74.0)	279 (70.4)	3486 (-510.5)
42	1836 (13.2)	336 (64.4)	9057↑ (-1486.1)
49	7729↑** 0 (retreatment)	664 (29.6)	8114 (-1321.0)
56	121 (98.4)	843 (10.6)	2600** 0 (retreatment)
63	343 (95.6)	457 (51.5)	29 (98.9)
70	64 (99.2)	393 (58.3)	7 (99.7)
77	5600 (27.5)	464 (50.8)	1464 (43.7)
84	664 (91.4)	1243↑** (-31.8)	357 (86.3)
91	2321 (70.0)	157 (83.4)	736 (71.7)
98	1729 (77.6)	129 (86.3)	643 (75.3)
105	2150 (72.)	364 (61.4)	221 (91.5)
112	2086 (73.0)	207 (78.0)	186 (92.8)
119	2143 (72.3)	421 (55.4)	514 (80.2)
126	1843 (76.2)	471 (50.4)	521 (80.0)
133	693 (91.0)	686 (27.3)	1521 (41.5)

` = Pretreated, * =Treated; ** =Retreated; ↑= Peak FEC.

9057epg respectively. These, however, declined progressively for group A for three consecutive weeks (121,343 and 64epg) post retreatment followed by a drastic rise again by the fourth week (5600epg). Following retreatment on day 56 in group C, there was a sharp decline in mean FEC on day 63 which lasted for two weeks (with epg of 29 and 7epg) before a rise began again. Meanwhile, the mean FEC in Group B kept declining in a fluctuating fashion till the end of the experiment.

Cost-benefit analysis of three different anthelmintics Albendazole (A), Ivermectin (B) and Levamisole (C) in sheep

Table 2 shows the cost-benefit analysis of three different anthelmintics (Albendazole, Ivermectin and Levamisole) in the treatment of gastrointestinal parasite of sheep. The constant factors in the treatment are veterinary visit cost, veterinary service cost per sheep and labour. The variable factors are; dosage, weight of animal, price of drug, drug cost/treatment, duration following the first treatment, number of treatments during the parasite favourable season to thrive (April to October). The consideration of the constant and variable factors for each treatment group shows that the cost of treatment of the groups (7 sheep) annually using ivermectin is ₦19,762.5, Albendazole is ₦50,310 and Levamisole is ₦48,750 (Figures 1 to 4).

DISCUSSION

The presence of nematode eggs in all the sheep sampled agrees with the report of Mendez et al. (1981), Hoste et al. (2009) that gastrointestinal parasitism in tropics and subtropics is common and amongst the most important constraint in sheep production. In the groups treated with Albendazole and Levamisole (Figures 1 to 3), there was a decline in FEC which lasted for about three weeks before an increase that peaked at day 28 and 34 (week 5 and 6) post-treatment respectively, indicating the efficacy of both drugs to last for 3 to 4 weeks. This agrees with the work of McKeller and Scott (1990) that albendazole is effective against all stages of gastrointestinal nematodes including arrested larva, lungworm and tape worms. Kistner and Wyse (1975); Callinanin and Barton (1979) and Armour (1983) reported that levamisole is highly effective against both adult and immature important gastrointestinal

Table 2. Cost benefit analysis of three different anthelmintics: Albendazole (A), Ivermectin (B) and Levamisole (C) in sheep.

Items/group	Albendazole	Ivermectin	Levamisole	Source
Drug price per unit (₦)	2000	2500	1500	Nigeria
Price/ml (₦)	50	200	200	
Dosage (mg/kg)	10	0.3	5	
Mean weight (kg)	18	20	23	
Dose administered (ml)	7.2	0.6	1.15	
Drug cost/treatment (₦)	360	120	230	
Vet visit cost (₦)	2920	2920	2920	
Veterinary service cost/animal (₦)	730	730	730	
Labour (₦)	182.5	182.5	182.5	
Cost of one-time treatment (₦)	4192.5	3952.5	4062.5	
Duration till retreatment of the flock (weeks)	4	10	4	
No of treatment required/year	12	5	12	
Annual treatment costs (₦)	**50,310**	**19,762.5**	**48,750**	

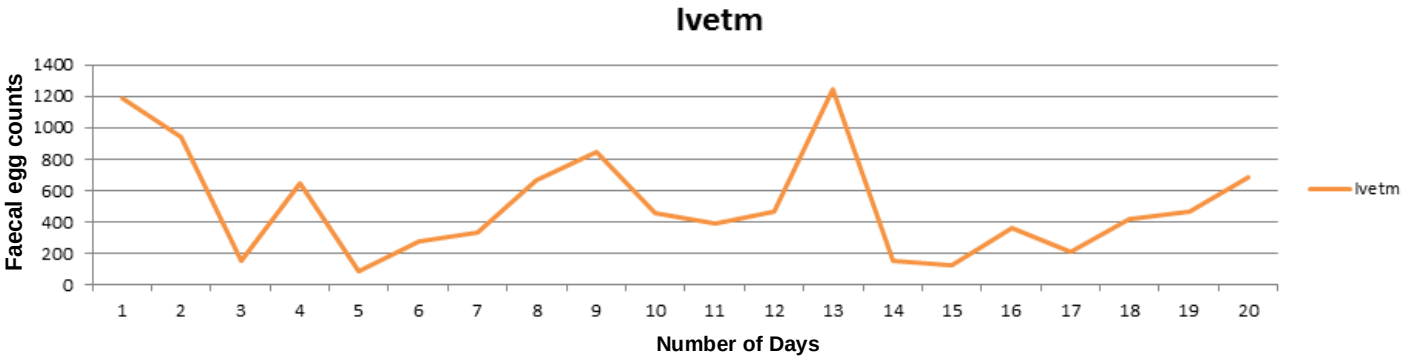

Figure 1. Efficacy of Ivermectin in West African dwarf sheep.

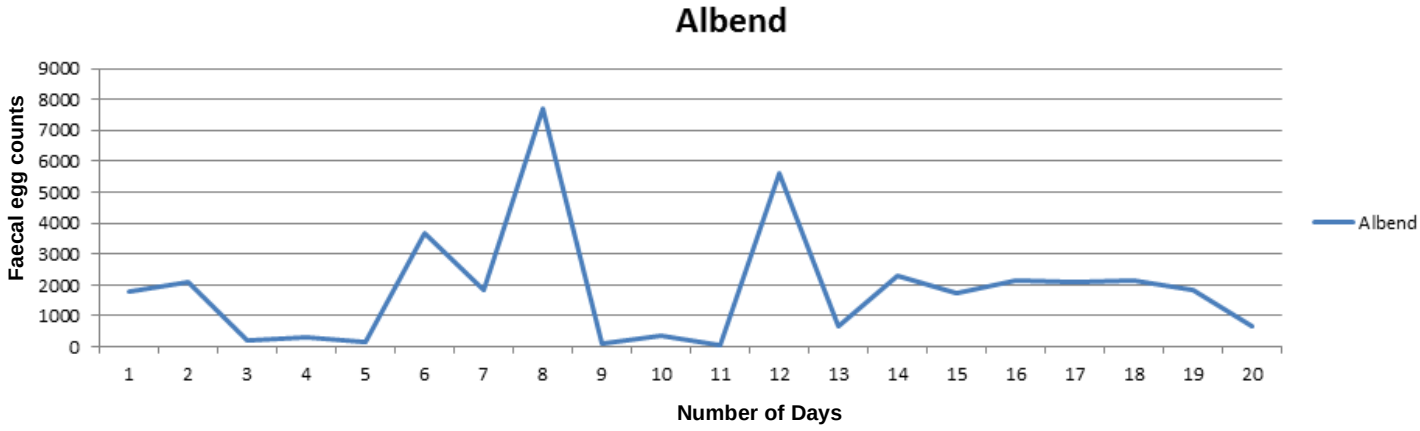

Figure 2. Efficacy of Albendazole in West African dwarf sheep.

nematodes of sheep. Although, Grimshaw et al. (1996) reported that the recommended dose of levamisole (7.5 mg/kg) may not be effective against levamisole resistant parasites and factors associated with the host animal

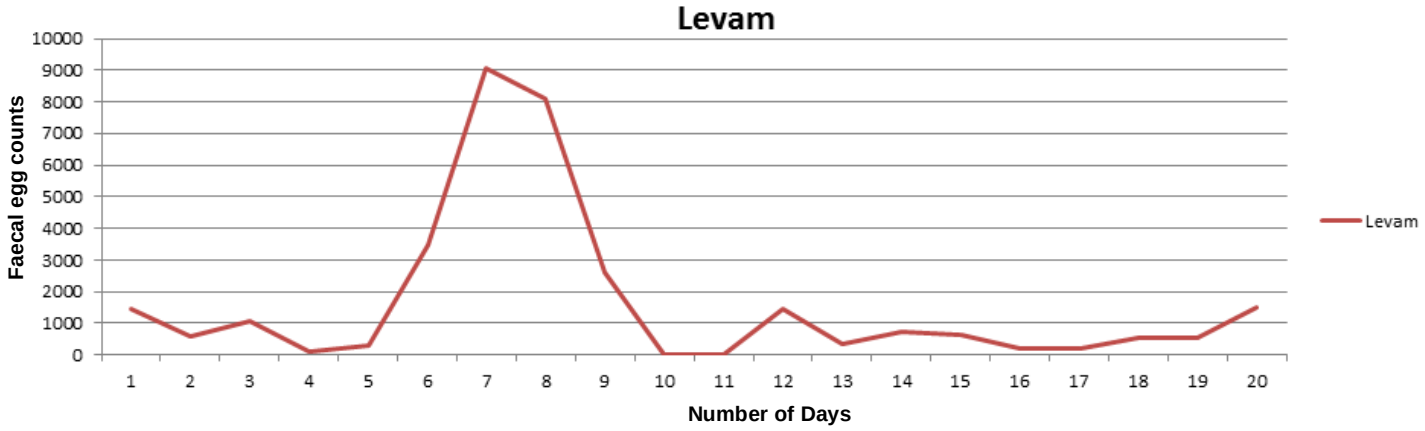

Figure 3. Efficacy of Levamisole in West African dwarf sheep.

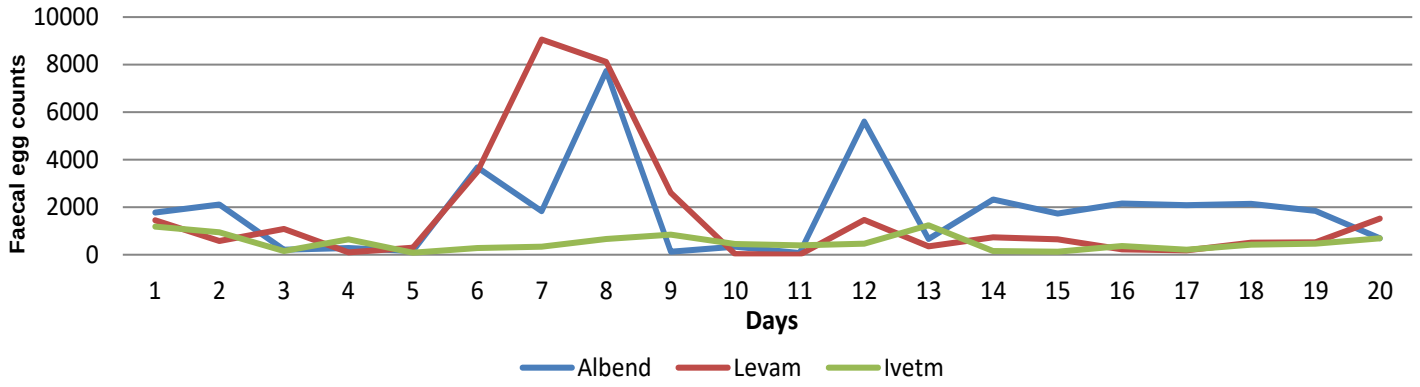

Figure 4. Comparative efficacy of Albendazole, Levamisole and Ivermectin in West African dwarf sheep.

could affect the efficacy of levamisole. This could account for the shortened interval between treatment, a renewed increase in FEC and retreatment as seen in both albendazole and levamisole treated sheep. Barber et al. (1992) reported an increased productivity in Marino sheep and lamb which could be attributed to the duration of anthelmintic protection after administration of controlled-release albendazole capsule. After retreatment with both albendazole and levamisole, there was a decrease in FEC which also lasted for about three weeks affirming the duration of efficacy of both agents to be about the same. Waruiru (1997) reported a 99 and 99.5% reduction of FEC in sheep infested with susceptible gastrointestinal parasites after treatment with albendazole and levamisole respectively. While in the sheep infested with resistance-developed helminthes, there was a 38.5 and 41.4% reduction in FEC with albendazole and levamisole respectively (Figure 4). This is similar to our result with 86 and 83% reduction in FEC for albendazol and levamisol respectively, which suggests possible development of resistance against these drugs or re-infection by the prevalent helminths within the area of study. Nevertheless, the fluctuating but reduced FEC observed in the two groups after retreatment suggests a possible immunological response to the animal against the parasite. Keyyu et al. (2002) also reported a 98 and 59.4% reduction in FEC after levamisole and albendazole treatment. In group B, there was a constant decrease in FEC a week after treatment with ivermectin which lasted till week 12 (day 77) after which there was a peak in week 13 (day 84). Then the decrease continued the weeks after even when no further treatment was given suggesting that the helminthes within the area of study are susceptible to the long-lasting effect of ivermectin. This is in agreement with the report of Adamu et al. (2019) that different formulations of ivermectin have a long-lasting anthelmintic effect. The decrease was sustained till the end of the experiment suggesting a possible interaction of the parasite and the host immune system in the course of the treatment. Thus, the longer

duration of activity of ivermectin could be attributed also to the route (subcutenous) of administration which allows for gradual systemic absorption. Entrocasso et al. (2008) report that a combination of albendazole and ivermectin administered through varied routes show an improved anthelmintic effect (99.9% FEC reduction). The results further revealed that treatment with ivermectin, both reduced the FEC more than the albendazole and levamisole, and extends the duration of reduced FEC before an increased FEC was observed. Thus, ivermectin showed better efficacy and potency compared to albendazole and levamisole. The cost-benefit analysis showed that ivermectin was the cheapest among the three drugs used.

Conclusion

The gastrointestinal nematode parasites in sheep within the region of study were sensitive to the used anthelmintics, although albendazole or levamisole alone could not proffer a long-lasting protection against the existing nematodes. Ivermectin on the other hand conferred a more potent, efficacious, cheaper and longer duration of protection when compared to albendazole and levamisole.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors wish to appreciate the laboratory staff of Veterinary Teaching Hospital and Department of Parasitology and Entomology for their numerous assistances.

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