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A Model for Strategic Control of Sheep Parasites at Qassim Region, Saudi Arabia

[1]M.M. El-Bahy, [2]N.M. El-Bahy and [3]S.A. El-Shehawy
[1]Department of Veterinary Medicine,
College of Agriculture and Veterinary Medicine, Qassim University,
P.O. Box 6622, Buraydah, Saudi Arabia
[2]Department of Parasitology, College of Veterinary Medicine,
Tanta University, Egypt
[3]Department of Mathematics, College of Science, Qassim University,
P.O. Box 6644, Buraydah 51452, Saudi Arabia

Abstract: Three strategic treatment programs were designed and tested in reducing parasitic infection and improving production parameters of sheep at Qassim Region, Kingdom of Saudi Arabia (KSA). The first regime was by application of 2 treatments per year, one versus internal parasites during April and the other versus external parasites during July. The second regime was done by application of 3 treatments per year (versus internal parasites during February, versus internal and external parasites in June and the last versus external parasite only in September). The third regime of treatment was depends on application of 4 treatments per year, start by treatment of internal parasites during February, flowed by external and internal parasite treatment in May, then treatment of external parasite in July and the last treatment was in October versus internal parasite only. The whole flock was treated, their movement was restricted and they examined after one year from the first treatment. The three times and four times treatment per year induce significant decrease in the incidence and level of parasitic infection, improve the mean body weight, lambing rate, blood parameters, some reproductive hormones, liver and kidney function. Selection of three or four times treatment will be evaluated in relation to economic coast and income during the next step of this project.

Key words: Strategic control, sheep, parasites, Saudi Arabia

INTRODUCTION

Parasitic infection considered as one of the most serious problem affecting sheep production allover the world. Heavy infection can decrease growth rate, increase susceptibility to other diseases, decrease the value of the wool, cause anemia and lower overall productivity of the infected animals (Maingi *et al*., 2006).

Effective control of parasitic infection is one of the most difficult challenges encountered by veterinarians in practice (Vebezuabi, 2004). Drug treatment is one of the most effective approaches inducing fast reduction in the parasite burden of the infected animals. Reflex of the treatment on the target parasites as well as on the animal production is highly

Corresponding Author: M.M. El-Bahy, Department of Veterinary Medicine,
College of Agriculture and Veterinary Medicine, Qassim University,
P.O. Box 6622, Buraydah, Saudi Arabia

improved if the treatment is applied at selected critical time for the parasite life cycle, this is called strategic treatment. Time of this treatment is selected to induce maximum relief to the animal from different parasitic stress and decrease the number of eggs shed especially at transmission season. Two successive strategic treatment application per year, leads to decrease in the number of the parasite infective stages around the animal, without application to any other control measures (Malone *et al*., 1990).

Several strategic treatment programs have been described all-over the world. Selection of each strategy was affected by several factors include seasonality of infection, time of the rainfall, animal movement, breeding, grazing and housing system per each localities. Maingi *et al*. (2002) applied a strategic anthelmintic treatment for sheep at the start of the wet season (April to June) the second application was 5-6 weeks later (at the start of the dry season). They found that this regime was effective in controlling gastrointestinal nematodes and prevents occurrence of high levels of re-infection during the season of the long lasting rains (April to June). Vercruysse *et al.* (2006) evaluated application of 3 times treatment at 5 weeks intervals. They applied an early-season treatment program with ivermectin (0.2 mg kg^{-1} per os for 3 days). This treatment resulted in very low to zero egg shedding in some herd and increased from October in the other one. Guimaraes *et al.* (2000) tested the efficacy of three treatment protocols using ivermectin for helminth control in dairy cattle in minas gerais. Three treatments strategy were evaluated on separate groups of calves, group 1 was treated with ivermectin in April (at the end of the rainy season) and October (beginning of the rainy season); group 2 was treated in April, August (middle of the dry season) and October; group 3 was treated in April, August, October and December (middle of the rainy season) and group 4 was left untreated as control. The treatments effectively eliminated the worm burden only in groups 2 and 3. Bakunzi and Serumaga-Zake (2000) dosed communally grazed sheep at 4, 12, 24 or 48 week intervals for 1 year. Dosing every 4 weeks proved to be the most effective, as it led to lower egg count in comparison with the other regimes. However, treating sheep every 12 week was found to keep worm egg numbers relatively low.

Martins *et al.* (2002) treated group of European breed heifers for eradication of *Boophilus microplus* ticks in Brazil. They were treated three times during the late spring-early summer and twice during autumn, with ivermectin. Cattle showed low to zero tick counts during the 28 day treatment interval periods and up to 14 days after the last application in comparison with untreated group. De Castro *et al*. (1997) controlled cattle ticks strategically in Zambia using pyrethroid acaricide spray for 12 applications between the onset and the end of the wet season (October to March).

Design a strategic control program for parasitic infection in a given region required knowledge about types, seasonality and prevalence of infection by different parasites in that area. Moreover, the relation between atmospheric condition (temperature difference, rain fall and relative humidity), type of the drug used, general health condition and the accurate transmission time must be determined.

The present study is the second part of a local funded project (No. AT-26-97) aimed to design a strategic control program for eradication of sheep and camel's parasites in Qassim Region. During the first year of this project data about parasitic infection and atmospheric conditions at this region was investigated (El-Bahy *et al*., 2008).

The current study aimed to design a strategic sheep parasite control model suitable for application in Qassim Region. Three strategic treatment regimes were designed and applied based on using the minimum treatment replication at critical time for each parasite. The impact of each regime on the prevalence of infection and on the improvement in some production parameters was evaluated. This aimed to determine the most effective control strategy to be recommended for further application allover the region.

MATERIALS AND METHODS

The current study is the second part of three years project (No. AT-26-97) undertaken during the period from December 2007 to November 2008.

Study Sites

Qassim Governorate is an agriculture region at North-Eeast of Kingdom of Saudi Arabia (KSA), the area has special atmospheric condition as it is exposed to frequent rain fall during the period from October to May with mainly three peaks at October, January and April. The temperature varies from freezing degree (3-5 days in January) up to over 45°C during July and August. The relative humidity varies from 11-65%. The study was carried out simultaneously in 5 distracts represent in Qassim Region include Buraydah, Al-Mezneb, Al-Asiah, Al-Rass and Oklet Al-Sakor.

Design of the Model

Three strategic control models were designed using the previous data about incidence, transmission, rain fall and types of parasites infecting sheep in Qassim Region that was previously determined by Magzoub *et al.* (2000) and El-Bahy *et al.* (2008). The data in Table 1 demonstrated monthly distributions and the advised treatment regimes for the main four parasites recorded in the region. These parasites include internal (Gastro-intestinal nematodes and coccidia) and external ones (hard ticks and mite). The strategically selected dosing schemes are as follow:

- Two treatments per year according to Maingi *et al.* (2002). They applied at the time of high rate of infection. The first one was applied during April against internal parasites, while the second was during July specified against external parasites
- Three treatments per year according to Guimaraes *et al.* (2000) and Magona *et al.* (2004). The animals were treated during February (middle of the rainy season) against internal parasites, second treatment was applied during June (middle of the dry season) for eradication of internal and external parasites, while the third one was applied for treatment of external parasites only and it was applied during September (end of the dry season)

Table 1: Periods of increase in the infection rate of sheep by different parasites and the selected time for strategic treatment in Qassim Region

	Times of increasing rate in parasitic infection along the year											
Target parasite	Dec	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.
Gastro-intestinal												
Nematodes			X	X	X	X	X					
Coccidia				X	X	X	X					
Hart ticks							X	X	X	X	X	
Mange						X	X	X	X	X		
Selected times for treatment among the year												
Two times					▲ Tr.			▲ Tr.				
Three times			▲ Tr.				▲ Tr.			▲Tr.		
Four times			▲ Tr.			▲Tr.		▲ Tr.			▲ Tr.	

XXX: Periods of increasing incidence of parasite infection. Two times treatment/year: Treatment of all animals by Anthalimintic (A) during April and by Acaricides (B) during July. Three times treatment/year: Treatment of all animals by (A) during February , by (A and B) during June and third time by (B) during September. Four times treatment/year: By (A) during February , by (A and B) during May, by (B) during July and fourth time by (A and B) during October

- Four treatments scheme according to Bakunis and Serumagas-Zake (2000). The first treatment was applied during February for eradication of internal parasites, the second one applied during May (end of the rainy season) against internal and external parasites. The third treatment was applied during July (middle of the dry season) for treatment of external parasite only, while the fourth treatment was applied during October (beginning of rainy season) for eradication of internal and external parasites

The Drugs

Ivomac 1% w/v, 1.0 mL 50 kg^{-1} b.wt., S/c injection (Ivermectin, USA), Amprolium, 1.0 g L^{-1} (for 5-7 days) (Poland) and Bayticol 1 mL 10 kg^{-1} b.wt., pour on at the animals back, (Deltamethrin, Bayer, Germany).

Sheep Groups

Five farms representing the area were selected in order to evaluate the different strategic control programs. A total number of 120 naturally parasite infected female Neamy sheep as well as 30 healthy sheep proved to be free from any parasitic infection, were selected. They were assigned into 5 representating groups (30 each) in two age groups (15 each), one younger than and the other older than 3 years old. Animals were ear tagged using plastic numbers.

They were examined before the first treatment and again at the end of the year. All animals in the same pen were treated each time. Animal movements were restricted into special area.

Animal Treatment and the Inspected Parameters

The animals were allocated into separate groups (30 each) as group 1: healthy control animals, group 2: infected untreated control, group 3: infected animals twice/year, group 4: infected animals treated three times/year and group 5: infected animals will be treated four times/year. Animals were investigated before and after one year from the first treatment in terms of, age, body weight, number of offspring, types and level of infection by different parasites, level of some physiological parameters were investigated.

Collection and Examination of Samples

Identified rectal fecal and jugular blood samples were collected from each animal directly before dosing and at the end of the treatment year (end of observation period). Fecal samples were examined for diagnosis of large size eggs using Fluke finder technique according to Welch *et al*. (1987). Concentration flotation technique using concentrated salt solution was adopted for diagnosis of different eggs, cysts and oocysts, according to Cebra (2008). Counting of the eggs and oocysts was done using McMaster slide according to Soulsby (1986). Cultivation of fecal samples for separation of nematodes larvae and collection of larvae using modified Baermann technique was done as described by El-Bahy *et al*. (2008). Moreover, number of ticks, size and number of mange infected area per each animal were counted by necked eyes. Coagulated and non-coagulated blood samples were collected. Serum samples were separated from clotted blood while non-coagulated blood used for estimation to RBSc count, WBCs, Hemoglobin according to Vatta *et al*. (2002). The ATP and AST, Albumin and Globulin were estimated according to Thamsborg and Hauge (2001). Some reproductive hormones such as FSH and LH were estimated before and after treatment according to Tarin *et al*. (2002). These parameters were selected as they reflect the improvement in the general health conditions and some production parameters after eradication of different parasites.

Statistical Analysis

Significant difference between individual production parameters per each animals before and after treatment were calculated using SPSS program version 15. Mean values were compared via independent-sample t-test (Unpaired t-test) and Paired-Samples t-test (Freund *et al*., 2003). Physiological parameters were presented as the mean $\pm t_{\alpha/2};\upsilon \times SE$, where SE the standard error, $\alpha = 0.05$ and

$$\upsilon = \begin{cases} n-1 & \text{:Paired t-test} \\ n_1 + n_2 - 2 & \text{: Unpaired t-test} \end{cases}$$

the degree of freedom.

Statistical significant of each value were various from the obtained data among four categories according to p-value p the probability of obtaining t-value whose absolute value is equal to or greater than the obtained critical value $t_{\alpha/2};\upsilon$, of a statistic t) as the following:

- Extremely statistically significant when $p \in [0; 0.0006]$
- Very statistically significant when $p \in]0.0006; 0.001]$
- Statistically significant when $p \in]0.001; 0.05]$
- Not quite statistically significant when $p \in]0.05; 0.08[$
- Not statistically significant when $p \in [0.08; \infty[$

RESULTS

The changes in infection by internal and external parasites in the selected sheep groups before and after application of the different regimes of strategic treatment were demonstrated in Table 2. The data evidenced complete eradication of the previously diagnosed parasites from sheep groups treated 4 times during the year. Extremely statistical difference was recorded in comparing the calculated t-value with the critical value $t_{\alpha/2;\upsilon}$ of each group before and after treatment (paired sample statistics). The difference in the level of infection by internal and external parasites reached to 7.237 and 5.949, respectively after 2 treatments. This rate of decrease was 7.409 and 6.045 after three times treatment. On the contrary t-value in infected untreated control animals was increased up to 2.997 and 2.349 for internal and external parasites, respectively.

Strategic treatment led to significant improvement in mean body weight and lambing rate of different treatment groups when comparing to their condition before and after treatment (Paired samples statistics) (Table 3). Extremely statistical significance was recorded in the body weight of sheep less than 3 years in groups treated two and three times, while statistical significance was occurred in older groups treated four times. The calculated t-value was ranged from 45.3794 to 34.9117 in young animals treated for three and 4 times, respectively. This was corresponded by a difference of 5.3936 in infected untreated and 5.2315 in health control sheep. These values were 18.5218 and 3.2291 in older groups treated by different regimes, corresponding to 3.1873 in infected untreated and 4.1632 in the healthy control groups (Table 3).

Table 2: The t-value for the difference in the rate of parasitic infection at the beginning and end of the treatment year

State	Internal parasites	External parasites
Infected un-treated	2.997**	2.349***
Infected treated 2 times	-7.237*	-5.949*
Infected treated 3 times	-7.409*	-6.045*

Paired samples statistics: $\alpha = 0.05$ and $n = 20$ and $t_{\alpha/2}$; n-1 = 2.093. *Extremely statistically significant. **Very statistically significant. ***Statistically significant

Table 3: The t-value for the difference in body weight and lambing rate before and after treatment

	In body weight		In lambing rate	
Animal infection status	Sheep less than 3 years	Sheep older than 3 years	Sheep less than 3 years	Sheep older than 3 years
Control non-infected sheep	5.2315*	4.1632**	0.4286	0.000
Control infected non treated	5.3936*	3.1873***	0.000	-1.000
Infected and treated 2 times	45.3794*	15.6446*	1.1523	2.2361
Infected and treated 3 times	34.9117*	18.5218*	3.6742**	4.7434**
Infected and treated 4 times	36.3353*	3.2291***	3.2796**	4.7434**

Paired samples statistics: $\alpha = 0.05$ and n = 10 and $t_{\alpha/2}$;n-1 = 2.262. *Extremely statistically significant. **Very statistical significant. ***Statistically significant

Table 4: The t-value for the difference between treated sheep and the control healthy at the end of the year

	In body weight		In lambing rate	
The difference between	Sheep less than 3 years	Sheep older than 3 years	Sheep less than 3 years	Sheep older than 3 years
Healthy and infected un-treated	6.27060*	4.1859*	4.7142*	5.8138*
Healthy and infected treated 2 times	3.19115**	3.4834**	3.7948**	3.2797 **
Healthy and infected treated 3 times	2.14660***	1.9356	2.6112***	1.3416
Healthy and infected treated 4 times	-0.0207	-0.0500	1.8974	1.3420

Unpaired samples statistics: $\alpha = 0.05$ and $n_1 = n_2 = 10$ and $t_{\alpha/2}$; n-1+n_2-2 = 2.101. *Extremely statistically significant. ** Very statistical significant. ***Statistically significant

Concerning the lambing rate, a very statistical significance was recorded in groups treated three and four times only in both age groups, while the difference considered to be non-significant in the group treated two times as well as in the control groups.

Comparing the difference between the treated groups with the healthy uninfected one (Unpaired sample statistics t-test) as in Table 4, evidenced that no statistical significant difference could be recorded between healthy groups and the groups treated four times concerning body weight and lambing rate. The difference considered to be extremely statistical on comparing the healthy with infected untreated groups. Very statistical significant was obtained at comparing the mean body weight and lambing rate of groups treated two times with the control healthy one. This difference was considered to be statistically significant in comparing the same parameters in groups that treated three times.

The data in Table 5 evidenced that two and three times treatment in sheep groups of less than 3 years old led to significant increase ($p<0.05$) in the mean values of RBCs, hemoglobin and PCV in comparison with infected non-treated groups. Mean RBCs count was increased from 6.86±2.19 before treatment to 10.92±1.74 post treatment after 3 times treatment. This improvement was reached to10.08±2.26 after 4 times treatment. Significant increase ($p<0.05$) was recorded in the two previous groups (12.18±1.53 and 12.13±1.63, respectively) post treatment. The PCV increased to 34.64±3.18 and 38.11±2.99 in the last two treated groups with a significant difference ($p<0.05$) with the infected non-treated control groups. This was accompanied with decrease in the number of total-Leukocyte count. Non significant increase was recorded in the groups treated for two times concerning the different parameters (Table 5). Treatment of sheep older than 3 years (Table 6) led to significant increase ($p<0.05$) in RBCs count and PCV value in the groups treated four times only. There was non-significant increase in the other treated groups except in RBCs count after two times treatment as they increased from 8.55±1.15 to 10.97±2.03 (Table 6).

The data in Table 7 demonstrated significant improve in the evaluated liver enzymes (AST and ALT) in the treated groups in comparison with untreated control. Moreover,

Table 5: Changes in blood picture of treated and control sheep (younger than 3 years old) at the end of the treatment year

	RBCs count (million mL^{-1})		Hb (%)		PCV	
Sheep groups	Before treatment	Post treatment	Before treatment	Post treatment	Before treatment	Post treatment
Healthy control	9.890±0.41	10.03±1.13	10.10±1.33	10.93±1.62	39.48±2.73	34.18±1.94
Infected control	6.360±0.83*	6.65±1.46*	7.64±0.4*	6.53±1.54	20.11±1.64*	18.24±2.20
Infected then treated 2 times	6.490±1.18	7.90±1.74*	8.34±1.03	10.19±1.64	35.19±1.19	21.45±1.19
Infected then treated 3 times	6.860±2.19	10.92±0.34a	11.64±1.48*	12.18±1.53a	28.13±2.92*	34.64±3.18a
Infected then treated 4 times	10.598±1.53*	10.08±2.26a	10.11±1.19	12.13±1.63a	40.29±4.15	38.11±2.09a

	ESR		Total Leukocytic (1000 mL^{-3})	
Sheep groups	Before treatment	Post treatment	Before treatment	Post treatment
Healthy control	1.84±0.21	1.29±0.42	11.83±1.34	11.64±1.13
Infected control	2.74±0.81	2.83±0.33	18.16±2.32*	17.24±1.09
Infected then treated 2 times	1.71±0.35	1.09±0.44	15.13±1.33	11.06±1.64
Infected then treated 3 times	1.43±0.19	1.83±0.11	10.26±1.19	9.93±1.05
Infected then treated 4 times	2.01±0.34	1.63±0.08	14.00±0.24	10.18±0.53

Means with (*) are significant different per column in comparison with control healthy animals. Means with (a) are significant different per column in comparison with control infected non-treated animals

Table 6: Changes in blood Picture of treated and control sheep older than 3 years old at the end of the treatment year sheep groups RBCs count

	RBCs count (million mL^{-3})		Hb (%)		PCV	
Sheep groups	Before treatment	Post treatment	Before treatment	Post treatment	Before treatment	Post treatment
Healthy control	8.13±1.81	9.43±2.70	10.74±2.53	11.38±1.19	8.28±2.03	39.18±1.77
Infected control	5.68±0.29	4.49±0.43	6.64±0.34*	7.10±1.44	19.87±1.24	20.19±2.19*
Infected then treated 2 times	8.55±1.15	10.97±2.03a	7.92±1.48	8.11±0.75	28.62±1.17	32.94±1.83
Infected then treated 3 times	8.03±1.23	9.56±3.47	8.31±1.63	8.64±1.11	31.65±3.42	33.87±1.93
Infected then treated 4 times	9.46±1.08	10.75±0.11a	9.90±0.13	10.14±2.08	35.71±4.08	38.43±2.11a

	ESR		Total Leukocytic (1000 mL^{-3})	
Sheep groups	Before treatment	Post treatment	Before treatment	Post treatment
Healthy control	1.74±0.21	1.32±0.34	9.11±1.09	10.14±1.11
Infected contro	2.88±0.15	2.94±0.11	16.15±2.18*	14.05±1.23
Infected then treated 2 times	1.83±0.09	1.19±0.13	10.13±1.66	7.54±0.63
Infected then treated 3 times	1.08±0.09	8.11±1.15	9.93±0.83	8.11±1.15
Infected then treated 4 times	1.48±0.09	1.95±0.11	11.64±1.03	9.05±1.22

Means with (*) are significant different per column in comparison with control healthy animals. Means with (a) are significant different per column in comparison with control infected non-treated animals

Table 7: Changes in some liver functions and Reproductive hormones in treated sheep (less than 3 years)

	Total plasma protein (mg %)		Albumin/Globulin		AST (U %)	
Observed groups	Before treatment	Post treatment	Before treatment	Post treatment	Before treatment	Post treatment
Healthy control	8.81±1.13	7.96±1.20	0.53±0.16	0.54±0.10	10.76±2.13	9.55±1.64
Infected control	5.19±0.14*	4.82±0.33	0.58±0.23	0.63±0.17	17.69±1.53	18.60±1.32
Infected then treated 2 times	6.18±1.80	7.54±0.63	0.75±0.10	0.73±0.21	16.50±0.53	16.20±1.11
Infected then treated 3 times	7.33±1.03	8.63±0.73	0.85±0.19	0.58±0.05	14.13±0.23*	10.24±1.71a
Infected then treated 4 times	8.46±0.17	8.76±0.23	0.76±0.18	0.65±0.17	12.20±1.23	8.32±1.29a

	ALT (U %)		LH (μg mL^{-1})		FSH (μg mL^{-1})	
Observed groups	Before treatment	Post treatment	Before treatment	Post treatment	Before treatment	Post treatment
Healthy control	5.16±0.11	5.54±0.64	14.22±2.06	10.18±2.22	11.64±2.03	10.18±1.73
Infected control	9.27±0.81	10.34±1.36*	4.83±0.88*	5.35±1.09	6.19±0.13*	6.18±0.05
Infected then treated 2 times	6.71±1.08	5.38±1.93a	9.88±1.74*	10.12±1.29a	8.60±1.38	10.31±1.61
Infected then treated 3 times	6.51±0.73	5.89±1.10a	9.24±0.65	10.55±0.33a	10.71±3.11	14.49±2.24b
Infected then treated 4 times	8.79±0.65*	4.98±0.55a	10.57±2.75	10.69±2.36a	7.12±2.00*	11.38±1.84a

Means with (*) are significant different per column in comparison with control healthy animals. Means with (a) are significant different per column in comparison with control infected non-treated animals

Table 8: Changes in some liver functions and reproductive hormones in treated sheep (older than 3 years)

Observed groups	Total plasma protein (mg %) Before treatment	Total plasma protein (mg %) Post treatment	Albumin/Globulin Before treatment	Albumin/Globulin Post treatment	AST (U %) Before treatment	AST (U %) Post treatment
Healthy control	7.34±1.22	8.56±1.06	0.42±0.17	0.54±0.24	9.81±1.50	9.98±1.42
Infected control	4.23±0.36*	4.11±0.23	0.58±0.20	0.85±0.16	18.75±2.19*	16.16±2.63
Infected then treated 2 times	5.66±1.12	6.73±0.88	0.67±0.19	0.63±0.04	14.34±0.62*	9.25±1.11a
Infected then treated 3 times	7.12±1.31	7.48±1.62a	0.55±0.13	0.66±0.19	18.47±0.53*	9.73±2.23
Infected then treated 4 times	6.39±0.21	8.16±1.08a	0.46±0.15	0.53±0.12	14.80±120*	9.23±3.50

Observed groups	ALT (U %) Before treatment	ALT (U %) Post treatment	LH (μg mL^{-1}) Before treatment	LH (μg mL^{-1}) Post treatment	FSH (μg mL^{-1}) Before treatment	FSH (μg mL^{-1}) Post treatment
Healthy control	6.94±0.56	4.18±0.36	12.65±1.05	10.55±1.93	11.22±2.31	12.13±1.28
Infected control	10.83±1.60*	10.77±1.83	8.54±2.44	6.43±0.80	7.93±0.93	5.13±0.49
Infected then treated 2 times	8.28±0.14*	6.45±1.07	7.29±2.17	5.83±0.41	8.94±0.25	7.83±2.11
Infected then treated 3 times	6.59±0.41	5.66±0.67a	8.36±1.22	9.19±3.64	10.11±2.34	11.21±1.29a
Infected then treated 4 times	10.71±0.36*	4.49±0.44a	10.46±2.16	12.46±2.08a	10.09±1.41	13.54±2.18a

Means with (*) are significant different per column in comparison with control healthy animals. Means with (a) are significant different per column in comparison with control infected non-treated animals

significant increase ($p<0.05$) was recorded in the level of FSH and LH hormones post treatment specially in sheep of less than 3 years old. The same phenomenon was recorded for sheep older than 3 years as demonstrated in Table 8. There is significant increase ($p<0.005$) in the total plasma protein in older sheep groups treated two and three times, in comparison with the control infected untreated sheep groups.

DISCUSSION

In order to design a strategic parasite control program, complete knowledge about types of different parasitic, incidence, seasonality, transmission season, temperature differences, rain fall, presence of reservoirs and type of drugs available in the target region must be identified. These data for Qassim Region were collected during the first year of the project as this described by El-Bahy *et al*. (2008). The survey data concluded presence of clear seasonality for different parasites infecting sheep at Qassim Region. Enteric parasites (GIN, Trichuris, Strongyloides and coccidia) are associated with warm-rainy period of the year (February to June), *Eimeria* species infection was increased during March to June. Hard tick infection was abundant during summer season (June to September). Sarcoptic mange infection was recorded from spring till end of summer season. These data were directed the authors to select the advised three treatment regimes described in the present study.

The authors supposed that critical treatment time of the parasite induce enormous effect on its eradication, minimize the parasitic stress on the animal and improve its general health condition and productivity. These benefits for strategic parasite treatment were previously mentioned by Vebezuabi (2004) and Maichomo *et al*. (2004).

Several strategic programs are applied in different countries allover the world include two time treatment during the year (Maingi *et al*., 2002; Magona *et al*., 2004), 3 times treatment program (Guimaraes *et al*., 2000; Magona *et al*., 2004) 4 time treatment and even monthly treatment (Bakunzi and Serumaga-Zake, 2000). Selection of the effective time for massive chemotherapy prophylaxis was differed from country to another. There is a firmly relation between rainfall, atmospheric temperature and parasitic seasonality. For this reason the current study was agreed with the other corresponding studies allover the world from the aspect of number of treatment replication per year, but it differ with these study concerning the selected times for treatment application.

The present study followed up the fact previously mentioned by Maingi *et al*. (2002) as the best practice in strategic treatment of different parasites is to give separate treatments for each type of parasites at its recommended times. In the present study, application of Anthalimintic treatment during April and Acaricidal treatment during July proved to be less adequate to induce complete eradication of the parasite in the infected animals moreover it did not induce extremely significant improvement in the different production parameters evaluated. This was previously mentioned by Bakunzi and Serumaga-Zake (2000) as dosing of grazed sheep once a year is not recommended because re-infection appeared as a result to presence of eggs in faeces of treated and untreated animals. It was worthy to mention that, selection of this regime in the current study was advised related to the desert nature of different sheep farms in Qassim Region. This nature minimize the survival periods of different parasite infective stages leading to disturbances in the continuation of the parasite life cycle out side the animal body.

Rainy seasons at Qassim Region start as frequently raining from November till May. January, April and October are months of high rainfall. The three times treatment regimes (treatment during February, June and September) were assigned according to the rainy seasons. February treatment aimed to freeing the animal from early season infection, June treatment was applied to eradicate the infection that happened during the rainy seasons and combat the early infection by external parasites. The third treatment in September was assigned to overcome tick and mite infection as they fast propagated during this time of the year (Magzoub *et al*., 2000; El-Bahy *et al*., 2008). This regime figured out to relief the animal from parasitic stress during the dry seasons. This was previously mentioned by Malone *et al*. (1990) as animals during summer months are suffering from three kinds of stress, nutritional stress from absence of green rations, physiological stress as they usually are in late stage of pregnancy and parasitic stress as development of infective stages become more fast.

The 4 times treatment regimes (3 times per each type of parasite) include addition of one more treatment over the previous regime. This was aiming to reduce the periods between treatments and minimize egg shedding from infected animals during the period till the next coming rainy seasons. In 4 treatment regimes, Prophylaxis anthelmentic treatment was applied through February. In May, animals were treated against internal and external parasites. The 3rd treatment was during July against external parasites only while the last one was during October using anthelmentic and acaricidal drugs.

Examination of the selected groups of sheep before treatment revealed deficiencies in mean body weight, haematological and physiological parameter. The study demonstrates indirect relationship between the decrease in these parameters and the increase in the rate of parasitic infections. This was in agreement with Maingi *et al*. (2006) as heavy parasites infestation can decrease growth rate, cause anemia and lower overall productivity. Disturbances in productivity of parasitic infected animals could be attributed to failure in absorption and metabolization of digested food as described by Roy *et al*. (2004). On the contrary with Vatta *et al*. (2002) infected animals in the present study did not suffer from growth or bone problem. This may be attributed to age and level of infection in the treated animals.

In the current study, significant improvement was recorded in animals treated three and four times during the year. Four times treatment regime induces absolute freeing of the treated animals from their previous parasitic infection. This was in agreement with Bakunis and Serumagas-Zake (2000) and on the contrary with Zinsstag *et al*. (2000) as anthelmintic intervention can not completely predict appearance of parasite eggs in faeces of the treated animals. In the authors' opinion, repeat treatment of animals in the same farm lead to gradual decrease in the number of infective stages shed from them. This few number of eggs or larvae can not tolerate the adverse desert nature of these farms of sandy soil for a long period. These conditions lead to in ability of the infective stage to survive during the hot periods of the year and clear cut in the parasite life cycle could be suspected.

The data demonstrated presence of an indirect relationship between the increase in the frequency of treatment and the decrease in the difference between the treated and control healthy animals. The increases in the treatment replications decrease the difference in mean body weight, lambing rate and different physiological parameters between the previously infected animals and the control healthy one. This improvement rate was affected by age of the treated animals and level of infection before treatment. Young mildly infected sheep were able to return to the level of healthy animals than old heavily infected sheep.

Improvement as a result of strategic application of the drugs was previously mentioned by Maichomo *et al*. (2004), Magona *et al*. (2004) and Maingi *et al*. (2006). Strategic treatment led to improvement in some physiological parameters. This occurs in the form of high weight gains and Packed Cell Volume (PCV) in the treated lambs compared with the untreated lambs (Maingi *et al*., 2006).

Availability of broad-spectrum parasiticide reduces the coast of the treatment program. In the present study, ivermectin was used as broad-spectrum parasiticide. The drugs were previously proved to be more effective in reducing faecal egg counts and total worm counts in lambs (Githiori *et al*., 2004). Ivermectin considered to be very effective (over 98% efficacy) against gastro-intestinal nematodes, sucking lice, ticks and mite in sheep and other ruminants (Davey and George, 2002). In order to exclude the effect of ivermictin on the internal parasite during targeting the external one, Bayticol (synthetic pyrethroids) was used for administration in the selected time of external parasites treatment.

It was worth mentioning that, there are no special characters for the selected drugs other than its efficacy, availability and coast. Several drugs were included in strategic control include ivermectin (Vercuysse *et al*., 2006), Moxidectin separate or in a combination with levamisole (Maingi *et al*., 2006) and moxidectin pour on (Cydectin) (Magona *et al*., 2004) in order to prefer complete freeing of the treated animal from all internal parasites, Amprolium were used with ivermectin for eradication of coccidia infection in treated sheep, as ivermictin did not effect on coccidia.

In conclusion testing the efficacy of three and four time treatment per year induce reasonable improvements on the treated animals. They led to significant reduction or even complete eradication from parasitic infection, improvement in mean body weight and lambing rate under the level of the current study. These treatments induce marked improvement in the general health condition of the treated animals. This appeared in the form of improvement in different hematological parameters, liver and kidney functions as well as reproduction performances. Rate of improvement was affected by number of treatment replication, level of parasitic infection and age of the treated animals.

The next step of the current project is to estimate the economic impact of the three or four time treatment per year on sheep production in order to recommend one strategic program for application at Qassim Region.

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