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EFFECT OF ANTHELMINTIC TREATMENT ON HAEMATOLOGICAL AND COAGULATION PARAMETERS IN LLAMAS (*Lama glama*) INFECTED WITH GASTROINTESTINAL PARASITES

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ABSTRACT

The present study was conducted on ten llamas naturally infected with gastrointestinal parasites. Examination of faecal samples obtained from these animals revealed that six, one and one were infected with *Nematodirus*, *Capillaria* and *Strongyloides* species, respectively. Mixed infection was found in two animals. Following treatment with albendazole, 8 animals recovered from infection, while 2 still had mild infection with *Nematodirus* species. Comprehensive haematological and coagulation parameters were determined in blood samples obtained from the 10 llamas before and after treatment. It appeared that there was an improvement in the haemogram of these llamas after treatment. Erythrocyte count, haemoglobin concentration and packed cell volume increased significantly ($P < 0.05$) after treatment. There were no significant ($P > 0.05$) differences in all other mean values of haematological and coagulation parameters examined before and after treatment.

Key words: Albendazole, blood coagulation, gastrointestinal parasites, haematology, *Lama glama*

Parasitic infection is among factors that limit the productivity of any animal including llamas, which may result in a depression of meat and wool production (Windsor *et al*, 1992). Nematodes are the most numerous of the lamoid gastrointestinal parasites.

The clinical signs seen with gastrointestinal parasitism in llamas are similar to those seen in parasitised cattle and sheep. Gastrointestinal parasites often produce a protein-losing enteropathy and hypoalbuminaemia may develop in severe infection. Enteritis associated with parasitism induce changes in the secretory status of the gut resulting in diarrohea (Guerrero and Alva, 1986; Rickard, 1992). Anorexia from parasitism may lead to emaciation and poor food utilisation in longstanding cases. Anaemia is one of the pathogenic effect of gastrointestinal parasites (Soulsby, 1982). A severe normocytic normochromic anaemia which has all the appearance of a selective depression of erythrogenesis, may occur in association with trichostrongyloid parasites (except *Haemonchus contortus*) of cattle and sheep (Schalm *et al*, 1975).

The present study was undertaken to determine the effect of treatment with albendazole on parasitic infection and some haematological and coagulation parameters in 10 llamas naturally infected with gastrointestinal parasites.

Materials and Methods

Five male and 5 female llamas (*Lama glama*) were used in this study. The ages of these animals ranged from 12 to 18 months. The llamas were kept in a fenced partially shedded open yard at Surman park in Libya. They were provided with water, green food, concentrates and blocks containing minerals and essential trace elements. All animals were examined and found free from ectoparasites and blood parasites.

Approximately 10 grams of faeces was collected from the rectum of each animal, transferred into a plastic screw-capped container and kept in refrigerator at 4°C till examined on the following day. Nine ml of blood was collected from the jugular vein of each animal and dispensed equally in two tubes one contained EDTA and the other with sodium citrate.

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Eggs of gastrointestinal parasites were detected in faecal samples using direct, flotation and sedimentation methods. The eggs were identified on the basis of their morphological characteristics. Number of eggs per gram of faeces was determined using McMaster egg-counting technique according to Soulsby (1982). Haematological parameters, platelet count and fibrinogen were estimated in EDTA blood samples. Haemoglobin concentration, leucocyte count and platelet count were determined using Sysmex^{TM} Model NE-1500 (Toa Medical Electronics Co. Ltd, Japan). Erythrocytes were counted using Neubauer haemocytometer according to Jain (1986). Microhaematocrit centrifuge was employed to measure packed cell volume. Mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were calculated as mentioned by Jain (1986). The reticulocyte count was made by differentiating 500 erythrocytes in brilliant cresyl blue stained blood smear. Blood smears were stained with May-Grunwald-Geimsa stain and 200 leucocytes were differentiated in one smear prepared from each animal. The plasma proteins and fibrinogen were estimated using Goldberg refractometer (American Optical Company, Buffalo, NY, USA) (Schalm *et al*, 1975).

DiaPlastin (liquid calcium-thromboplastin, rabbit brain) and diaCelin (liquid cephaloplastin, rabbit brain, with complexed kaolin) kits were used for prothrombin time and partial thromboplastine time determinations, respectively (DiaMed AG 1975 Cressier sur Morat, Switzerland).

The llamas were treated with albendazole (Bimeda chemicals Ltd. Broomhill Road, Tallaght, Dublin 24, Ireland) twice at a dose rate of 5mg/kg body weight at two weeks interval as suggested by Delatour *et al* (1989). Six weeks later, faecal and blood samples were collected from the llamas and tests performed on these samples were similar to those conducted on pretreatment samples. A pair of t-test was used to compare the values of haematological and coagulation parameters before and after treatment.

Results

The incidence of gastrointestinal parasites in llamas examined in the present study and the intensity of infection represented by the number of eggs per gram of faeces are given in table 1. *Nematodirus* species was the most common parasite among these nematodes. The severity of parasitic infection ranged from mild to low moderate. It appeared that albendazole was effective in eliminating the worms in eight animals, while 2 retained very mild infection of *Nematodirus*. After treatment, there was a gradual improvement in animal health, obvious gain in body weight and the coat appeared shiny with well growing wool.

Table 1. Incidence of gastrointestinal parasites in 10 llamas before and after treatment with albendazole.

Anim. No.	Before treatment		After treatment	
	Type of Parasite	Eggs/ gm of faeces	Type of Parasite	Eggs/ gm of faeces
1.	*Nematodirus* spp. *Strongyloides* spp.	900 300	*Nematodirus* spp.	<100
2.	*Capillaria* spp.	300	Nil	0
3.	*Nematodirus* spp. *Trichostrongylus*	300 300	*Nematodirus* spp.	<100
4.	*Nematodirus* spp.	300	Nil	0
5.	*Strongyloides* spp.	300	Nil	0
6.	*Nematodirus* spp.	300	Nil	0
7.	*Nematodirus* spp.	600	Nil	0
8.	*Nematodirus* spp.	300	Nil	0
9.	*Nematodirus* spp.	300	Nil	0
10.	*Nematodirus* spp.	200	Nil	0

There was a significant ($p > 0.05$) increase in erythrocyte count, haemoglobin concentration, packed cell volume and monocyte count, while mean corpuscular haemoglobin decreased ($p>0.05$) after treatment (Table 2). Treatment with albendazole resulting in recovery from parasitic infection did not have a significant ($p< 0.05$) effect on the values of coagulation parameters (Table 3).

Discussion

Several genera are reported from South and North American llamas including : *Nematodirus, Trichostrongylus, Capillaria, Trichuris and Strongyloides* (Bishop and Rickard, 1987; Cheney and Allen, 1989; Navone and Merino, 1989). *Haemonchus, Ostertagia, marshalagia, Cooperia* and *Oesophagostomum* (Cheney and Allen, 1989; Navone and Merino, 1989; Rickard and Bishop, 1991).

Table 2. Haematological parameters in ten llamas before and after treatment with albendazole.

Parameter	Before treatment Mean ± SD	After treatment Mean ± SD
Erythrocytes ($\times 10^6/\mu l$)	11.6 ± 1.5	14.7 ± 2.2*
Haemoglobin (g/dl)	13.0 ± 1.6	14.3 ± 1.7*
Packed cell volume (%)	29.5 ± 3.7	32.5 ± 4.1*
Mean corpuscular volume (fl)	25.4 ± 2.7	22.1 ± 2.6
Mean corpuscular haemoglobin (pg)	11.2 ± 0.7	9.7 ± 0.9*
Mean corpuscular haemoglobin concentration (g/dl)	44.1 ± 3.2	44.0 ± 1.8
Nucleated erythrocytes (/100 WBC)	0.4 ± 0.5	0.5 ± 0.5
Reticulocytes (%)	0.3 ± 0.2	0.2 ± 0.1
Plasma proteins (g/dl)	6.3 ± 0.6	6.5 ± 0.5
Leucocytes ($\times 10^3/\mu l$)	18.8 ± 5.4	19.9 ± 5.1
Neutrophils (/µl)	12032 ± 3942	12820 ± 3335
Band neutrophils (/µl)	48 ± 79	58 ± 94
Lymphocytes (/µl)	4590 ± 1471	4283 ± 1408
Monocytes (/µl)	203 ± 173	438 ± 203*
Eosinophils (/µl)	1927 ± 1108	2261 ± 1377
Basophils (/µl)	0	40 ± 90

* Significant at 0.05 level

Table 3. Coagulation parameters in ten llamas before and after treatment with albendazole.

Parameter	Before treatment Mean ± SD	After treatment Mean ± SD
Platelets ($\times 10^5/\mu l$)	4.4 ± 1.3	4.6 ± 1.4
Fibrinogen (mg/dl)	190.0 ± 87.6	235.0 ± 94.4
Prothrombin time (sec.)	12.0 ± 0.8	11.6 ± 0.5
Partial thromboplastin time (sec.)	21.9 ± 1.0	22.0 ± 2.4

Although the number of animals examined in this study was limited, there was an indication that nematodes were the most common gastrointestinal parasites in llama. *Nematodirus* species was detected in faecal samples obtained from 8 out of 10 llamas. These findings were in agreement with those observed in South and North American llamas as well as those raised in the United Kingdom (Bishop and Rickard, 1987; Navone and Merino, 1989; Rickard and Bishop, 1991; Neyra *et al*, 2002; Tait *et al*, 2002).

The levels of nematode infection were very low, with the maximum egg count of 1,200 egg per gram of faeces. The highest level of parasitism was low when judged by the criteria of Soulsby (1982). Treatment with anthelmintics is advisable when 1000 eggs per gram or more are found. However, faecal egg count bears no relationship to the damage caused by the helminths (Guerrero and Alva, 1986), the presence of a single egg may mean that the animal is losing productivity (Windsor *et al*, 1992). Previous work in camels, phylogenetically closely related to the llama, has shown the pharmacodynamics of albendazole are more similar to sheep than cattle. This finding indicate that dose and dosing interval recommended for sheep should be selected over those used for cattle (Delatour *et al*, 1989). On the basis of this information usage of albendazole similar to that in sheep was adopted and it was effective in deworming the treated llamas.

There appeared a gradual gain in body weight after treatment in 10 llamas. Animal coat was shiny and the fleece was thick and well grown 6 weeks after the second dose of treatment. Similarly, ivermectin had been used to control both external and internal parasites resulting in significant gain in body and wool weights (Windsor *et al*, 1992).

The mean values of the haematological parameters in the ten llamas before treatment were within normal reference ranges (Fowler and Zinkl, 1989; Houten *et al*, 1992), but two of them were mildly anaemic. The anaemic llamas had the highest parasitic egg count (600 and 1,200 epg). Correlation between the egg count and the severity of anaemia can not be justified because of the very low number of affected animals. Low erythrocytic values were attributed to a low but constant parasitic burden which affected a flock of sheep and goats (Oduye, 1976). The increase in erythrocyte count, haemoglobin concentration and packed cell volume after treatment supported our expectation that the low red blood cell values was due to parasitic infection. Mean corpuscular haemoglobin decreased significantly ($p > 0.05$) after treatment which was due to the increase in erythrocyte count more than in haemoglobin concentration. Monocyte count increased significantly ($p > 0.05$) after treatment and this was probably due to the enhancement of the mononuclear phagocyte system to eliminate the tissue damage at the recovery stage from parasitic infection.

There were no significant ($p < 0.05$) differences in the mean coagulation values before

and after treatment. This result indicated that species of nematodes detected in the present study and their levels of infection did not cause significant changes in the coagulation system. Infection with *Strongyloides* species is mainly by skin penetration, though oral infection may occur. In both ways, the infected larvae are carried by the blood to the lungs (Soulsby, 1982). Changes in blood coagulation is anticipated due to the invasion of the circulatory system but further comprehensive study is needed to determine the effect of *Strongyloides* species on the coagulation parameters in llama.

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