Bangl. J. Vet. Med. (2016). 14 (2): 191-197 ISSN: 1729-7893 (Print), 2308-0922 (Online)

EFFICACY OF IVERMECTIN AGAINST GASTROINTESTINAL NEMATODIASIS AND ECTOPARASITES IN CROSSBRED CATTLE IN BANGLADESH

M. Ahammed[1], M. A. Ali[2], M. A. Ehsan[3*] and M. Mostafa[1]

[1]Department of Pharmacology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202; [2]Department of Pathology and Parasitology, Jhenaidah Govt. Veterinary College, Jhenaidah; [3]Department of Medicine, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202

ABSTRACT

The experiment was carried out to determine the efficacy of Ivermectin (Ivomec® S/C Formulation) against gastrointestinal nematodiasis and ectoparasites including stephanofilaria on crossbred cattle, to determine the effect of drug on certain hematological parameters like hemoglobin (Hb) content, packed cell volume (PCV) and erythrocyte sedimentation rate (ESR)in crossbred cattle and to determine the effect of the drug on live weight. A total of 100 cattle were selected randomly and examined for presence of both endo and ectoparasites including stephanofilaria. Gastrointestinal nematodiasis were detected by examination of fecal samples and ectoparasites as well as stephanofilaria were detected by physical examination. Out of 100 cattle, 20 were found to suffer from both endo and ectoparasites. These 20 cattle were selected finally for the research work. Then these cattle were divided into two groups, group A (treated group, n=15) and group B (control group, n=5). Ivermectin was injected subcutaneously to the cattle of group A @ 200µm/kg body weight (1ml/50 kg body weight). The therapeutic efficacy of the drug against gastrointestinal nematodiasis was determined by investigation of fecal egg count reduction and the efficacy was 100% against the common nematodes in crossbred cattle on day 7, 14, 21 and 28 of post treatment period. Ticks within a markable area (25 square inches) were counted on day 0 and lice infestation was marked as infected on day 0. Ivermectin showed 100% effectiveness at the 7, 14, 21 and 28 day of post treatment period against both tick and lice infestation. The efficacy of the drug against stephanofilariasis (humpsore) was determined by reduction of diameter of the sore on the day 14, 42 and 56 of post treatment period. All the sores were completely healed up by the 56 days. During the study of hematological parameters it was seen that Hb and PCV were increased whereas ESR values were decreased on post treatment days. In this study the mean live weight of the cattle of treated group was increased after treatment with ivermectin and increased body weight was 5.13% on the 28th day of post treatment period. From the above findings it may be concluded that ivermectin was 100% effective against gastrointestinal nematodes common in crossbred cattle. Effectiveness of the drug against external parasites was 100%. In this study hematological parameters were changed significantly after treatment with ivermectin, body weight of animal treated with ivermectin was increased and no adverse effect of the drug was found in this study.

Key words: Ivermectin, Gastrointestinal nematodes, ectoparasites, cattle

INTRODUCTION

Bangladesh, being an agricultural country, is largely dependent on agriculture for its economy. The backbone of agriculture of this country is the livestock but the general condition of this livestock is miserable mainly due to parasitic infestation. Gastrointestinal nematodiasis is a common problem of cattle which causes economic losses in the form of mortality, stunted growth, weight loss, decreased milk and meat production, draft power, market value of living animal, infertility and condemnation of carcasses during meat inspection. In addition to gastrointestinal nematodes, the ectoparasites like tick, mite, lice also cause loss of productivity in cattle. They cause loss of productivity by damaging skin and hides and sucking blood from animal body resulting in poor growth rate of animal. Stephanofilariasis, commonly known as humpsore is very common in Bangladesh and India which causes severe economic losses by decreasing productivity and cost of animals and their skin quality also.

*Corresponding e-mail address: amimul.med@bau.edu.bd

In Bangladesh many drugs are being used for a longtime to combat parasitic infestation in livestock. The indiscriminate use of anthelmintics available in the market has made parasites to be resistant against the drugs. Moreover there was not a single anthelmintic effective against both endo and ectoparasites. Among all the anthelmintics in use up to date a very limited number are broad spectrum and effective against a large number of endoparasites. Although there are few ectoparasiticides, they are too toxic for both animal and human being. In this circumstance it was very much urgent to find out an anthelmintic which would be effective against both endo and ectoparasites. This search leads to find out the efficacy of ivermectin against both the types of parasites. There was no available report on efficacy of ivermectin in the crossbred cattle which are more susceptible to parasitic infestations than our indigenous cattle. Considering all these constraints this work aimed to determine the efficacy of ivermectin (subcutaneous injection formulation) against gastrointestinal nematodes and ectoparasites in crossbred cattle along with the effect of Ivermectin on certain blood parameters and body weight of crossbred cattle.

MATERIALS AND METHODS

The experiment was carried out in two villages namely Kewatkhali and Balashpur and BAU Dairy Farm nearby Bangladesh Agricultural University, Mymensingh. The following procedure was adopted to perform the experiment-

Primarily a total of 100 crossbred cattle were selected randomly and the cattle were examined carefully to detect the presence of both endo and ectoparasites by fecal and physical examination respectively. By fecal examination gastrointestinal nematodiasis were recorded in seventy five cattle. By physical examination it was found that 40 animals had tick infestation, 30 animals had lice infestation and 20 animals had humpsore. Out of the primarily selected 100 crossbred cattle, 20 animals harboring both endo and ectoparasites were finally selected for the present study. These twenty cattle were randomly divided into two groups- group A (treated group) consisting of 15 cattle and group B (control group) consisting of the rest 5 cattle. These selected animals were marked by plating at the neck by wire.

For the detection of gastrointestinal nematodiasis fecal sample was collected directly from the rectum of the cattle under experiment belonging to both group A and group B. It was performed both at pre and post treatment period. After treatment it was done on 7^{th}, 14^{th}, 21^{st} and 28^{th} day. The collected samples have been examined by Direct Smear Method and McMaster Egg Counting Technique as described by Soulsby (1986). The presence of ectoparasites on body coat of cattle was detected by thorough physical examination and the infestation was marked as slight, moderate and severe. Tick and lice infestations and stephanophilariasis were considered in this study.

Selection and administration of drug

Injectable ivermectin preparation (Ivomec S/C Formulation) was purchased from the local market. Then the drug was injected subcutaneously to all the cattle of group A at the dose rate of 1 ml/50 kg body weight (0.2 mg/kg body weight. The egg reduction test was performed on the 7^{th}, 14^{th}, 21^{st} and 28^{th} day of post treatment period. The ticks within a selected area (25 square inches) of body coat were counted physically prior to treatment with ivermectin (day 0) and after treatment on the 7^{th} , 14^{th}, 21^{st} and 28^{th} day. The total count of ticks was recorded. The cattle infestated with lice were marked as infestated on day 0. After treatment with ivermectin observations on the basis of physical examination were recorded on the 7^{th}, 14^{th}, 21^{st} and 28^{th} day. The diameter of hump sore was recorded before treatment and on the day 14, 28, 42 and 56 after treatment with the drug. To study the effect of ivermectin on hematological parameters, blood samples were collected from the external jugular vein of the cattle of treated and control group in vials containing anticoagulant (Sodium EDTA) at the day 0, 7, 14, 21 and 28 to determine the effect of Ivermectin to the following hematological parameters- hemoglobin (Hb) content, packed cell volume (PCV) and erythrocyte sedimentation rate (ESR). The hematological parameters were determined as per standard method cited by Coffin (1955)

Statistical Analysis

The data were analyzed statistically between pretreatment and post treatment values by using well known student ‘T’ test.

RESULTS AND DISCUSSION

The cattle belonging to the group A were treated with Ivermectin at the dose rate of 1ml per 50kg body weight (200µg/per kg body weight) and there gastrointestinal nematodiasis showed 100% egg reduction on the 7th day of the post treatment period. The same result was found on the 14th, 21st and 28th day of post treatment period. In control group (Group B) the EPG was increased gradually on the 7th, 14th, 21st and 28th day (Table 1).

Table 1. Efficacy of Ivermectin (S/C formulation) against gastrointestinal nematodiasis based on the number of egg in feces

Group	Tag No	Sex	Pretreatment	Post Treatment							
			Day 0	Day7		Day14		Day21		Day28	
			EPG	EPG (mean ± SE)	EPG (mean ± SE)	EGG Reduction	EPG (mean ± SE)	EGG Reduction	EPG (mean ± SE)	EGG .eduction	EPG (mean ± SE)	EGG Reduction
A	105	F	950									
	110	M	700									
	115	M	800									
	120	F	750									
	125	M	900									
	130	F	600									
	135	F	750									
	140	M	700	810±6.87	0	100%	0	100%	0	100%	0	100%
	145	M	800									
	150	F	900									
	155	M	950									
	160	F	800									
	165	M	900									
	170	M	850									
	175	F	800									
B	180	F	700									
	185	M	650									
	190	M	800	800 ± 5.5	930	0%	1050	0%	1150	0%	1200	0%
	195	F	950									
	200	F	900									

Ivermectin showed 100% efficacy against lice infestation of Group A cattle which were treated with the drug at the dose rate of 1ml/50kg body weight (200µg/kg body weight).No lice was found by physical examination on the 7th day of treatment. The similar result was found on the 14th 21st & 28th day of post treatment period. Whereas the rate of lice infestation was constant in the cattle of group B (Control Group) this finding was shown in Table 2.

The number of ticks of cattle of group A were determine by physical examination within a selected area (25 square inches). Again ticks in the selected area were counted on the 7th, 14th, 21st and 26th day after treatment with ivermectin. No ticks were found with the selected area of the body of cattle. On the other hand in control group the numbers of ticks were increased gradually on the 7th, 14th, 21st & 28th day (Table 3).

The cattle of Group A with humpsore showed significant reduction of lesion 14 days after a single dose of Ivermectin(S/C Formulation). After 42nd day of post treatment period smaller lesions were completely healed up but the larger lesions were not completely healed. By the 56th day of post treatment period the larger lesions were also healed up completely leaving the scar tissue. So it can be stated that S/C injection of Ivermectin (Ivomec®) is very much effective drug against stephanofilariasis for crossbred cattle in Bangladesh.

Effect of Ivermectin (S/C Formulation) on certain Hematological Parameters (Hb, PCV and ESR)

Although no significant change in gm% of Hb was observed at the 7th day of post treatment period, it was increased significantly from the 14th day onwards and continued upto 28th day of treatment. No such change was observed in cattle of control group (Table 4).

Table 2. Efficacy of Ivermectin (S/C Formulation) against lice infestation in crossbred cattle

Group	No of cattle	Drug with dose	Pretreatment day	7th Day		14th Day		21st Day		28th Day	
				Findings	% Reduction	Findings	% Reduction	Findings	% Reduction	Findings	% Reduction
A	15	Ivermectin @ 200µg/kg	Infected	Nil	100%	Nil	100%	Nil	100%	Nil	100%
B	5	Nil	Infected	Infected	0	Infected	0	Infected	0	Infected	0

Table 3. Efficacy of Ivermectin (S/C formulation) against ticks infestation in crossbred cattle

Group	Tag No	Sex	Drug with dose	Pretreatment		Post treatment							
						7th Day		14th Day		21st Day		28th Day	
				Number of ticks within 25 sq,inches	Mean ± SE	Number of ticks (mean)	% Reduction	Number of ticks (mean)	% Reduction	Number of ticks (mean)	% Reduction	Number of ticks (mean)	% Reduction
A	105	F	Ivermectin	7									
	110	M	@	9									
	115	M	200µgm/	8									
	120	F	kg	10									
	125	M	body	8									
	130	F	weight	7									
	135	F		9									
	140	M		10	7.0 ±0.45	0	100%	0	100%	0	100%	0	100%
	145	M		7									
	150	F		9									
	155	M		8									
	160	F		10									
	165	M		6									
	170	M		7									
	175	F		4									
B	180	F		5									
	185	M	Nil	9									
	190	M F		8	7.8 ± 1.98	8.8	0	10	0	11.5	0	12.5	0
	195	F		10									
	200			7									

Table 4.Efficacy of Ivermectin (S/C Formulation) on Hemoglobin (Hb gm%) in crossbred cattle.

Group	Tag No	Drug with dose	Pretreatment 0 Day		Post Treatment							
					7th Day		14th Day		21st Day		28th Day	
			Hb in individual animal	Mean ±SE	Hb in individual animal	Mean ±SE	Hb in individual animal	Mean ±SE	Hb in individual animal	Mean ±SE	Hb in individual animal	Mean ±SE
A	105	Ivermectin	6.5		7.0		7.5		7.8		8.0	
	110	@	8.0		8.4		8.5		9.0		9.5	
	115	200µg/kg	7.5		8.0		8.5		8.8		9.0	
	120	body	8.5		8.5 6.8		9.0		9.5		10.0	
	125	weight	6.0		9.5		7.0		7.8		8.5	
	130		9.0		8.0		9.8		10.0		10.0	
	135		7.5		9.0		8.5		9.0		9.8	
	140		8.5		7.0		9.4		9.5		10.0	
	145		6.5	7.53±0.26	7.0	7.98±0.25	7.5	8.40±0.22	8.0	8.94±0.214	8.8	9.48±0.21
	150		6.5		8.0		7.8		8.4		9.0	
	155		7.5		9.5		8.5		8.8		9.5	
	160		9.0		8.5		9.5		10.0		10.5	
	165		8.0		8.7		9.0		10.0		10.4	
	170		7.5		6.8		8.0		9.5		10.0	
	175		6.5				7.5		8.0		8.8	
B	180		7.5		7.5		7.0		6.8		6.5	
	185		8.0	7.36±0.30	8.0		7.8		7.0		6.5	
	190	Nil	7.8		7.5	7.30±0.29	7.5	7.10±0.28	7.4	6.74±0.26	7.0	
	195		6.5		6.5		6.4		6.0		5.8	6.36±0.24
	200		7.0		7.0		6.8		6.5		6.0	

PCV values of treatment group increased significantly at the 28th day of treatment but it was decreased in control group. These findings of PCV values were shown in Table 5.

Table 5. Efficacy of Ivermectin (S/C Formulation) on Packed Cell Volume (PCV%) in crossbred cattle

Group	Tag No	Drug with dose	Pretreatment Day 0		Post Treatment							
			PCV in individual cattle	Mean ±SE	7th day		14th day		21st day		28th day	
					PCV in individual cattle	Mean ±SE	PCV in individual cattle	Mean ±SE	PCV in individual cattle	Mean ±SE	PCV in individual cattle	Mean ±SE
A	105	Ivermectin @ 200µg/kg body weight	32.00		32.50		33.50		34.00		35.00	
	110		30.50		31.00		31.50		32.50		33.00	
	115		34.00		35.00		36.00		36.00		36.50	
	120		32.50		33.00		33.50		34.00		35,00	
	125		30.00		31.00		32.00		33.50		34.00	
	130		31.50		32.50		33.00		34.00		35.50	
	135		35.50		35.00		36.00		36.50		36.50	
	140		30.50	32.23±0.45	31.00	32.83±0.42	31.50	33.62±0.44	32.00	34.36±0.39	33.00	35.06±0.35
	145		32.00		32.50		33.00		34.00		35.00	
	150		35.50		36.00		36.50		36.50		36.50	
	155		33.00		33.50		34.00		35.00		35.50	
	160		30.50		31.00		31.80		32.50		33.00	
	165		32.50		33.00		33.50		34.00		35.00	
	170		33.00		33.50		35.00		36.00		36.50	
	175		31.00		32.00		33.50		35.00		36.00	
B	180		32.50		32.00		31.00		30.50		30.00	
	185		30.00		31.00	32.30±0.70	30.50	31.20±0.52	30.00		29.00	29.80±0.28
	190	Nil	34.00	32.60±0.99	33.50		32.00		3100	30.50±0.25	30.50	
	195		35.00		34.00		32.50		31.00		30.00	
	200		31.50		31.00		33.00		30.00		29.50	

The Erythrocyte Sedimentation Rate (ESR) was decreased significantly at the 14th, 21st and 28th day of post treatment period in case of the cattle of treatment group but not in case of control group (Table 6).

Table 6. Effect of Ivermectin on Erythrocyte Sedimentation Rate (ESR min/hr) in crossbred cattle

Group	Tag No	Drug with dose	Pretreatment (Day 0)		Post Treatment							
			ESR in ind. cattle	Mean±SE	7th Day		14th Day		21st Day		28th Day	
					ESR in ind. cattle	Mean±SE	ESR in ind. cattle	Mean±SE	ESR in ind. cattle	Mean±SE	ESR in ind. cattle	Mean±SE
A	105	Ivermectin @ 200µg/kg bodyweight	1.50		1.40		1.30		1.20		1.10	
	110		0.90		0.80		0.70		0.60		0.60	
	115		1.00		0.90		0.80		0.70		0.60	
	120		0.80		0.70		0.60		0.60		0.55	
	125		0.80		0.75		0.70		0.60		0.50	
	130		1.20		1.00		0.90		0.80		0.70	
	135		1.10	1.13±0.067	1.00	1.03±0.066	0.85	0.93±0.066	0.80	0.85±0.059	0.65	0.77±0.057
	140		1.30		1.20		1.10		1.00		0.90	
	145		1.40		1.30		1.20		1.10		1.00	
	150		0.90		0.90		0.80		0.90		0.80	
	155		0.80		0.70		0.60		0.60		0.50	
	160		1.10		1.00		0.90		0.80		0.70	
	165		1.40		1.30		1.20		1.10		1.00	
	170		1.30		1.20		1.10		1.00		0.90	
	175		1.50		1.40		1.30		1.20		1.10	
B	180		0.90		1.00		1.10		1.20		1.30	
	185		1.30	0.96±0.104	1.40	1.08±0.216	1.50	1.19±0.097	1.60		1.65	
	190	Nil	0.80		0.90		1.00		1.10	1.28±0.096	1.25	1.38±0.080
	195		1.00		1.20		1.20		1.30		1.40	
	200		0.80		0.90		1.10		1.20		1.30	

The effect of Ivermectin (S/C Formulation) on body weight of crossbred cattle

Both individual and mean live weight of the cattle of treated group were recorded prior to treatment and on the 28th day of treatment. There was a significant improvement in live weight gain after treatment and it was calculated in kilogram and shown in Table 7.

Table 7. Efficacy of Ivermectin (S/C Formulation) on bodyweight of crossbred cattle

Group	Tag no	Pretreatment (Day 0)		Post treatment (28th day)		Weight gain/ loss	Improvement (%)
		body wt (kg)	Mean ±SE	body wt (kg)	Mean ±SE		
A	105	110		118			
	110	195		208			
	115	120		130			
	120	100		106			
	125	115		120			
	130	150		158			
	135	120		126			
	140	150	144 ±7.91	155	151.4± 8.16		5.13%
	145	180		185		7.4	
	150	140		148			
	155	155		158			
	160	135		145			
	165	130		135			
	170	190		198			
	175	170		179			
B	180	165		161			
	185	120	134± 11.37	118	130.4±11.93		
	190	150		145		-3.6	Nil
	195	110		108			
	200	125		120			

In this study subcutaneous injection of Ivermectin was found 100% effective against gastrointestinal nematodes in crossbred cattle. This effectiveness was determined by fecal egg per gram (EPG) reduction. This result was in conformity with earlier workers (Rehbein *et al.*, 1997; Rendal and Callinan, 1996; Singh *et al*., 1994; Williams and Plue, 1992; Maru *et al*., 1990; Soll *et al*., 1988). Some other workers found more than 99% efficacy of Ivermectin (Barth *et al*., 1997; Pitt *et al.*, 1996; Cleartier and Pors, 1994). In this study 100% efficacy of Ivermectin against ectoparasites were recorded in crossbred cattle. This efficacy was detected by physical examination. Some other workers found 100% effectiveness of Ivermectin against ectoparasites (Titcherer *et al*., 1994; Thompson *et al*., 1994; Genchi and Tada, 1992; Gill *et al.*, 1989). After 7th day to the end of the experiment (28th day post treatment) no ectoparasites were seen on the body of the treated cattle.

The hematological changes in crossbred cattle affected with the gastrointestinal nematode were determined at pre and post treatment period dosed with Ivermectin. The mean value of hemoglobin of the cattle of control group was decreased and this result is in agreement with the reports of Nettleton and Beckelt (1976) and Auosa (1977). In this study, significant increases in Hb gm% and PCV% were found in the treated group of cattle which might be due to expulsion of blood sucking and other parasites from the body of treated cattle. There was a significant reduction in the ESR in treated group of cattle which might be a result of recovery from inflammation in gastrointestinal tract produced by gastrointestinal nematodes. Kumar and Joshi (1992) also found increase in Hb gm% level in ivermectin treated cattle.

The body weight of cattle infected with parasites was increased after using anthelmintics. Islam (1992) reported significant (P> 0.01) increase of bodyweight in cows and buffaloes after treatment with anthelmintics. In the present study the live weight gain was 5.13% after treatment with Ivermectin. This may be a result of proper digestion, absorption and metabolism of feed nutrient because of absence of gastrointestinal nematode infection. In earlier period some workers found improvement of body weight after treatment with Ivermectin (Rehbein *et al.*, 1997; Taylon *et al.*, 1995).

The present study was conducted on a small population of crossbred cattle and the efficacy of Ivermectin was ®determined on the basis of egg count reduction. Since there were some limitations neither any animals were

slaughtered on post treatment days for detection of presence or absence of nematodes or any milk sample wasexamined for the presence of Ivermectin. It was not possible to study the effect of the drug on pregnant animal and embryo or fetus due to time limitation. Further study should be conducted to observe the effect of the drug on pregnant cattle and its embryo or fetus and its residue in milk.

REFERENCES

1. Arantes GJ, Sulva CR and Marra DB (1996). Anthelmintic activity of 1% Ivermectin (injectable solution) in the treatment of calves naturally infected with gastrointestinal nematode. *Revista Brasilera and Parasitologia Veterinaria* 4: 113-116.
2. Amin MR and Samad MA (1987). Clinico-therapeutic studies on gastrointestinal nematode infection in diarrhoeic cattle. *Bangladesh Veterinary Journal* 4: 25-28.
3. Ashok K, Yadab CL, Sudesh K and Rajendra K (1996). Experimental evaluation of Ivermectin against gastrointestinal nematodes of sheep. *Indian Veterinary Journal* 73:782-783.
4. Barth D, Erricsson GF, Kunkle BN, Rehbein S, Ryan WG and Vallace DH (1997). Evaluation of the persistence of the effect of ivermectin and abamectin against gastrointestinal and pulmonary nematodes in cattle. *Veterinary Record* 140: 278-279.
5. Cleartier C and Pors I (1994). Efficacy of three broad spectrum anthelmintics, against gastrointestinal nematodes in goats. *Veterinary Record* 134: 523-524.
6. Genchi C and Traldi G (1992). Efficacy of Ivermectin clorsulon combination against gastrointestinal nematodes, Fasciola hepatica and ectoparasites (Psoroptes bovis) in cattle. *Atti-della-Societa-Italiana-di-Buiatria* 24: 307-309.
7. Gill BS, Balakrishnan P, Hossain M and Singh J (1988). Treatment of humpsore-stephanophilariasis of cattle with Ivermectin*. Indian Journal of Animal Sciences* 58: 552-560.
8. Islam AWMS (1979). Stephanofilariasis in cattle of Bangladesh. *Indian Journal of Animal Health* 18: 7-8.
9. Kumar A and Joshi BP (1992). Anthelmintic efficacy of ivermectin against naturally occurring gastrointestinal nematodes of sheep. *Indian Veterinary Journal* 69: 935-937.
10. Maru A, Srivastatava CP and Dubey SC (1990). Efficiency of ivermectin against infection of gastrointestinal nematode in sheep. *Indian Journal of Parasitology* 14: 241-242.
11. Pitt SR, Heinz-Mutz EM, Baggot DG and Barth D (1996). Control of established infection of parasitic nematodes in cattle by an ivermectin sustained release intraruminal bolus. *Helminthologia* 33: 125-131.
12. Rehbein S, Pitt SR, Lengholfe WK, Barth D and Eagleson JS (1997). Therapeutic and prophylactic efficacy of Ivomec SR bolus against nematodes and Psoroptes ovis in cattle weighing more than 300 kg at the time of treatment. *Parasitology Research* 83: 722-726.
13. Rendal D and Callinan L (1996). The duration of anthelmintics effects of moxidectin and ivermectin in grazing sheep. *Australian Veterinary Journal* 23: 35.
14. Soulsby EJL (1986). Helminth, Arthropod and Protozoa of domesticated Animals, 7th edition. The ELBS and Baiers, Tindle, Casseil, London, pp.216, 234. 763-766.
15. Sastri UV (1989). Efficacy of Ivermectin against gastrointestinal nematode infection in goat. *Indian Veterinary Journal* 66: 345-346.
16. Singh J, Gill JS, Ramneck M and Kwatra MS (1994). Comparative efficacy of anthelmintics against nematode infection of sheep and goats in Punjab. *Journal of Veterinary Parasitology* 8: 47-50.
17. Soll MD, Carmichal IH and Harvey RG (1988). Prophylactic efficacy of sustained release Ivermectin against induced nematode infestation in cattle. *Journal of South African Veterinary Association* 59: 9-11.
18. Taylon SM, McMullin PF, Mallor TR, Kelly A and Grimashaw WTR (1995). Effects of treatment with tropical ivermectin, three and eight weeks after turnout nematode control and the performance of second beef sucker cattle. *Veterinary Records* 136: 558-561.
19. Thompson DR, Kugg D, Scott PG, Cramer LG and Barrick RA (1994). Rainfall and breed effects on the efficacy of ivermectin jetting fluid for the prevention of fly strike and treatment of infestation of lice in long wooled sheep. *Australian Veterinary Journal* 21: 161-164.
20. Titcherer RN, Parry JM and Grimshaw WTR (1994). Efficacy of formulation of abamectin and moxidectin against sucking and biting lice of cattle. *Veterinary Record* 134: 452-453.
21. Williams JC and Plue RE (1992). Efficacy of Ivermectin delivered from a sustained release bolus against inhibited early fourth stage larvae of Ostertagia ostertagi and other nematodes in cattle. *American Journal of Veterinary Research* 53: 793-795.