Efficacy of Closantel, *Ferula Asafetida* and Common Dewormer Against Haemoncus Contortus in Small Ruminants

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Abstract

Background

Haemonchosis caused by *H. contortus* has been recognized as one of the main limitations to the beneficial goat farming, worldwide. Albendazole, Oxfendazole, and Ivermectin are the most common drugs used against *Haemonchosis*, development of allopathic drugs resistance with time, availability, and price are another critical issues; these are absent in herbal drugs. It is important to establish a most effective protocol for the treatment of *Haemonchosis.* Closantel and herbal plant *Ferula asafetida* are reported to be effective against roundworms infestation.

Methodology:

The current study was conducted on goat and sheep farms of Tehsil Pattoki District Kasur, Pakistan. Coprological examination was performed and animals n = 720 (n = 360 caprines & n = 360 Ovines) positive *Haemonchosis* were selected, each breed animals were divided into six groups (A-F), n = 60 animals were assigned in each group for therapeutic trails. By oral route, Albendazole, Oxfendazole, Ivermectin, Closantel and *Ferula asafetida* were given to A-E groups while F served as control. All animals treated with single dose and EPG performed by McMaster technique at day 0 (pre-treatment), 7th, and 14th (post-treatment).

Results

Closantel and *Ferula asafetida* showed the highest efficacy in both caprines and ovines.

Conclusion

Allopathic drug Closantel and herbal drug *Ferula asafetida* proved as an efficient dewormer against *Haemonchosis*.

1. Introduction

Haemonchosis in small ruminants is caused by blood sucking gastrointestinal roundworm, *Haemonchus contortus (H. contortus)*, Adult parasite suck blood (0.05 ml blood/day/parasite) and damage intestinal walls of host, severe infestations lead to anaemia, hypo proteinemia, edema, pregnancy toxemia, diarrhea, severe emaciation and high mortality (Besier et al. 2016, Dey et al. 2019, Dutta et al. 2017). The prevalence of this parasite reported worldwide and in Pakistan prevalence range is 24.6%to 80.64%, that varies with season (Al-Shaibani et al. 2008, Asif et al. 2008, Dey, Zhang, Begum, Alim, Hu and Alam 2019, Qasim et al. 2016). *Haemonchosis* is one of the main limiting factors in beneficial small ruminants farming and Pakistan is standing at 3rd in production of goat population in the world (Shah et al. 2017).

In Pakistan, losses are in billions in form of growth, milk, death in young animals, hair and wool production (Rizwan et al. 2017). Anthelmintic resistance (AR) is described as low efficacy of an anthelmintic against parasites population that is generally susceptible to that drug (Fleming et al. 2006). Among many species of gastrointestinal nematodes, resistance of variable degree has been developed due to use of frequent and low dose of same drug, and usually resistance appears with in ten years of introduction of new drug. Field populations of *H. contortus* species show resistance to major classes of anthelmintic like benzimidazole, macrocyclic lactons and imidazothiazoles. In Pakistancommonly used anthelmicts are albenzaloes and ivermectin, and anthelmintic resistance is the main challenge to treat *Haemonchosis* in animals (Iqbal et al. 2017, Kotze and Prichard 2016, Shalaby 2013).

Albendazole and Oxfendazole belongs to benzimidazole group of anthelmentics, and Ivermectin from Tetrahydropyramidine, showed high efficacy against nematodes in goats both in vivo and vitro trials but these drugs are used in huge way that resistance have been developed against them (Adediran and Uwalaka 2015, Das et al. 2015, Gonzalez et al. 2019, Kaplan and Vidyashankar 2012, Wang et al. 2017). Closantel is another drug reported very effective against *H. contortus*, and is preferred routine wise over benzimidazoles (Dixit et al. 2019, Westers et al. 2016). Resistance with allopathic is always an issue however, disadvantage of allopathic drugs is resistance that develop with time furthermore, availability and price is another issue whereas these issues are absent in case of herbal drugs. Many herbal drugs are effective against gastrointestinal nematodes (Hamad 2014).

Ferula asafoetida (Hing) is a herbal drug, it has traditionally been used for its anthelminthic properties in many countries such as Iran, China and Nepal, where it has been used for treating infection with intestinal parasites (Bhatnager et al. 2015, Şahin et al. 2003). This drug has not yet been tried against *H. contortus*, furthermore, this drug is easily available in Pakistan. In this study, we planned to document in vivo anthelmintic effect of Albendazole, Oxfendazole, Ivermectin, Closantel and crude aqueous extract of herbal drug *Ferula asafoetida* on *H. contortus*, gastrointestinal nematodes of Goats and Sheep.

2. Material And Method

2.1. Ethical approval and informed consent

Ethical approval for this study was otained from University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan.

2.2. *Sampling area*

The current study was conducted at the sheep and goats farms in Tehsil Pattoki, District Kasur, Punjab, Pakistan. It lies between 168 meters above the sea level; it is bordered by the Ravi River in the north-west and river Sutlej in the south-east. In district Kasur, mean temperature in summer is 45ºC, whereas in winter, it becomes as lower as 6ºC. The average rainfall in Kasur district ranges from 161.9 with an average of 0 mm.

2.3. *Sample collection*

Fecal Samples were collected from the animals which was not dewormed in the last 4 months showing signs of anemia, edema, diarrhea, loss of hairs and loss of weight during July to December 2018 according to Soulsby protocol which is considered as standard. Approximately 5 g fresh sample of faeces directly collected from the rectum of animals in a labelled plastic tube having ratio of 3:1 formalin (1 part of sample and 3 parts formalin). Gender and age were recorded for each animal and transported to University Diagnostic Lab, University of Veterinary and Animal Sciences Ravi campus Pattoki. The samples were kept in refrigerator until examination within 24 hours. These fecal samples were characterized into three scores, one for normal, two for semisolid and three for diarrheic feces (Rizwan, Sajid, Iqbal and Saqib 2017).

2.4. *Grouping of animals*

Total haemonchosis positive animals n = 720 (n = 360 Caprines & n = 360 Ovines) were there. On the number of Egg per Gram animals were divided into three different groups' highly infected, moderate infected and light infected animals with *H. contortus*, their EPG was respectively more than 1200, 800 to1200 and 50 to 799 (8). For therapeutic trail animals were arranged into six groups (A-F) each containing 60 animals A-E groups were in therapeutic trail while F group was control group.

2.5. *Fecal Egg Count (FEC)*

Samples were preceded by using techniques of parasitology (sedimentation and flotation) and identified as positive samples. For quantitative examination to know egg's concentration "McMaster technique" was done. By the identification of ova or egg of *H. contortus* were known. Egg of *H. contortus* is shown in Fig. 1.

2.6. *Therapeutic trails*

Group A, B, C, D, E were treated orally with albendazole, oxfendazole, Ivermectin, Closantel and *Ferula asafetida* by using the dose rate of 10 mg/ kg, 5mg/kg, 0.02 mg/kg, 10 mg/kg and 100 mg/kg respectively, while F was not treated with any medicine and kept as control. The animals of respective groups were treated at day 0 after sample collection. Fecal samples were collected at day 0 (pre-treatment), day 7 and at 14 (post treatment) of all animals (Dixit, Das, Dixit and Sharma 2019, dos Santos et al. 2017, Puspitasari et al. 2016). Control group was dewormed using Closantel on day 14th after sample collection. *Ferula asafoetida* plant was collected in July 2017, the plant was shade dried for several days. Whole plants were dried and ground in a hammer mill then soaked in water for seven days at room temp and dried powered was given at rate of 100mg/kg oral, procedure followed as (Tavassoli et al. 2018). Allocation of groups and treatments with their dose rates is given in the **Table. I**

2.7. *Statistical analysis*

The collected data set was imported into SPSS (SPSS Inc., Chicago, Illinois, USA) version 26.0. The Chi-Square (X^2) was used for the efficacy while repeated measure ANOVA was used for the EPG count.

3. Result

In the current study, the effectiveness of Albendazole, Oxfendazole, Ivermectin, Closantel, and *Ferula asafoetida* were evaluated against *H. contortus* on the basis of the decrease of EPG in caprine and ovine. The results showed that there was significantly higher efficacy of closantel (100%) as compared to other treatment drugs in caprine (Fig. 2). The data of drugs efficacy showed that in ovine, closantel, and *ferula asafetida* (99 & 87%; respectively) were highly effective as compared to other treatment and control group (Fig. 3).

Moreover, both in caprine and ovine, there was no significance difference of drugs efficacy between male and female in all treatment groups (Table 2). Similarly, there was no significance difference in the efficacy of drugs between different age groups in both caprine and ovine (Table 3).

Table 1
Experimental groups, drugs and route of administration (dose and route)

Group	Formulation	Trade Name	Company	Route	Dose rate
A	Albendazole	Valbazine	Pfizer	Per oral	10mg/ kg
B	Oxfendazole	Systamax	ICI	Per oral	5mg/kg
C	Ivermectin	Ivoteck drench	Star	Per oral	0.02mg/kg
D	Closantel	Closancare	advacare	Per oral	10mg/kg
E	*Ferula asafetida*	---	---	Per oral	100mg/kg
F	Control Group	---	---	---	---

Table 2
Drug efficacy against *Haemonchus contartus* in caprine and ovine with relationship between gender.

Treatment Groups	Caprine		Ovine	
	Male	Female	Male	Female
Group A	40	39	9	9
Group B	33	33	4	4
Group C	22	22	17	17
Group D	100	100	99	99
Group E	70	70	87	87
Group F	0	0	0	0

Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, *Ferula asafetida and control groups.*

Table 3
Drug efficacy against *Haemonchus contartus* in caprine and ovine relationship between different age

Treatment groups	Caprine			Ovine		
	0–2 Yrs	2–3 Yrs	3–4 Yrs	0–2 Yrs	2–3 Yrs	3–4 Yrs
Group A	39	39	39	8.5	9	9
Group B	33	32	33	4.3	4	4
Group C	23	22	22	18	17	17
Group D	100	100	100	99	99	99
Group E	70	70	70	87	87	87
Group F	0	0	0	0	0	0

Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, *Ferula asafetida and control groups. Drug efficacy against Haemonchus contratus in caprine and ovine show in percentage (%)*

3.1. *Effect of drugs on reduction of EPG on various days in caprine and ovine*

The results of reduction in the EPG in caprine showed that there was significantly higher reduction of EPG in closantel treatment at days 7 and 14 (104.13 ± 28.11 & 0, respectively) compared with other treatment drugs. The lowest reduction of EPG was noticed in ivermectin group at days 7 and 14 (1257.00 ± 409.24 and 1096.50 ± 356.73, respectively) among all treatment drugs. Moreover in all treatment, groups of therapeutic trail showed a significant reduction of EPG from day 0 through day 14 as compared to control (F), as presented in (Table 4).

Table 4
Effect of drugs on reduction of EPG on various day in Caprine.

Treatment groups	Day 0	Day 7	Day 14
Group A	1215.12 ± 344.37^{Z}	969.88 ± 278.81^{bcY}	730.88 ± 203.06^{bcX}
Group B	1462.12 ± 481.06^{Z}	1164.63 ± 384.18^{cdY}	937.13 ± 322.68^{cdX}
Group C	1409.87 ± 456.21^{Z}	1257.00 ± 409.24^{cdY}	1096.50 ± 356.73^{cdX}
Group D	1508.75 ± 407.11^{Z}	104.13 ± 28.11^{aY}	0.00^{aX}
Group E	1468.00 ± 342.53^{Z}	498.50 ± 116.69^{abY}	439.13 ± 103.63^{bX}
Control	1466.75 ± 340.27	1465.63 ± 337.85^{d}	1537.13 ± 365.13^{d}

Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, *Ferula asafetida and control groups. a, b, c and d show the level of significance between treatment groups, while X, Y and Z show level of significance difference within treatment groups.*

The result of reduction in the EPG in ovine showed that there was significantly higher reduction of EPG from day 0 to days 14 in closantel and ferula (1873.51 ± 638.91 to 17.75 ± 5.65 and 1873.63 ± 607.19 to 243.54 ± 78.91, respectively) treatment groups among treatment and control group. There was non-significant difference between Albendazole, Oxfendazole, and Ivermectin treatment in EPG reduction at days 7 and 14 (Table 5).

Table 5
Effect of drugs on reduction of EPG on various days in ovine.

Treatment groups	Day 0	Day 7	Day 14
Group A	1747.13 ± 679.41^{Y}	1663.62 ± 646.91^{bY}	1582.25 ± 632.73^{bY}
Group B	1816 ± 729.61^{Y}	1781 ± 716.18^{bY}	1734.75 ± 699.73^{bY}
Group C	1738.25 ± 632.46^{Y}	1573.81 ± 578.02^{bY}	1432.75 ± 466.61^{bY}
Group D	1873.51 ± 638.91^{Y}	147.13 ± 51.13^{aX}	17.75 ± 5.65^{aX}
Group E	1873.63 ± 607.19^{Y}	399.12 ± 143.97^{aX}	243.54 ± 78.91^{aX}
Control	1884.88 ± 622.89	1910 ± 607.49^{b}	1951.51 ± 630.06^{b}

Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, *Ferula asafetida and control groups. a and b show the level of significance between treatment groups, while X and Y show level of significance difference within treatment groups.*

However, there was no significant difference in reduction of EPG between male and female caprine and ovine in all treatment groups (Figs. 4 and 5). Similarly, there was no significant difference in EPG

reduction between 0–2, 2–3 and 3–4 years caprine and ovine in all treatment groups (Figs. 6 and 7).

4. Discussion

Traditionally anthelmintics are considered as major part of the strategies for the control of helminth in grazing animals for the prevention of losses of production. Use of same, unselective and having similar mode of action anthelmintics for many years cause resistance in animals (Coles and Roush 1992, Islam et al. 2018). Therefore in this study four common and one herbal anthelmintics drugs were used to evaluate the efficacy and anthelmintics resistance in caprine and ovine. To the best of our knowledge this was the first study in which efficacy of anthelminics were determined in goats and sheep. The main finding of this study was (a) the overall efficacy of closantal was higher in caprine, however in ovine closantel and ferula asafetida had higher drug efficacy irrespective of age and gender. (b) The EPG reduction was higher in closantel in both caprine and ovine, while ferula asafetida significantly reduced EPG in ovine than caprine.

The result of the current study showed that in caprine the EPG reduction was highest at 7th and 14th days post treatment in colantal than other anthelmintics, therefore the efficacy of closantal was 100% than other anthelmintics against h. contortus. Our result had in agreement with previous result that closantal had higher efficacy and low anthelminitics resistant in goats (Das, Dixit, Nath, Agrawal and Dongre 2015, Uppal et al. 1993) who also found Closantel to be 100 % effective against *Haemonchus contortus* in goat by using 10mg/kg body weight of medicine. The (Dixit, Das, Dixit and Sharma 2019) found that closantel is 95.64% effective against *H. contortus*.

The reason of higher efficacy of closantal against *H. contartus* might be high bounding properties to blood protein that is important for oxidative phosphorylation in parasites, which decreased the adenosine triphosphate and nicotinamide in the mitochondria, therefore availablily of energy lower for parasites (Lanusse et al. 2009). However some previous studies observed that anthelminitics developed resistant against closantal (Baihaqi et al. 2019, Chandrawathani et al. 2013, Premaalatha et al. 2014). The result of current study showed that the efficacy of ferula asafetida was 70% that is lowered than closantal and higher than other anthelminitics. (Singh et al. 2016) reported that 100% efficacy of aqueous extract of Zanthoxylum armatum DC. Seeds against *H. contartus*. (Akhtar et al. 2000) observed that different medicinal plants had high efficacy against anthelminitcs in goats of Indo-Pakistan. The high efficacy of these medicinal plants might be the high contents of phenolic flavonoid and tannin that is improved the immune defense system of host to destroy the parasites (Atoui et al. 2005, Tiwary et al. 2007). The other reason of low anthelminitcs resistant is the high concentration of cooper and zinic in these plants, which is high wormicidal and indirect role in improving immune defence of host (Burke et al. 2005, Chartier et al. 2001, Waruiru et al. 2004). We found high anthelminitics resistant against albendazol, oxfendazol and ivermectin, that is in agreements with previous reports (Kumar Jaiswal et al. 2013, Maharshi et al. 2011, Uppal, Yadav and Bhushan 1993).

The finding of current study showed that closantal and ferula asafetida had higher efficacy against *H. contortus* in sheep. Our result in agreements with previous studies that closantal had high efficacy against *H. contortus* and other strongylieds in sheep (Westers, Jones-Bitton, Menzies, Van Leeuwen, Poljak and Peregrine 2016) and merino sheep (Kadam et al. 2009, Shahana 2013, Tramboo et al. 2017). observed 100% and 98% respectively efficacy of closantal against *H. contortus* at 8th and 14th days of post treatment in Indian sheep. The higher efficacy of closantal against *H. contortus* may be due to lowered population of *H. contortus* eggs and improvement of immune defense of sheep. In literature ivermectin had higher efficacy (99%) against strongly and *H. contortus* in sheep, when injected subcutaneously (Canga et al. 2009, Westers, Jones-Bitton, Menzies, Van Leeuwen, Poljak and Peregrine 2016). The reason of higher efficacy of subcutaneous ivermectin might be higher bioavailability of ivermectin to plasma. The recent review of literature reports that aqueous extract of herbal plants had higher efficacy against strongly And *H. contortus* (de Souza Chagas and da Silva Vieira 2007, Dongre et al. 2015).

The reason of higher efficacy of herbal plants due to increased quantity of cooper and zinic that is lethal for the growth and production worm eggs (Chartier, Soubirac, Pors, Silvestre, Hubert, Couquet and Cabaret 2001, Waruiru, Mutunu and Otieno 2004). Similar finding have reported by (41,50) that suppimentation of copper and zinic had significant reduction of strongly eggs in host. In the current study albendazol, oxfendazol and ivermectin had lowered efficacy. Our finding has in agreement with previous reports that lowered efficacy of albendaol and fenbendazol due to higher anthelminitics resistance in small ruminants (Baihaqi, Widiyono and Nurcahyo 2019, Shahardar et al. 2014, Westers, Jones-Bitton, Menzies, Van Leeuwen, Poljak and Peregrine 2016). The higher anthelminitics resistance was due to higher frequency of deworming and use of insufficient dose of anthelminitics (Sissay et al. 2006).

The finding of current study revealed that no significant difference in age and gender wise efficacy of anthelminitics in both goats and sheep. This might be due to similar improvements of immune defense system against *H. contortus* in host. The reducation of eggs of *H. contortus* was significantly higher in closantal and ferula asafetida in both goats and sheep regardless of age and gender. Our finding support the previous findings that higher reduction of eggs in closantal and plants extract and leaves (Dixit, Das, Dixit and Sharma 2019, Nabukenya et al. 2014, Tramboo, Shahardar, Allaie, Wani and Abbas 2017). Albendazol, oxfendazol and oraly ivermectin had lowered reduction of eggs in the current study. These might be due to low availability of drug in the plasma that might be more expression of resistan genes (Coles et al. 2006, Kenyon and Jackson 2012, Van den Brom et al. 2015). A longer term study would be necessary to fully evaluate the resistance genes in the H. contortus.

Conclusion

Finally in conclusion, the higher reduction of *H. contortus* eggs after the treatment of closantal in goats and in sheep, the higher reduction of *H. contortus* eggs after the treatment of closantal and ferula asafetida. Therefore, higher efficacy of closantal against *H. contortus* is displayed in both goats and sheep, however, *ferula asafetida* displayd only higher efficacy in sheep.

Declarations

Ethics approval was taken from University of Veterinary and Animal Sciences Lahore

Ethical considerations

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors

Author contributions

HMI designed the project. Sampling, data collection, processing and interpretation of results were made by AJ, MZI the data analysis was made by MA and MNW. The manuscript was written by AJ, HS, MI and MSZG. All the authors read the manuscript and approved the contents.

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Conflict of interest

The authors declare no conflict of interest

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All authors contributed equally

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Competing interests

The authors declare that they have no competing interests

References

1. Adediran, O.A., and Uwalaka, E.C., 2015. Effectiveness evaluation of levamisole, albendazole, ivermectin, and Vernonia amygdalina in West African dwarf goats, Journal of parasitology research, 2015,
2. Akhtar, M.S. et al., 2000. Anthelmintic activity of medicinal plants with particular reference to their use in animals in the Indo–Pakistan subcontinent, Small Ruminant Research, 38, 99–107
3. Al-Shaibani, I. et al., 2008. Epidemiology of ovine gastrointestinal nematodes in Hyderabad district, Pakistan, Pakistan Veterinary Journal, 28,
4. Asif, M. et al., 2008. Prevalence of gastrointestinal parasites of sheep and goats in and around Rawalpindi and Islamabad, Pakistan, J. Vet. Anim. Sci, 1, 14–17
5. Atoui, A.K. et al., 2005. Tea and herbal infusions: their antioxidant activity and phenolic profile, Food chemistry, 89, 27–36
6. Baihaqi, Z.A., Widiyono, I., and Nurcahyo, W., 2019. Prevalence of gastrointestinal worms in Wonosobo and thin-tailed sheep on the slope of Mount Sumbing, Central Java, Indonesia, Veterinary world, 12, 1866
7. Besier, R. et al., 2016. Diagnosis, treatment and management of Haemonchus contortus in small ruminants, Advances in parasitology, 93, 181–238
8. Bhatnager, R., Rani, R., and Dang, A.S., 2015. Antibacterial activity of Ferula asafoetida: a comparison of red and white type, J Appl Biol Biotechnol, 3, 18–21
9. Burke, J., Miller, J., and Brauer, D., 2005. The effectiveness of copper oxide wire particles as an anthelmintic in pregnant ewes and safety to offspring, Veterinary parasitology, 131, 291–297
10. Canga, A.G. et al., 2009. The pharmacokinetics and metabolism of ivermectin in domestic animal species, The Veterinary Journal, 179, 25–37
11. Chandrawathani, P. et al., 2013. Severe anthelmintic resistance in two free grazing small holder goat farms in Malaysia, J Veterinar Sci Technol, 4, 2
12. Chartier, C. et al., 2001. Prevalence of anthelmintic resistance in gastrointestinal nematodes of dairy goats under extensive management conditions in southwestern France, Journal of helminthology, 75, 325–330
13. Coles, G. et al., 2006. The detection of anthelmintic resistance in nematodes of veterinary importance, Veterinary parasitology, 136, 167–185
14. Coles, G., and Roush, R., 1992. Slowing the spread of anthelmintic resistant nematodes of sheep and goats in the United Kingdom, The Veterinary Record, 130, 505–510
15. Das, G. et al., 2015. Levamisole and fenbendazole resistance among gastrointestinal nematodes in goats at Jabalpur, Madhya Pradesh, Journal of Veterinary Parasitology, 29, 98–102
16. de Souza Chagas, A.C., and da Silva Vieira, L., 2007. Azadirachta indica (Neem) action in goats gastrintestinal nematodes, Brazilian Journal of Veterinary Research and Animal Science,

17. Dey, A.R. et al., 2019. Genetic diversity patterns of Haemonchus contortus isolated from sheep and goats in Bangladesh, Infection, Genetics and Evolution, 68, 177–184
18. Dixit, A. et al., 2019. Efficacy of herbal extracts and closantel against fenbendazole-resistant Haemonchus contortus, Journal of helminthology, 93, 529–532
19. Dongre, S. et al., 2015. Anthelmintic effeicacy of Azadirachta indica (neem) against strongyles in goats, The Indian Journal of Veterinary Sciences and Biotechnology, 10, 18–21
20. dos Santos, J.M.L. et al., 2017. High levels of benzimidazole resistance and β-tubulin isotype 1 SNP F167Y in Haemonchus contortus populations from Ceará State, Brazil, Small Ruminant Research, 146, 48–52
21. Dutta, B. et al., 2017. Occurrence and pathology of Haemonchus contortus infection in Goats, Journal of Entomology and Zoology Studies, 5, 1284–1287
22. Fleming, S.A. et al., 2006. Anthelmintic resistance of gastrointestinal parasites in small ruminants, Journal of veterinary internal medicine, 20, 435–444
23. Gonzalez, A.E. et al., 2019. Oxfendazole: a promising agent for the treatment and control of helminth infections in humans, Expert review of anti-infective therapy, 17, 51–56
24. Hamad, K.K., 2014. Combined strategies to control antinematicidal-resistant gastrointestinal nematodes in small ruminants on organized farms in Pakistan, Pakistan Journal of Agricultural Sciences, 51,
25. Iqbal, N. et al., 2017. Prevalence of gastrointestinal parasites in Faisalabad and comparative efficacy of Ivermectin and Albendazole, Pure and Applied Biology (PAB), 6, 499–504
26. Islam, S. et al., 2018. Status of anthelmintic resistance of gastrointestinal nematodes in organized sheep and goat farms, Asian Journal of Medical and Biological Research, 4, 378–382
27. Kadam, Y. et al., 2009. Efficacy of oral ivermectin and closantel against haemonchosis in sheep, Indian Veterinary Journal, 86, 633–634
28. Kaplan, R.M., and Vidyashankar, A.N., 2012. An inconvenient truth: global worming and anthelmintic resistance, Veterinary parasitology, 186, 70–78
29. Kenyon, F., and Jackson, F., 2012. Targeted flock/herd and individual ruminant treatment approaches, Veterinary parasitology, 186, 10–17
30. Kotze, A., and Prichard, R., 2016. Anthelmintic resistance in Haemonchus contortus: history, mechanisms and diagnosis, Advances in parasitology, 93, 397–428
31. Kumar Jaiswal, A. et al., 2013. Emergence of ivermectin resistance in gastrointestinal nematodes of goats in a semi-organized farm of Mathura district-India, Veterinarski arhiv, 83, 275–280
32. Lanusse, C.E., Virkel, G.L., and Alvarez, L.I., 2009. Anticestodal and antitrematodal drugs,
33. Maharshi, A. et al., 2011. Correlation between status of benzimidazole resistance in Haemonchus contortus on bio and molecular assays, Indian Journal of Animal Sciences, 81, 110
34. Nabukenya, I. et al., 2014. Anthelmintic resistance in gastrointestinal nematodes in goats and evaluation of FAMACHA diagnostic marker in Uganda, Veterinary parasitology, 205, 666–675

35. Premaalatha, B. et al., 2014. Anthelmintic resistance in small ruminant farms: an ongoing challenge for perak farmers to control helminths, ETERINARY RESEARCH, 320
36. Puspitasari, S., Farajallah, A., and Erni Sulistiawati, M., 2016. Effectiveness of ivermectin and albendazole against Haemonchus contortus in sheep in West Java, Indonesia, Tropical life sciences research, 27, 135
37. Qasim, H.M. et al., 2016. Dynamic dispersal of haemonchosis, its treatment and effect on blood profile of small ruminants of Lodhran district, Punjab, Pakistan, Pakistan Journal of Zoology, 48, 755–761
38. Rizwan, H. et al., 2017. Point prevalence of gastrointestinal parasites of domestic sheep (Ovis aries) in district Sialkot, Punjab, Pakistan, Journal of Animal and Plant Sciences, 27, 803–808
39. Şahin, F. et al., 2003. Evaluation of antimicrobial activities of Satureja hortensis L, Journal of ethnopharmacology, 87, 61–65
40. Shah, M.K. et al., 2017. Isolation rate and antimicrobial susceptibility profiles of Mycoplasma mycoides subspecies capri field isolates from sheep and goats in Pakistan, Small Ruminant Research, 153, 118–122
41. Shahana, R., 2013. Prevalence and theraupatic studies in GI helminth parasites of sheep in Budgam District of Kashmir Valley, MVSc thesis submitted to the Sheri-Kashmir University of Agricultural Sciences and Technology, Shalimar,
42. Shahardar, R. et al., 2014. Anthelmintic resistance in GI nematodes of sheep at farms of Kashmir Valley, Journal of Veterinary Parasitology, 28, 151–153
43. Shalaby, H.A., 2013. Anthelmintics resistance; how to overcome it?, Iranian journal of parasitology, 8, 18
44. Singh, G. et al., 2016. Anthelmintic efficacy of aqueous extract of Zanthoxylum armatum DC. seeds against Haemonchus contortus of small ruminants, Journal of parasitic diseases, 40, 528–532
45. Sissay, M. et al., 2006. Assessment of anthelmintic resistance in nematode parasites of sheep and goats owned by smallholder farmers in eastern Ethiopia, Tropical Animal Health and Production, 38, 215–222
46. Tavassoli, M. et al., 2018. The in vitro effect of Ferula asafoetida and Allium sativum extracts on Strongylus spp, Annals of parasitology, 64,
47. Tiwary, M. et al., 2007. Chemical composition and larvicidal activities of the essential oil of Zanthoxylum armatum DC (Rutaceae) against three mosquito vectors, Journal of vector borne diseases, 44, 198
48. Tramboo, S. et al., 2017. Efficacy of ivermectin, closantel and fenbendazole against gastrointestinal nematodes of sheep in Kashmir valley, Journal of parasitic diseases, 41, 380–382
49. Uppal, R., Yadav, C., and Bhushan, C., 1993. Efficacy of closantel against fenbendazole and levamisole resistant Haemonchus contortus in small ruminants, Tropical Animal Health and Production, 25, 30–32

50. Van den Brom, R. et al., 2015. Haemonchus contortus resistance to monepantel in sheep, Veterinary parasitology, 209, 278–280
51. Wang, C. et al., 2017. Recent research progress in China on Haemonchus contortus, Frontiers in Microbiology, 8, 1509
52. Waruiru, R., Mutunu, M., and Otieno, R., 2004. Efficacy of copper needles for the control of gastrointestinal nematodes in goats,
53. Westers, T. et al., 2016. Efficacy of closantel against ivermectin-and fenbendazole-resistant Haemonchus sp. in sheep in Ontario, Canada, Veterinary parasitology, 228, 30–41

Figures

Figure 1

Haemonchus contortus egg under microscope

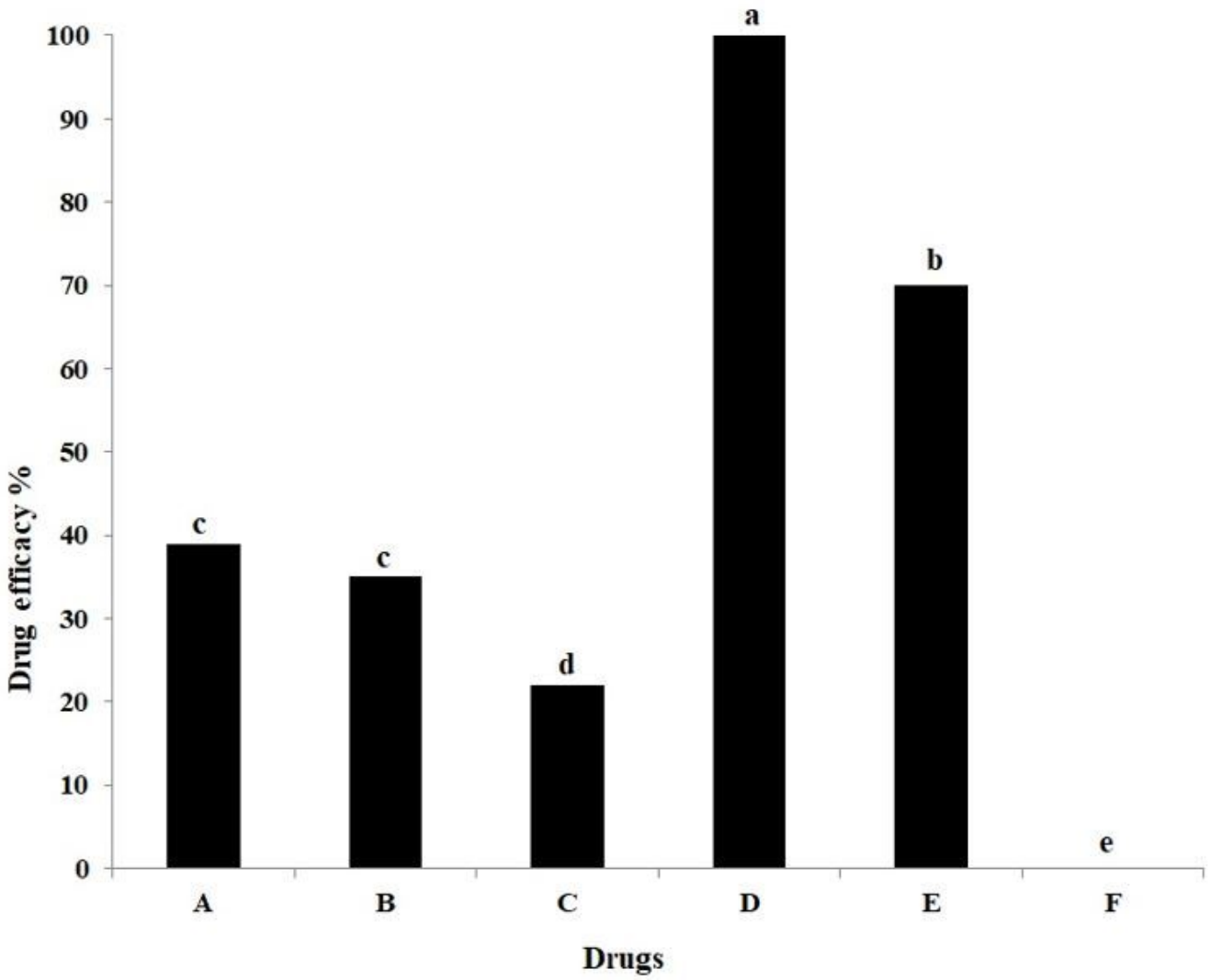

Figure 2

Comparative efficacy of anthelmintics in caprine, Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, Ferula asafetida and control groups. Different superscripts show the level of significance between treatment groups.

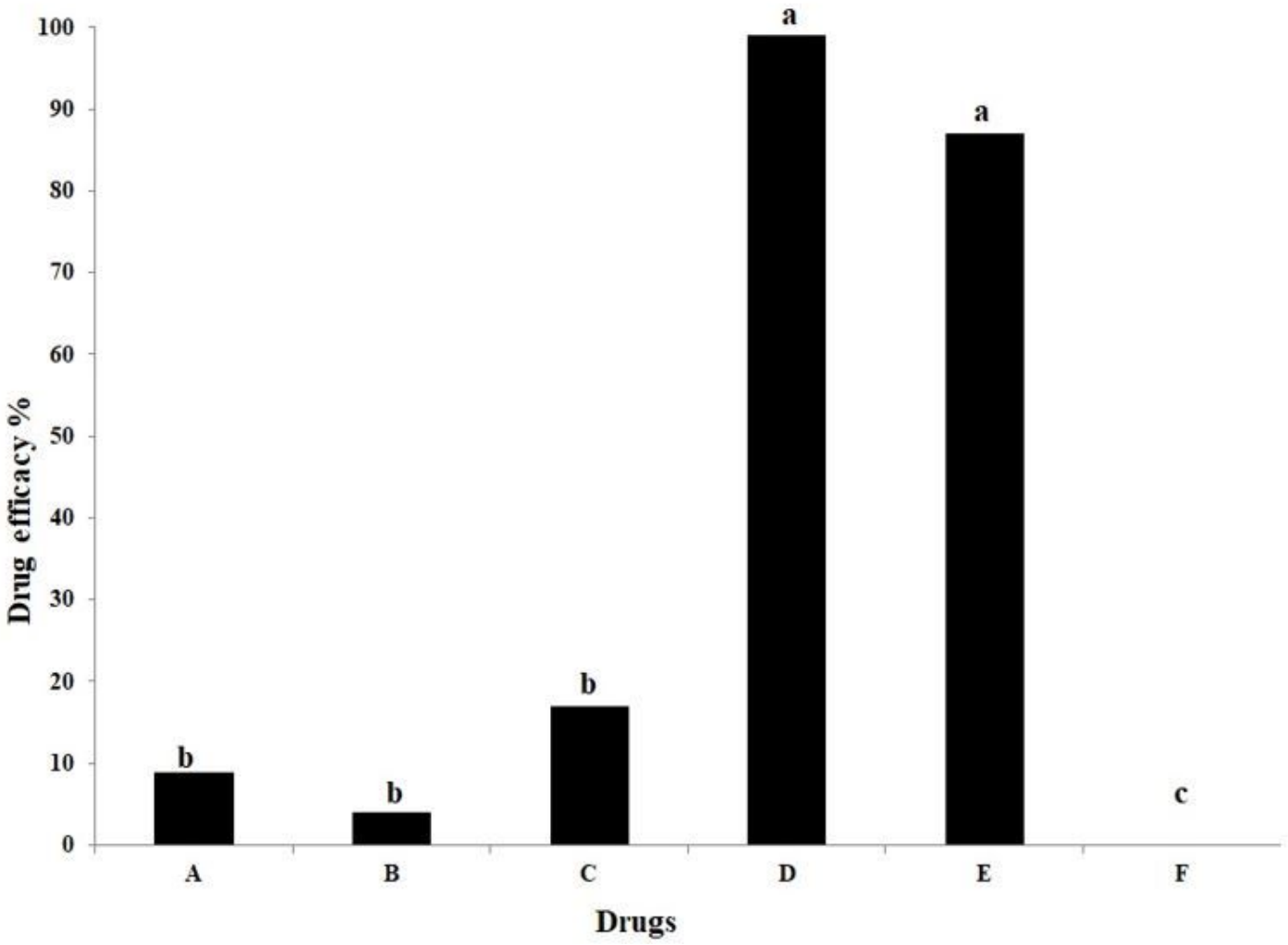

Figure 3

Comparative efficacy of anthelmintics in ovine, Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, Ferula asafetida and control groups. Different superscripts show the level of significance between treatment groups.

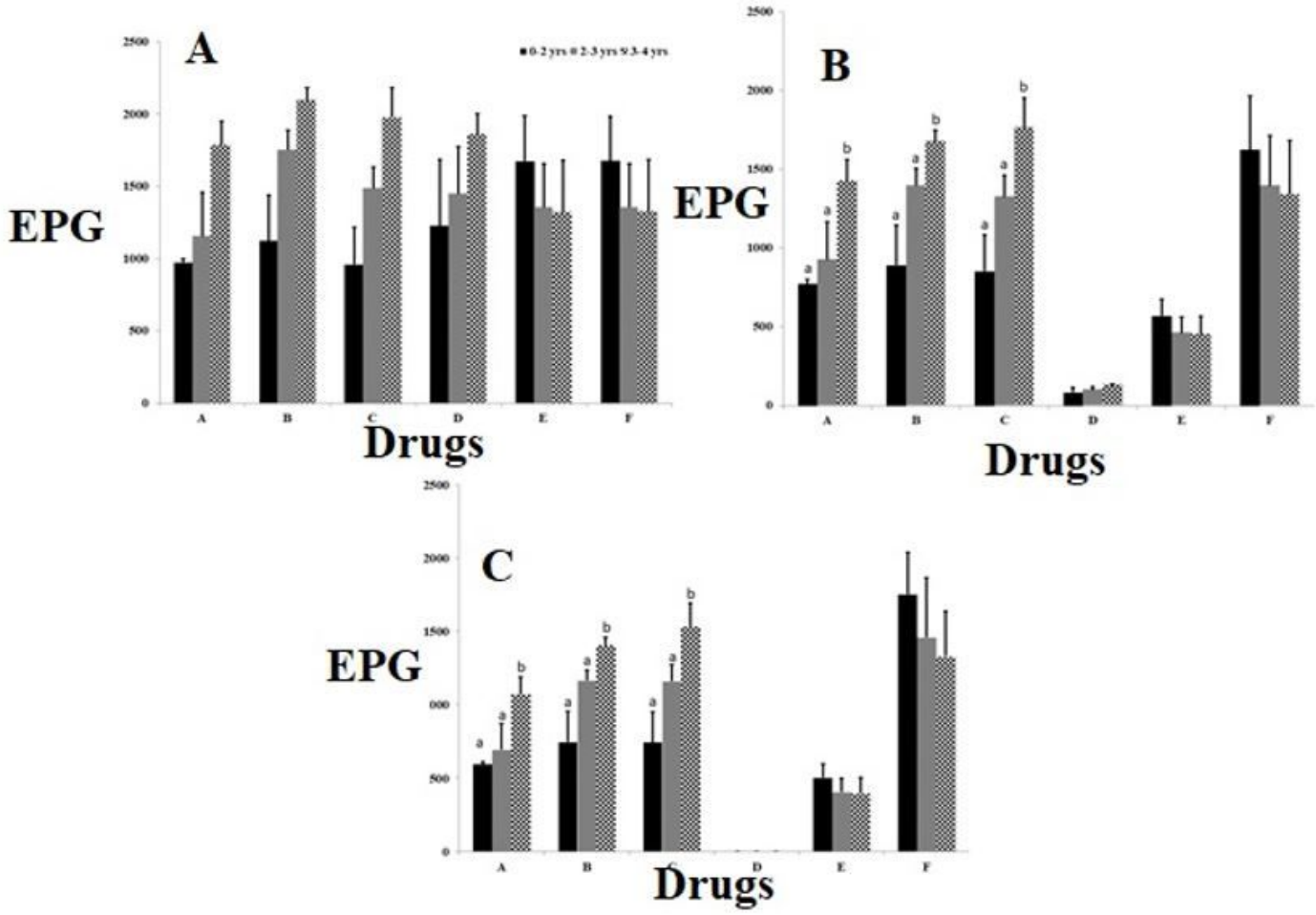

Figure 4

Comparative reduction of EPG on the basis of age wise on various days in Caprine. (A) Represented day 0 of treatment, (B) show day 7 after treatment and (C) show day 14 of treatment. Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, Ferula asafetida and control groups. Different superscripts show the level of significance in reduction of EPG within treatment group in different age wise animals.

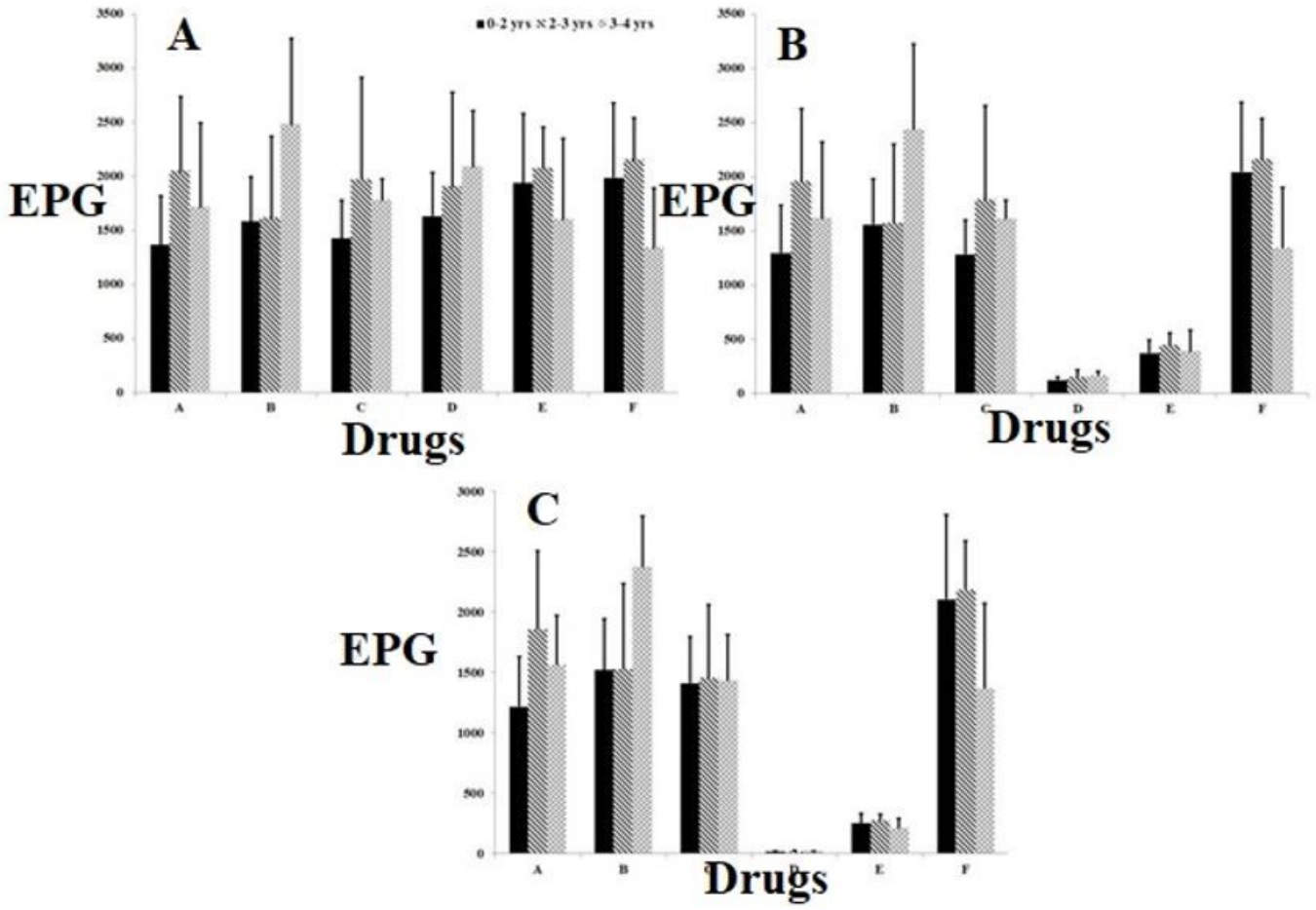

Figure 5

comparative reduction of EPG on the basis of age wise on various days in ovine. (A) Represented day 0 of treatment, (B) show day 7 after treatment and (C) show day 14 of treatment. Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, Ferula asafetida and control groups.

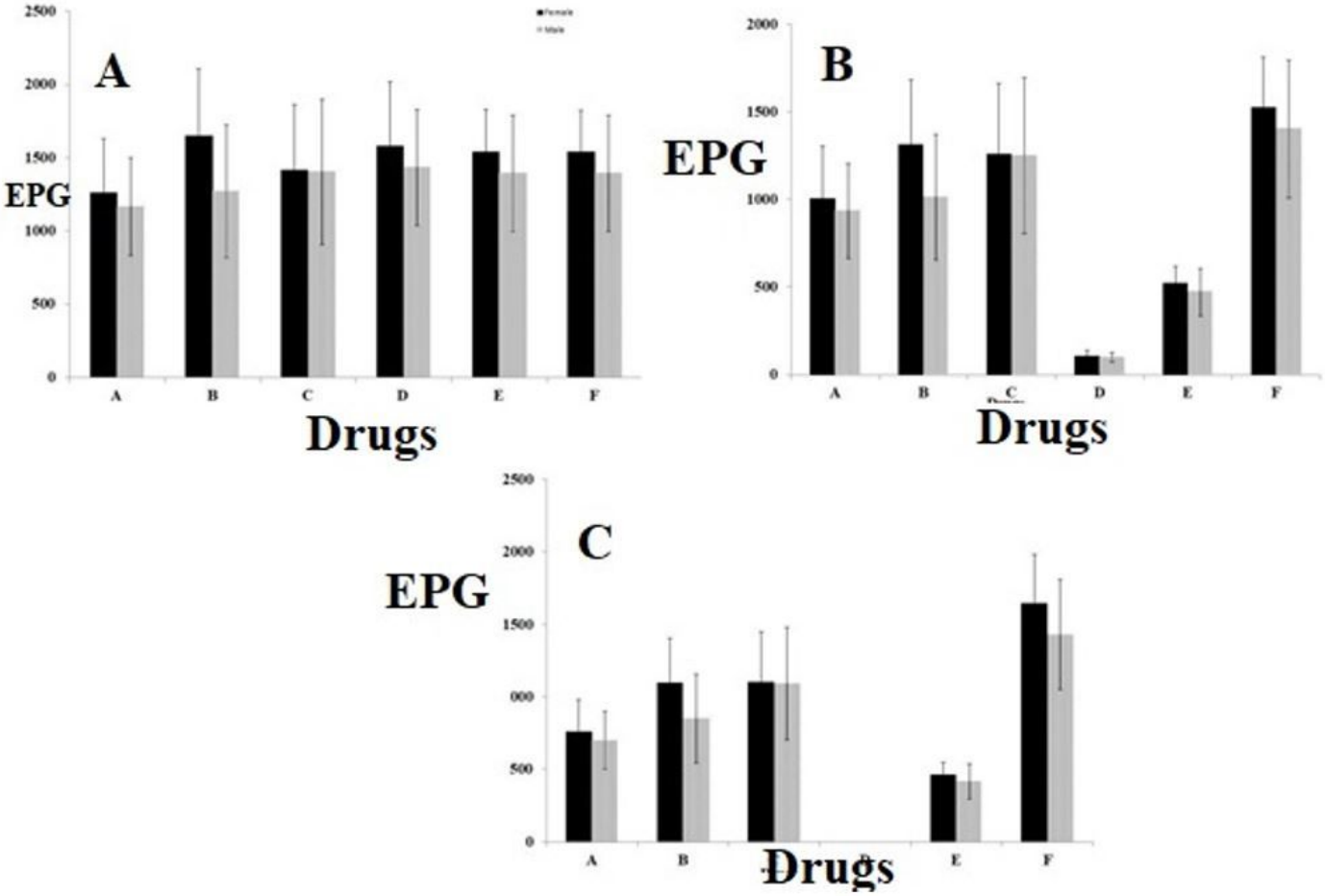

Figure 6

Comparative reduction of EPG on the basis of gender wise on various days in Caprine. (A) Represented day 0 of treatment, (B) show day 7 after treatment and (C) show day 14 of treatment. Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, Ferula asafetida and control groups.

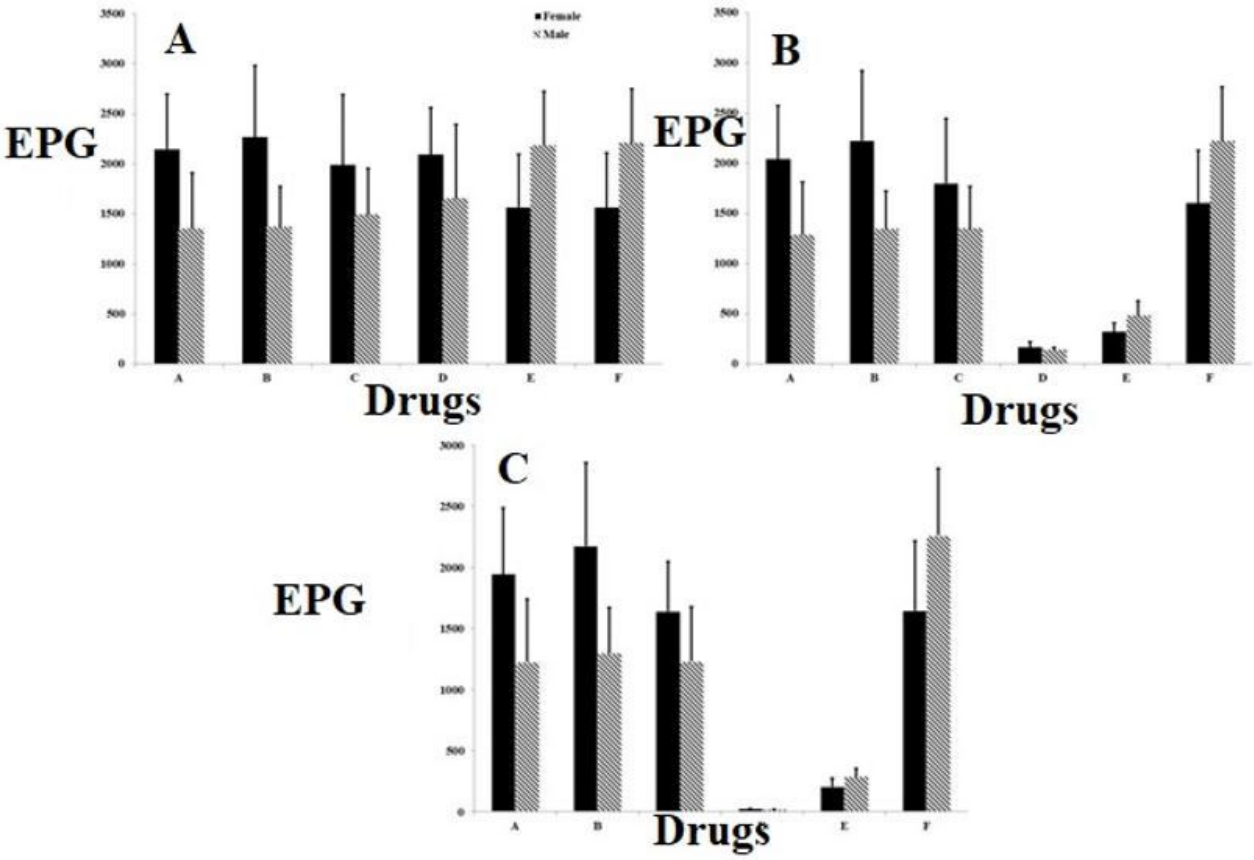

Figure 7

Comparative reduction of EPG on the basis of gender wise on various days in ovine. (A) Represented day 0 of treatment, (B) show day 7 after treatment and (C) show day 14 of treatment. Group A to F show Albendazole, Oxfendazole, Ivermectin, Closantel, Ferula asafetida and control groups.