Turkish Journal of Veterinary & Animal Sciences

Volume 29 | Number 5 Article 18

1-1-2005

An Abattoir Survey of Gastro-Intestinal Nematodes in Sheep in the Burdur Region, Turkey

ŞİNASİ UMUR

BAYRAM ALİ YUKARI

Turk J Vet Anim Sci
29 (2005) 1195-1201

Research Article

An Abattoir Survey of Gastro-Intestinal Nematodes in Sheep in the Burdur Region, Turkey

Şinasi UMUR
Department of Parasitology, Faculty of Veterinary Medicine, 19 Mayıs University, 55139 Kurupelit, Samsun - TURKEY
E-mail: sumur@omu.edu.tr

Bayram Ali YUKARI
Department of Parasitology, Faculty of Veterinary Medicine, Akdeniz University, Burdur - TURKEY
E-mail: byukari@akdeniz.edu.tr

Received: 10.11.2004

Abstract: The gastro-intestinal (GI) organs of 50 sheep randomly selected from local abattoirs in the Burdur region were investigated between September 2000 and August 2001 for the prevalence of GI nematodes and their larval forms and the seasonal fluctuations of these parasites. All the animals examined were infected (100%) with GI nematodes.

Twenty-two nematode species were identified and 38,639 nematodes were collected from the infected sheep. The number of parasites per sheep ranged from 11 to 5052 (mean 772.78), while the number of nematode species per animal ranged from 1 to 12 (mean 5.98).

The most frequently detected nematodes in the sheep were *Ostertagia circumcincta* (80%), *Trichuris skrjabini* (74%), *T. ovis* (72%), *Marshallagia marshalli* (64%), *Nematodirus spathiger* (44%), *Trichostrongylus vitrinus* (42%), *N. abnormalis* (40%) and *Trichuris discolor* (40%).

The parasite counts in the sheep increased slightly in spring and summer, and then reached maximum levels in autumn. Species of Ostertagia, Marshallagia, Trichostrongylus, Nematodirus and Trichuris were observed in all seasons of the year, with minimum levels in winter. The numbers of Ostertagia spp. and Trichostrongylus spp. peaked in spring, and *M. marshalli* and Nematodirus spp. counts moved in parallel, increasing in October and July. The infection level of the Trichuris spp. was not uniform throughout the season, but increased slightly in May, July, September and January and remained at minimum levels in the other months of the year.

Key Words: Sheep, GI nematodes, prevalence, season, Burdur.

Burdur Yöresi Koyunlarında Sindirim Sistemi Nematodlarıyla İlgili Bir Mezbaha Çalışması

Özet: Burdur yöresi koyunlarında mide-bağırsak nematodları ve mevsimsel aktivitelerini belirlemek amacıyla Eylül 2000- Ağustos 2001 tarihleri arasında, her hafta lokal mezbahaya gidilerek rasgele seçilen bir koyuna ait mide-bağırsak sistemi alınmış ve laboratuara getirilmiştir. Bu şekilde 1 yılda 50 koyuna ait mide-bağırsak sistemi tekniğine uygun olarak GI nematodlar ve gelişim şekilleri yönünden incelenmiştir. İncelenen koyunların tamamı (% 100) mide-bağırsak nematodlarıyla enfekte bulunmuş ve 22 nematod türü saptanmıştır. Enfekte koyunlardan 38.639 adet nematod toplanmıştır. Bir koyunda bulunan toplam parazit sayısı 11-5052 (ort. 772,78), bir hayvanda bulunan tür sayısı ise 1- 12 (ort. 5,98) arasında değişmiştir.

Koyunlarda en çok görülen türler *Ostertagia circumcincta* (%80), *Trichuris skrjabini* (% 74), *T. ovis* (% 72), *Marshallagia marshalli* (% 64), *Nematodirus spathiger* (% 44), *Trichostrongylus vitrinus* (% 42), *N. abnormalis* (% 40) ve *Trichuris discolor* (% 40) olarak saptanmıştır.

Koyunlarda toplam parazit yükü ilkbahar ve yaz ortasında hafif yükselmiş, sonbaharda en yüksek düzeye çıkmıştır. Ostertagia, Marshallagia, Trichostrongylus, Nematodirus ve Trichuris türlerine yılın tüm mevsimlerinde rastlanmış, ancak bütün türler kışın hafif yükselmelerle birlikte düşük düzeyde seyretmiş, Ostertagia ve Trichostrongylus türleri ilkbaharda, *M. marshalli* ve Nematodirus türleri yaz başı ve sonbaharın başında en üst düzeye çıkmıştır.

Anahtar Sözcükler: Koyun, mide-bağırsak nematodları, prevalens, mevsim, Burdur

Introduction

Sheep breeding is an important feature of the regional economy in Burdur (1). However, small-scale farming fails to reach its full economic potential because diseases often prevent optimum productivity, especially under the traditional management system in sheep production (2).

Parasitic infections, especially GI nematodosis in animals, are a cause of considerable economic loss in Turkey (3-6) and the rest of the world (7-9). Sub-clinical and clinical GI nematodosis in sheep induces body weight loss and a persistent decrease in milk yield and wool growth (3,4,7-9).

Turkey has a sub-tropical climate and therefore GI nematodes are prevalent in sheep (4). Although there are a large number of reports concerning the prevalence, epidemiology and/or economic importance of GI nematodosis in Turkey (3,5,6,10-15), there has been no study in the Burdur region.

The prevalence, seasonal activity, epidemiology, and pathogenicity of GI nematodes vary with animal species, breed and age, with nematode species and with geographical region (16-23). In general, the mean worm burdens increase with favourable climatic conditions (4,7,9,14-19,23). Thus, prevention methods differ in relation to climatic factors (4,7,9,15).

The aim of this study was to determine the species, prevalence and seasonal changes in the worm burden GI nematodes in sheep slaughtered in the Burdur region, during a 12-month period.

Materials and Methods

This study was conducted between September 2000 and August 2001. One gastrointestinal tract per week during the study period was randomly selected from a sheep slaughtered at a local abattoir (Burdur or Bucak Municipality) and brought to our laboratory. The abomasa, and small and large intestine lumens were ligatured to prevent environmental contamination.

In the laboratory, the GI tracts were separated anatomically; then each organ was opened separately and its contents and mucosa were washed in water to remove all parasites. The contents of the abomasum and small intestine were washed through a 90–mesh sieve and those of the large intestine through a 250-mesh sieve for the collection of mature and immature parasites. The abomasa and small intestines were opened with scissors, examined by the naked eye for parasitic nodules, put into a digestion solution (Pepsin 5 g, HCl 7 ml, distilled water 1000 ml) and incubated at 37 °C for 2 h. The fluids were washed by the method mentioned above (15).

The contents of the abomasum and small intestine were diluted and examined under a stereomicroscope to permit the collection of 100 nematodes from each organ. The total content of the large intestine was examined in large (13 cm) petri dishes by the naked eye under a light and then the large intestine was examined under a stereomicroscope for larval nematodes (15).

Every nematode recovered from the contents was cleaned with physiologic saline and fixed in hot 70% alcohol. The nematodes were then cleared in lactophenol, identified under the microscope with reference to the literature (4,7,11,24-27) and then kept in nematode storing solution (15).

Weather data for the Burdur region, including total rainfall, mean monthly temperatures and average relative humidity, were obtained from the Government Meteorological Department in Ankara.

Results

All the animals examined (100%) were found to be infected with GI nematodes and 22 nematode species were identified. The prevalence, organs affected, mean worm burdens, total parasite counts and the ranges within which parasite numbers fell are given in the Table.

A total of 38,639 nematodes were collected from the infected sheep. The mean counts of the commonest parasites among the 50 sheep examined were: *Marshallagia marshalli* 282.0, *Nematodirus abnormalis* 270.4, *Ostertagia circumcincta* 254.0, *Trichostrongylus vitrinus* 212.4, *N. spathiger* 167.5 and *N. lanceolatus* 158.5. The mean count for other species was less than 100 for each case. The number of large intestine parasites ranged from 2.27 to 22.9.

The number of nematodes species per animal ranged from 1 to 12. Most of the infected sheep had 4 nematode species (20%), while the mean number of species was 5.98. The total number of parasites per sheep ranged from 11 to 5052, average 772.78.

No nematode larvae were found in digested material collected from the abomasa and small intestines.

Table. Species, prevalence and range of worm burden of GI nematodes found in infected sheep.

Species	GI parts	Prevalence	Mean worm burden	(Range)	Total worms
Marshallagia marshalli	Ab + SI	64	282.0	22 - 1995	9023
Ostertagia circumcincta	Ab + SI	80	254.0	14 - 1556	10,158
O. occidentalis	Ab	38	44.5	12 - 114	846
O. trifurcata	Ab	22	47.7	12 - 188	525
Ostertagia sp.	Ab	4	4.5	4 - 5	9
O. ostertagi	Ab	2	23.0	23 - 23	23
Telodorsagia davtiani	Ab	6	27.7	6 - 68	83
Haemonchus contortus	Ab	10	50.4	5 - 132	252
Trichostrongylus vitrinus	Ab + SI	42	212.4	15 - 1307	4460
T. colubriformis	Ab + SI	6	35.3	8 - 64	106
T. axei	Ab	4	40.5	36 - 45	81
Nematodirus spathiger	SI	44	167.5	13 - 664	3686
N. abnormalis	SI	40	270.4	16 - 1380	5409
N. lanceolatus	SI	30	158.5	7 - 1124	2377
Cooperia punctata	SI	2	32.0	32 - 32	32
Bun. *trigonocephalum*	SI	2	64.0	64 - 64	64
Trichuris skrjabini	LI	74	22.9	3 - 97	848
T. ovis	LI	72	13.9	2 - 55	499
T. discolor	LI	36	2.7	1 - 9	49
T. globulosa	LI	22	3.2	1 - 10	35
Chabertia ovina	LI	12	6.0	2 - 13	36
Oe. venulosum	LI	10	7.6	3 - 19	38

Ab: Abomasus, SI: Small Intestine, LI: Large Intestine

The meteorological characteristics of the Burdur region reflect its proximity to the Aegean, Anatolian and Mediterranean regions. Moreover, it is a region of many lakes. While rainfall in the period of this study was irregular, relative humidity was over 50% (except in July). The climatic features of the region are conducive to the development of GI nematodes (Figure 1).

Monthly fluctuations in the total numbers of GI nematodes are shown in Figure 2. The total parasite counts in the sheep decreased in late autumn and winter,

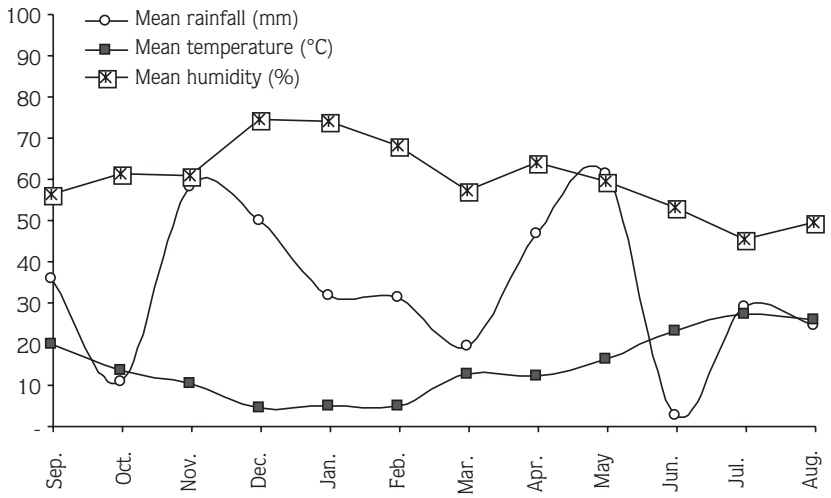

Figure 1. Climatic data of Burdur district (Turkey).

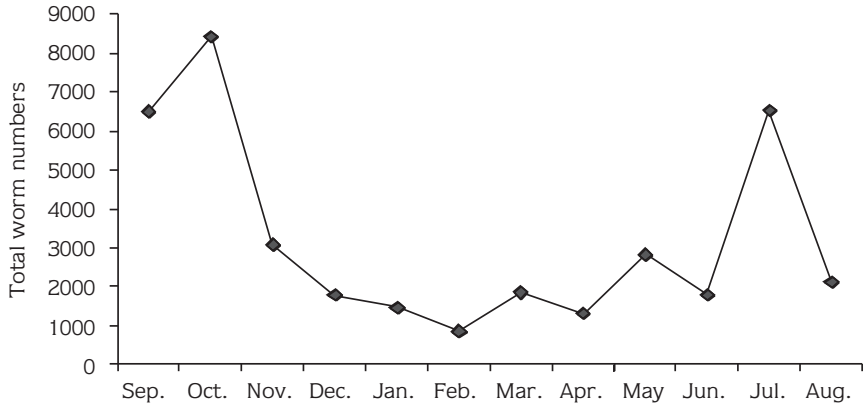

Figure 2. Monthly fluctations of worm burden of GI nematodes.

increased in early and late spring, and in July and September, and then decreased again in August and reached their maximum levels in October. The springtime increase in the total of worms tended to parallel the increase in rainfall, while the summertime (in July) decrease tended to parallel the decrease in rainfall.

Species of Ostertagia, Trichostrongylus, Nematodirus and *M. marshalli* were observed in all seasons of the year. Nematodirus spp. peaked in July and October, and a small rise was observed in March. Ostertagia spp. increased in May and July and peaked in September. *M. marshalli* increased in March and peaked in October. Trichostrongylus spp. increased slightly in January, May and July and peaked in October (Figure 3).

Trichuris spp. were observed in all seasons of the year. There was a slight increase in September, January, April and August, whereas there was a decrease and little change for the remainder of the year.

Discussion

There are many articles on the prevalence and seasonal activity of GI nematodes in Turkey (3,5,6,10-16) and in the rest of the world (17-23). For example, Le Riche et al. (21) examined 889 sheep and goats in Cyprus and reported the prevalence of various species of GI nematode as follows: 77% *O. circumcincta* and *O. trifurcata*, 67% *T. colubriformis* and *T. vitrinus*, 53% *T. axei*, 23% *H. contortus*, 55% *Trichuris ovis*, 38% *C. ovina*, 15% *N. filicollis* and *N. spathiger*, 12% *Oe. venulosum*, 6% *B. trigonocephalum* and 1.6% *P. skrjabini*. Another survey, in sheep and goats in Nigeria

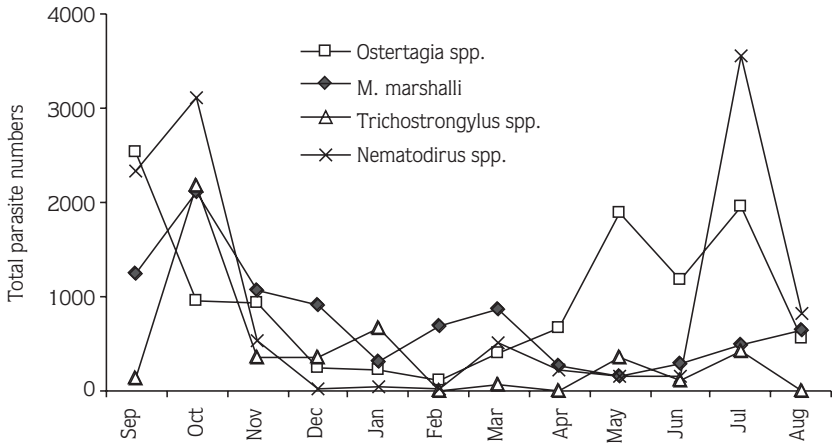

Figure 3. Monthly fluctuations of some abomasus and small intestine nematodes.

(18), recorded the prevalence of GI nematodes as 87% for *H. contortus*, 63.8% for Trichostrongylus spp., 22.4% for *Oe. columbianum*, 18.8% for Strongyloides spp., 17.2% for *Cooperia* spp., 6% for *Gaigeria pachyscelis*, 4.3% for *B. trigonocephalum*, 3.5% for *T. ovis* and 0.9% for Capillaria spp. Rehbein et al. (22) examined 59 slaughtered sheep in Germany and reported the prevalence of various species of GI nematodes as follows: *O. circumcincta* and *C. curticei* 100%, *O. trifurcata* and *C. ovina* 98.3%, *Oe. venulosum* 96.6%, *N. filicollis* 76.3%, *O. pinnata* 78% and *Trichuris ovis* and *Trichostrongylus colubriformis* 76.3% each.

In this study, all randomly selected sheep were infected (100%) with GI nematodes. The prevalence of common species identified was as follows: *M. marshalli* 64%, *O. circumcincta* 80%, *O. occidentalis* 38%, *O. trifurcata* 22%, *H. contortus* 10%, *Trichostrongylus vitrinus* 42%, *Nematodirus spathiger* 44%, *N. abnormalis* 40%, *N. lanceolatus* 30%, *Trichuris skrjabini* 74%, *T. ovis* 72%, *T. discolor* 36%, *T. globulosa* 22%, *C. ovina* 12% and *Oe. venulosum* 10%. Although these results share some similarities with those of other studies (5,6,13-15), there were some clear individual variations, especially in *H. contortus* (12,18,19) and these may be explained by the fact that the incidence of nematode parasites in an area is directly related to environmental conditions and to the species of animal affected (4,7,16,19).

M. marshalli was one of the dominant species (64%) in this study. This species has been reported as a predominant species in sheep in Turkey (13-15) and in some other countries (4). This species is evaluated in the genus Ostertagia in some classical books (4,7) and by some researchers (14); the genus Teladorsagia is likewise evaluated in the genus Ostertagia. For this reason, these genera are not seen in some studies. In the latest taxonomic reviews (26,27), some Ostertagia species (*O. circumcincta*, *O. trifurcata* and *O. occidentalis*) have been transferred to the genus Teladorsagia. However, since there is no agreement upon this transfer in Turkey, the classical taxonomy was preferred in this study.

The commonest species of Ostertagia in small ruminants in Turkey (12-15) and other countries (22,23) are *O. circumcincta* and *O. trifurcata*. The commonest species in this study was *O. circumcincta* (80%). Other common species of Ostertagia recorded were *O. occidentalis* (38%) and *O. trifurcata* (22%).

Trichostrongylus species are one of the major agents of GI nematodosis in sheep (18-23). In our study, they were also found to be a common species in the sheep. However, the dominant Trichostrongylus species in sheep is found to vary according to the literature. For example, De Chaneet and Dunsmore (17) observed that the commonest Trichostrongylus species in Western Australian sheep was *T. vitrinus* (39%). In contrast, Rehbein et al. (22) recorded that the most common species in sheep in Germany was *T. colubriformis* 76.3%. Again, in contrast to these articles, Öncel (12) reported that the predominant Trichostrongylus species was *T. axei* 46%. In the present study, the prevalence of Trichostrongylus species was recorded as *T. vitrinus* 42%, *T. colubriformis* 6% and *T. axei* 4%.

N. abnormalis, *N. spathiger*, *N. filicollis* and *N. lanceolatus* are causes of GI nematodosis and their prevalence is, except for *N. lanceolatus*, high in young small ruminants in Turkey (12,15). However, the identification of *N. filicollis* and *N. lanceolatus* is subject to error because of morphological similarities (15). For this reason, the prevalence of *N. lanceolatus* may be presented as lower than its true rate. The prevalence of Nematodirus species was recorded as *N. spathiger* 44%, *N. abnormalis* 40%, and *N. lanceolatus* 30% in this study.

Trichuris species have been observed frequently in Turkey in domestic ruminants (4-6,10-15). The commonest Trichuris species is *T. ovis* and the other species are *T. skrjabini, T. globulosa* and *T. discolor* (12,14). The results of studies undertaken in other countries (21,22) are similar to those for Turkey. In this study, prevalence rates were 74% for *T. skrjabini,* 72% for *T. ovis*, 36% for *T. discolor* and 22% for *T. globulosa*.

Oesophagostomum species occur in the large intestines of domestic ruminants (4,7,18). One of them, *Oe. venulosum*, occurs especially in small ruminants, while *Oe. columbianum* occurs in large ruminants (4,7,12,14,15). The prevalence of *Oe. venulosum* is 10%, but there was no *Oe. columbianum* in this study.

Bunostomum trigonocephalum is one of the most pathogenic nematode species in animals (4,7,12,18), but the prevalence and numbers of this nematode were very low (2%) in this study.

Umur (15) recorded that the mean counts of some GI nematodes in sheep in Kars were 1337.9 for *M. marshalli*, 1390.3 for *O. circumcincta*, 122.7 for *H.*

contortus, 445.9 for *T. axei*, 1406.1 for *T. colubriformis*, 1358.5 for *N. spathiger*, 65.0 for *C. oncophora*, 3.5 for *Oe. venulosum* and 13.0 for *Trichuris globulosa*. Vural et al. (6) reported the number of parasites per sheep in Bursa as ranging from 11 to 31,153. In this study, the mean numbers of some nematodes were 282.0 for *M. marshalli*, 270.4 for *N. abnormalis*, 254.0 for *O. circumcincta*, 212.4 for *T. vitrinus*, 167.5 for *N. spathiger* and 158.5 for *N. lanceolatus*.

The seasonal activity of the parasites differs according to the animal species and ages, parasite species and geographic localities (4,7,9,14-17). According to Le Riche et al. (21), *H. contortus*, *Oe. venulosum* and *C. ovina* increased in spring and autumn, Ostertagia spp. increased in autumn and Trichostrongylus spp. increased in spring in sheep and goats in Cyprus. De Chaneet and Dunsmore (17) reported that the prevalence of *T. vitrinus* was negatively correlated with the mean autumn, winter and spring temperatures of a locality, whereas the prevalence of *T. colubriformis* was positively correlated with mean autumn, winter and spring temperatures. Like this report, Güralp et al. (14) reported that there is no parallelism of the seasonal activities of the GI nematodes in the same region according to different towns.

The present study revealed that the worm burdens increased in mid and late spring, peaked in mid autumn, declined towards winter, and increased again in midsummer. The midsummer increase was very evident and was almost in parallel with the rainfall. The first little and second waves of infection, which occurred in March and May respectively, were derived almost exclusively from Ostertagia spp. and Nematodirus spp. overwintering larvae coming from eggs deposited the previous autumn. The third wave of infection, which occurred in July, was apparently derived from eggs deposited by the animals in the spring. This wave originated from 3 genera of nematodes, Ostertagia, Nematodirus and Trichuris. The late high wave of infection, occurring in October, may have derived from eggs deposited by young and mature sheep grazing on pasture in summer. The species responsible for this wave were from all GI genera, except Ostertagia.

The Burdur region lies at the crossroads of the Mediterranean, Anatolian and Aegean regions. The relatively high rainfall, humidity and temperature may enable the larval forms to live on the pastures (4,7,16,17).

In conclusion, we found that the sheep population in Burdur was rich in nematode species and that the sheep were infected by the nematodes during all seasons of a year. The common parasites were Ostertagia, Trichostrongylus, Nematodirus and Trichuris species and *M. marshalli* and we found that the severity of the infections was low or moderate. Worm burdens increased in spring and summer and peaked in mid autumn.

To decrease the harmful effects of the parasites, young and adult stock should be pastured separately and deworming with appropriate anthelmintics should be carried out at 3-4-week intervals in spring, summer and autumn. New parasite control strategies should be developed that combine grazing management techniques with the use of bioactive forages and biological control of parasites.

Acknowledgement

This work was supported by the Scientific and Technical Research Council of Turkey, Project No.VHAG-1600.

References

1. Devlet Istatistik Enstitüsü, 2001. (http//www.die.gov.tr. erişim 20.12.2001).
2. Doğanay, A.: Paraziter hastalıklardan ileri gelen kayıplarımız. Vet. Hek. Dern. Derg., 1993; 64: 52-59.
3. Umur, Ş., Arslan, M.Ö.: Doramectin'in doğal enfekte kuzularda mide-bağırsak nematodları ve canlı ağırlık artışına etkisi. T. Parazitol. Derg., 2000; 24: 67-72.
4. Güralp, N.: Helmintoloji. İkinci Baskı. Ankara Üniv. Basımevi, Ankara. 1981; 261-538.
5. Celep, A.: Samsun yöresinde kuzu ve toklularda paraziter fauna tespiti ile kontrol ve tedavi gruplarında aylık ortalama ağırlık artışlarının belirlenmesine dair araştırmalar. Vet. Hek. Dern. Derg., 1987; 57: 69-79.

6. Vural, A., Doğru, C., Onar, E., Özkoç, Ü.: Bursa bölgesi kuzularında paraziter fauna tespiti ve parazitlerin et verimine olan etkileri. Pendik Vet. Mikrobiyol. Enst. Derg., 1980; 12: 36-53.

7. Soulsby, E.J.L.: Helminths, Arthropods and Protozoa of Domesticated Animals. 7th. Ed., Bailliere Tindall, London. 1986; 212-342.

8. Altaif, K.I.: Effect of anthelmintic treatment on the performance of Awassi sheep in Iraq. Trop. Anim. Health. Prod., 1979; 11: 241-245.

9. Thomas, R.J.: Modern strategies for the control of gastro-intestinal parasitism in sheep. Outl. Agric., 1982; 11: 73-78.

10. Vuruşaner, C. Tüzer, E.: Trakya'da kıvırcık koyunlarında abomasum ve ince bağırsak nematodları. T. Parazitol. Derg., 1996; 20: 443-455.

11. Oğuz, T.: Yurdumuz koyun ve sığırlarında tespit ettiğimiz Trichuris (Trichocephalus) türleri. Ankara Üniv. Vet. Fak. Derg., 1977; 23; 412-421.

12. Öncel, T.: Güney Marmara bölgesindeki koyunlarda helmint türlerinin yayılışı. T. Parazitol. Derg., 2000; 24: 414-419.

13. Güçlü, F., Dik, B., Kamburgil, K., Sevinç, F., Aytekin, H., Aydenizöz, M.: Konya yöresi koyunlarında mide-bağırsak nematodlarının yayılışı ve mevsimsel dağılımları. Veterinarium, 1996; 7: 50-55.

14. Güralp, N., Oğuz, T., Burgu, A., Doğanay, A., Bürger, H.J., Tınar, R.: Ankara yöresinde (Çubuk, Polatlı) koyunlardaki mide-bağırsak nematod larvalarının mevsimsel aktivitesi. Doğa, Turk. Vet. Hayv. Derg., 1986; 10: 259-274.

15. Umur, Ş.: Kars yöresi koyunlarının mide-bağırsak nematodları ve mevsimsel dağılımları. Turk. J. Vet. Anim. Sci., 1997; 21: 57-65.

16. Zeybek, H.: Parazitlerin mevsimsel etkinlikleri. Etlik Vet. Mikrobiyol. Derg., 1988; 6: 261-264.

17. De Chaneet, G.C., Dunsmore, J.D.: Climate and the distribution of intestinal Trichostrongylus spp. of sheep. Vet. Parasitol., 1988; 26: 273-283.

18. Fakae, B.B.: The epidemiology of helminthosis in small ruminants under the traditional husbandry system in eastern Nigeria. Vet. Res. Comm., 1990; 14: 381-391.

19. Gupta, R.P., Yadav, C.L., Chaudhri, S.S.: Epidemiology of gastrointestinal nematodes of sheep and goats in Haryana, India. Vet. Parasitol., 1987; 24: 117-127.

20. Bekele, T., Kasli, O.B., Woldemariam, W.: Endoparasite prevalences of the highland sheep in Ethiopia. Prevent. Vet. Med., 1989; 13: 93-102.

21. Le Riche, P.D., Efstathiou, G.C., Campell, J.B., Altan, Y.: A helminth survey of sheep and goats in Cyprus. Part I. The seasonal distribution and prevalence of gastro-intestinal parasites. J. Helminthol., 1973; 47: 237-250.

22. Rehbein, S., Visser, M., Winter, R.: Endoparasitic infections in sheep from the Swabian Alb. Dtsch. Tierarztl. Wochenschr., 1998; 105: 419-424.

23. Uriarte, J., Llorente, M.M., Valderrabano, J.: Seasonal changes of gastrointestinal nematode burden in sheep under an intensive grazing system. Vet. Parasitol., 2003; 118: 79-92.

24. Skrjabin, K.I., Shikhobalova, N.P., Shul'ts, R.S.: Essentials of Nematodology. Vol. III. Trichostrongylids of Animals and Man. Natn. Sci. Foundation, Washington D.C. Dep. Agric. USA. The Israel Program for Scientific Translation. 1960.

25. Lancester, M.B., Hong, C.: The identification of females within the subfamily Ostertaginae Lopez-Neyra 1947. Vet. Parasitol., 1990; 35: 21-27.

26. Lichtenfels, J.R., Hoberg, E.P.: The systematics of nematodes that cause ostertagiasis in domestic and wild ruminants in North America: an update and a key to species. Vet. Parasitol., 1993; 46: 33-53.

27. Durette-Desset, M.C.: Nomenclature proposée pour les especes décrites dans la sous-famille des Ostertaginae Lopez-Neyra, 1947. Ann. Parasitol. Hum. Comp., 1989; 64: 356-373.