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Research Article

Prevalence of gastrointestinal and haemoparasites in cattle herds in Burdur, Türkiye: A field-based survey using conventional diagnostic methods

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ABSTRACT

The aim of this study was to obtain epidemiological data on gastrointestinal and haemoparasites in cattle raised in Burdur province. Blood and fecal samples were collected from 578 randomly selected cattle, with at least 50 animals sampled from each of the 11 districts in the province. Samples were examined microscopically for various parasitic agents and their developmental stages using conventional parasitological methods. Among the animals tested, 125 were positive for at least one parasitic agent or developmental form, resulting in an overall parasitological positivity rate of 21.62%. The prevalence of blood and gastrointestinal parasites was 9.86% (57/578) and 14% (85/578), respectively. The most frequently detected parasites, regardless of single or mixed infections, were *Theileria* spp. piroplasms (8.65%), followed by *Eimeria* spp. oocysts (7.61%), Trichostrongylidae eggs (6.4%), *Dicrocoelium dendriticum* eggs (2.07%), *Anaplasma* spp. (1.73%), and *Marshallagia* spp. eggs (0.34%). The least prevalent were *Fasciola* spp., *Nematodirus* spp., *Moniezia* spp. eggs, and *Cryptosporidium* spp. oocysts, each detected at 0.17% (1/578). District-level positivity rates varied, with Yeşilova (50%) and Karamanlı (48%) showing the highest prevalence, followed by Çavdır (38.18%), Altınyayla (26%), Gölhisar (21.56%), Tefenni (14%), Bucak (11.11%), Kemer (10%), Merkez (10%), Ağlasun (9.61%), and Çeltikçi (3.57%).

INTRODUCTION

It is well established that countries recognized as leaders in economic development and adopting a production-based economic model consider agricultural and livestock activities as strategic sectors, thereby formulating long-term policies in these areas. Agricultural and animal production hold significant importance in developed and developing economies alike. Beyond their economic value, animal proteins are critical nutritional components that cannot be substituted by alternatives and are essential for the physical and mental well-being of individuals, enabling them to sustain life and contribute to a high-welfare society. In this context, cattle farming plays a crurial role, particularly in the production of red meat and milk (FAO, 2004; Lopes et al., 2015; Greenwood, 2021).

One of the major challenges to healthy and efficient livestock production is diseases caused by parasitic organisms such as helminths, protozoa, and arthropods. It is estimated that mortality and productivity losses due to parasites far exceed the figures reported in official statistics. Various parasitic species, which inhabit their hosts either permanently or temporarily, cause significant harm by impeding both humans and animals from leading healthy and productive lives, sometimes resulting in death. For any society aspiring to modernity and productivity, prioritizing human and animal health and welfare is imperative. Therefore, addressing parasitic infections through scientific, systematic, and sustainable approaches, and implementing preventive measures against their direct or indirect harmful effects, is a necessity (Corwin, 1997; FAO, 2004; Lopes et al., 2015).

Failure to prevent losses caused by parasites in livestock production not only leads to economic consequences but also impacts public health directly (via zoonoses) and indirectly (through increased costs). Therefore, it is crucial to implement preventive measures against these agents before disease onset, as well as ensuring accurate diagnosis and treatment when diseases occur (Corwin, 1997; Strydom et al., 2023). To achieve this, the presence, species, and distribution of parasitic agents must first be identified.

Based on this necessity, the present study aims to determine the prevalence and distribution of various parasitic agents infecting cattle raised in Burdur province—one of Türkiye's major cattle breeding regions—and to provide epidemiological data that will serve as a basis for prevention and control strategies to mitigate the damage caused by these pathogens.

MATERIALS and METHODS

Selection of animals and collection of study material

The study material consisted of blood and fecal samples collected from a minimum of 50 cattle in each district of Bur-

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dur province. Sampling was conducted at multiple locations within each district, with priority given to herds experiencing decreased productivity and similar issues, herds with uncontrolled animal movements, areas with significant animal trade, and those with a high potential for exposure to parasitic agents due to grazing practices. The study covered all 11 districts of Burdur province: Ağlasun, Altınyayla, Bucak, Çavdır, Çeltikçi, Gölhisar, Karamanlı, Kemer, Merkez, Tefenni, and Yeşilova (Figure 1). In total, samples were collected from 578 cattle, with the number of animals sampled in each district detailed in Table 1.

Samples collected from all districts were stored in foam boxes containing ice packs, transported to the laboratory on the same day, and refrigerated upon arrival. Fecal samples were examined in the laboratory the following day without exception, while blood samples were used to prepare smears, which were fixed immediately. Staining of the smears was completed in the subsequent days.

ation in methanol for 3–5 minutes, the smears were stained with 5% Giemsa solution for 45–60 minutes. Following gentle rinsing under running tap water to remove excess stain, the slides were air-dried and then examined microscopically. Each smear was evaluated under a 100× oil immersion objective by at least two parasitology experts.

Fecal samples were examined macroscopically and microscopically for gastrointestinal and respiratory parasites using direct smear, flotation, sedimentation, and Baermann-Wetzel techniques (Ok et al., 1997). Specific staining methods, including carbol fuchsin and Giemsa staining, were employed when necessary.

Microscopic examination of native fecal samples: A small amount of fecal material was mixed with a few drops of tap water on a slide and homogenized using the edge of another slide. Coarse particles were removed, and the homogenate was treated with a drop of Lugol's iodine solution. Preparations were covered with one to three coverslips and examined under

Figure 1. The districts of Burdur from which samples were collected

Table 1. Number of sampled animals according to districts

Districts	Ağlasun	Altınyayla	Bucak	Çavdır	Çeltikçi	Gölhisar
Number of animals	52	50	54	55	56	51
Districts	Karamanlı	Kemer	Center	Tefenni	Yeşilova	Total
Number of animals	50	60	50	50	50	578

Preparation and analysis of samples

Blood smears were prepared on clean slides, fixed in methanol, and stained with 5% Giemsa stain (Ozbilgin et al., 1997). Residual blood and sera collected in serum tubes were stored at -80°C for subsequent serological and molecular analyses. For each sample, two blood smears were prepared. After fix-

10× and 40× objectives (Ok et al., 1997).

Flotation technique: Approximately 1–2 g of fecal material was homogenized with water in a fecal container, filtered through a tea strainer, and transferred to a centrifuge tube. The suspension was centrifuged at 500 × g for several minutes, after which the supernatant was discarded using a Pasteur pi-

pette. The sediment was then resuspended in zinc sulfate solution, and coverslips were placed on the surface. After 15–20 minutes, the coverslips were carefully removed and mounted onto slides for microscopic examination under 10× and 40× objectives (Ok et al., 1997).

Sedimentation technique: Approximately 1–2 g of fecal sample was homogenized with tap water and strained into a beaker. After filling with water, the suspension was allowed to sediment for one hour. The supernatant was then gently decanted without disturbing the sediment. This process was repeated 3–4 times. The final sediment was mixed with Lugol's solution, and aliquots were placed between slides and coverslips for microscopic examination under 10× and 40× objectives (Ok et al., 1997; Ribeiro & Furst, 2012).

Baermann-Wetzel technique: To detect lungworm larvae, a walnut-sized fecal sample was placed in a double-layered gauze bundle and tied. The bundle was suspended in a funnel filled with water connected to a plastic tube and centrifuge tube. After overnight incubation, the sediment in the centrifuge tube was examined microscopically using Lugol's solution (Carrau et al., 2021).

Cryptosporidium spp. oocyst examination: To detect *Cryptosporidium* spp. oocysts, native carbol fuchsin and Kinyoun acid-fast staining methods were applied (Ok et al., 1997).

Native Carbol Fuchsin staining: A small amount of fecal sample was smeared on a slide with a few drops of carbol fuchsin and examined under a 100× oil immersion objective after drying.

Kinyoun Acid-Fast staining: Thin smears were prepared from fresh feces, fixed in methanol for 1–3 minutes, stained with Kinyoun carbol fuchsin for 5 minutes, then washed to remove excess stain and treated with 1% sulfuric acid for 2 minutes. Slides were counterstained with Loeffler's methylene blue. Permanent mounts were prepared using Canada balsam and examined under a 100× oil immersion objective (Ok et al., 1997).

Statistical Analysis

Data obtained in this study were analyzed using Minitab 16 Statistical Software. The Chi-square test was applied to evaluate associations among age, sex, breed, and positivity. Differences with a P value less than 0.05 were considered statistically significant.

RESULTS

Out of the total 578 cattle examined, 125 were found to be infected with at least one parasite species, resulting in an overall prevalence of 21.62%. The prevalence of blood parasites was 9.86% (57/578), while gastrointestinal parasites were detected in 14% (81/578) of the animals. Blood smear examination revealed the presence of erythrocytic forms of *Theileria* spp. and *Anaplasma* spp., whereas fecal samples contained eggs of Trichostrongylidae, *Moniezia* spp., *Nematodirus* spp., *Fasciola* spp., *Marshallagia* spp., and *Dicrocoelium dendriticum*, along with oocysts of *Eimeria* spp. and *Cryptosporidium* spp.

Prevalence by district was as follows: Yeşilova (50%) and Karamanlı (48%) ranked highest, followed by Çavdır (38.18%), Altınyayla (26%), Gölhisar (21.56%), Tefenni (14%), Bucak (11.11%), Kemer (10%), Merkez (Center) (10%), Ağlasun (9.61%), and Çeltikçi (3.57%).

In Ağlasun, three blood samples tested positive: *Theileria* spp. at 1.92% (1/52) and *Anaplasma* spp. at 3.84% (2/52). Three fecal samples (5.76%) were positive for Trichostrongylidae (trichostrongylid-type). Overall, five cattle (9.61%) in Ağlasun were infected, including four single infections and one mixed infection of *Anaplasma* spp. + Trichostrongylidae.

In Altınyayla, two blood samples (4%) were positive for *Theileria* spp. Single fecal infections were observed as follows: Trichostrongylidae in 12% (6/50), *Eimeria* spp. in 8% (4/50), and *Dicrocoelium dendriticum* in 2% (1/50). Mixed infections of Trichostrongylidae + *Eimeria* spp. and Trichostrongylidae + *Theileria* spp. were each detected in 2% (1/50) of the animals.

In Bucak, one animal (1.85%) had a single *Theileria* spp. infection, two animals (3.7%) had Trichostrongylidae and one animal (1.85%) had a mixed infection of Trichostrongylidae + *Theileria* spp. Additionally, two animals (3.7%) showed single infections with *Eimeria* spp.

In Çavdır, single infections were detected as *Theileria* spp. (12.72%, 7/55), *Eimeria* spp. (9.09%, 5/55), and Trichostrongylidae (1.81%, 1/55). Mixed infections included Trichostrongylidae + *Eimeria* spp. (5.45%, 3/55), *Theileria* spp. + *Eimeria* spp. (3.63%, 2/55), Trichostrongylidae + *Theileria* spp. (1.81%, 1/55), Trichostrongylidae + *D. dendriticum* + *Eimeria* spp. (1.81%, 1/55), and *Theileria* spp. + *Moniezia* spp. + *Eimeria* spp.

Table 2. Detected parasite species and their percentages

Parasite species	*Theileria* spp.	*Eimeria* spp.	Trichostronglydae spp.	*D. dendriticum*	*Anaplasma* spp.
Percentage	8.66% (50/578)	7.61% (44/578)	6.4% (37/578)	2.07% (12/578)	1.73% (10/578)
Parasite species	*Marshallagia* spp.	*Fasciola* spp.	*Nematodirus* spp.	*Monezia* spp.	*Cryptosporidium* spp.
Percentage	0.34% (2/578)	0.17% (1/578)	0.17% (1/578)	0.17% (1/578)	0.17% (1/578)

(1.81%, 1/55).

Çeltikçi had the lowest prevalence, with only two cattle (3.57%) infected with single *Eimeria* spp.

In Gölhisar, single infections included *Eimeria* spp. (11.76%, 6/51), Trichostrongylidae (5.88%, 3/51), and *Theileria* spp. (1.96%, 1/51). Mixed infections involved Trichostrongylidae + *Theileria* spp. (1.96%, 1/51) and Trichostrongylidae + *Eimeria* spp. (1.96%, 1/51).

In Karamanlı, single infections were observed for *Theileria* spp. (18%, 9/50), *Eimeria* spp. (8%, 4/50), *Anaplasma* spp. (6%, 3/50), Trichostrongylidae (4%, 2/50), and *Cryptosporidium* spp. (2%, 1/50). Mixed infections included *Theileria* spp. + *Eimeria* spp. (4%, 2/50), *Theileria* spp. + *Anaplasma* spp. (2%, 1/50), *Theileria* spp. + *Nematodirus* spp. (2%, 1/50), and Trichostrongylidae + *Eimeria* spp. (2%, 1/50).

In Kemer, single infections of Trichostrongylidae (5%,

Table 3. Rates of haemo/gastrointestinal parasites and single/multiple infections according to discticts

Districts	Haemoparasite	Gastrointestinal parasite	Single infection	Multiple infection
Ağlasun	5.76% (3/52)	5.76% (3/52)	7.69% (4/52)	1.92% (1/52)
Altınyayla	4% (2/50)	24% (12/50)	22% (11/50)	4% (2/50)
Bucak	3.7% (2/54)	9.25% (5/54)	9.25% (5/54)	1.85% (1/54)
Çavdır	20% (11/55)	25.45% (14/55)	23.63% (13/55)	14.54% (8/55)
Çeltikçi	0/56	3.57% (2/56)	3.57% (2/56)	0/56
Gölhisar	3.92% (2/51)	19.6% (10/51)	17.64% (9/51)	3.92% (2/51)
Karamanlı	32% (16/50)	22% (11/50)	38% (19/50)	10% (5/50)
Kemer	5% (3/60)	6.66% (4/60)	8.33% (5/60)	1.66% (1/60)
Center	2% (1/50)	8% (4/50)	10% (5/50)	0/50
Tefenni	6% (3/50)	8% (4/50)	14% (7/50)	0/50
Yeşilova	28% (14/50)	32% (16/50)	30% (15/50)	20% (10/50)
Total	9.86% (57/578)	14% (85/578)	16.43% (95/578)	5.19% (30/578)

Table 4. Rates of haemo/gastrointestinal parasites and single/multiple infections according to age, gender and breed

Age	Haemoparasite	P	Gastrointestinal parasite	P	Single infection	P	Multiple infection	P
<1	7.14% (1/14)		14.28% (2/14)		21.42% (3/14)		0/14	
1-3	7.88% (16/203)		11.82% (24/203)		12.31% (25/203)		4.92% (10/203)	
3-7	10.17% (35/344)	P1=0,031	15.4% (53/344)	P2=0,039	18.31% (63/344)	P3=0,033	4.94% (17/344)	
>7	23.52% (4/17)		29.41% (5/17)		23.52% (4/17)		17.64% (3/17)	
Gender								
♀	9.23% (51/552)		14.13% (78/552)		16.66% (92/552)		4.71% (26/552)	P4=0,021
♂	19.23% (5/26)		23.07% (6/26)		11.53% (3/26)		15.38% (4/26)	
Breed								
Holstein	8.56% (34/397)		14.86% (59/397)		14.86% (59/397)		5.54% (22/397)	
		P5=0,003				P6=0,007		
Montofon	19.75% (16/81)		18.51% (15/81)		27.16% (22/81)		7.4% (6/81)	
		P7=0,005				P8=0,027		
Simmental	6% (6/100)		10% (10/100)		14% (14/100)		2% (2/100)	

3/60) and *Theileria* spp. (3.33%, 2/60) were detected. One animal (1.66%) showed a mixed infection of Trichostrongylidae + *Theileria* spp.

In the Center district, five animals (10%) were infected, all with single infections: *Eimeria* spp. (4%, 2/50), Trichostrongylidae (4%, 2/50), and *Theileria* spp. (2%, 1/50).

In Tefenni, single infections of *Theileria* spp. and *Eimeria* spp. were both found in 6% (3/50) of animals, while Trichostrongylidae was detected in 2% (1/50). No mixed infections were identified.

Yeşilova had the highest prevalence at 50% (25/50). Single infections included *Theileria* spp. (10%, 5/50), *D. dendriticum* (8%, 4/50), *Eimeria* spp. (4%, 2/50), *Marshallagia* spp. (4%, 2/50), *Anaplasma* spp. (2%, 1/50), and Trichostrongylidae (2%, 1/50). Mixed infections detected were *Theileria* spp. + *Anaplasma* spp. (6%, 3/50), *Theileria* spp. + *D. dendriticum* (4%, 2/50), *Theileria* spp. + *D. dendriticum* + *Eimeria* spp. (4%, 2/50), Trichostrongylidae + *Theileria* spp. (2%, 1/50), Trichostrongylidae + *D. dendriticum* (2%, 1/50), and *D. dendriticum* + *Fasciola* spp. + *Eimeria* spp. (2%, 1/50).

Overall, regardless of whether infections were single or mixed, *Theileria* spp. was the most frequently detected parasite with a prevalence of 8.65% (50/578), while *Fasciola* spp., *Nematodirus* spp., *Moniezia* spp., and *Cryptosporidium* spp. were the least observed, each at 0.17% (1/578) (Table 2).

The prevalence rates of haemo and gastrointestinal parasites (including both single and mixed infections) by district, along with the rates of single and multiple infections (regardless of parasite type), are summarized in Table 3.

The prevalence rates of parasites detected in the blood and gastrointestinal systems or related organs, along with the frequencies of single and multiple infections categorized by age group, sex, and breed, are presented in Table 4.

Statistical analysis revealed significant differences in the prevalence of haemoparasites ($P_1 = 0.031$), gastrointestinal parasites ($P_2 = 0.039$), and multiple infections ($P_3 = 0.033$) between the age groups of 1–3 years and over 7 years. Regarding sex, a significant difference was observed between males and females in the occurrence of multiple infections ($P_4 = 0.021$).

Breed-related comparisons demonstrated statistically significant differences between Holstein and Montofon breeds in terms of haemoparasite prevalence ($P_5 = 0.003$) and single infections ($P_6 = 0.007$), as well as between Simmental and Montofon breeds for haemoparasites ($P_7 = 0.005$) and single infections ($P_8 = 0.027$).

DISCUSSION

Microscopic examination has long been the primary diagnostic method worldwide, including in Türkiye, for detecting and investigating the prevalence of blood parasites. It remains the first-line diagnostic tool in suspected cases due to its affordability, rapidity, and practicality. However, its reliability is often limited in cases where species differentiation is morphologically challenging or when parasitemia is low, such as in latent or chronic infections (Bose et al., 1995; Gubbels et al., 1999; Almeria et al., 2001; Schnittger et al., 2004; Ndao, 2009; Mans et al., 2015). Technological advancements have introduced more sensitive and specific diagnostic methods, including serological techniques that detect parasite antigens or host antibodies and molecular approaches targeting parasite nucleic acids (DNA, RNA). These newer methods demonstrate markedly higher sensitivity for detecting subclinical or latent infections, low parasitemia cases, and carrier animals (Bose et al., 1995; Gubbels et al., 1999; Almeria et al., 2001; Schnittger et al., 2004; Mosqueda et al., 2012; Rajendran & Ray, 2014; Eshetu, 2015; Lu et al., 2015; Mans et al., 2015).

In Türkiye, multiple diagnostic methods have been employed to detect *Theileria* species, including microscopic examination of blood smears and lymph node aspirates, analysis of tick salivary gland preparations, and serological and molecular techniques. Numerous studies conducted across diverse geographical regions have identified *T. annulata*—the highly pathogenic agent responsible for tropical theileriosis—as well as *T. buffeli/orientalis*, which is generally considered less pathogenic in cattle (Altay et al., 2007; Kose et al., 2022; Simsek ve Aydenizoz, 2024).

Due to budget constraints, this study relied exclusively on microscopic examination, detecting *Theileria* spp. piroplasms in 8.66% of samples. Diagnosis was based on identifying intraerythrocytic piroplasm forms, allowing genus-level classification but not species-level differentiation. At the district level, *Theileria* spp. were found in all districts except Çeltikçi, with the highest prevalences observed in Karamanlı and Yeşilova (26%) and Çavdır (20%). The overall prevalence of *Theileria* spp. in Burdur (8.66%), its widespread detection, and relatively high prevalence in certain districts (above 20%) are noteworthy.

Microscopy-based studies in other regions of Türkiye have reported similar prevalences, such as 9% in Aydın (Eren et al., 1998) and 9.2% in the Black Sea Region (Duzlu et al., 2011). Other studies have documented considerably higher prevalences: 22.8% (Mimioglu, 1955), 20% (Goksu, 1970), and 32.8% (Dincer et al., 1991) in the Black Sea Region; 94.3% in Ankara (Ozcan, 1961); 43.2% in the Aegean Region (Erkut, 1967) and 31.3% in Polatlı, Ankara (Vatansever & Nalbantoglu, 2002). A recent study examining 542 cattle blood samples across 13 Black Sea provinces found *Theileria* piroplasms in 9.2% of cases (Duzlu et al., 2011). Thus, the 8.66% prevalence observed here aligns closely with Aydın and Black Sea data but is lower than rates reported in some other regions.

Contrastingly, a molecular study in Burdur using Reverse Line Blot (RLB) hybridization detected only 0.59% *T. annulata* and no other *Theileria* species (Kose et al., 2022). This low molecular prevalence suggests that Burdur may not represent an endemic-stable area for *T. annulata*. However, the current microscopy-based findings, indicating a wider distribution and higher prevalence, suggest considerable temporal and spatial variability in host-parasite dynamics. Such fluctuations may result from factors including uncontrolled animal movement, livestock imports, and inadequate or unsustainable tick control measures.

Parasite prevalence can also be influenced by climatic and geographical factors, which are beyond direct human control. Nevertheless, effective interventions—including systematic and sustainable vector control programs, stringent regulation and quarantine of animal movements, regular vaccination programs (where available), and optimization of animal husbandry practices such as nutrition and housing—can significantly reduce disease incidence and even achieve regional eradication in some cases. The responsibility for controlling parasites extends beyond individual farmers and veterinarians, requiring coordinated efforts from the Ministry of Agriculture and Forestry and its affiliated institutions.

Another hemoparasite identified in this study was *Anaplasma* spp., a rickettsial pathogen. Although four species—*Anaplasma marginale*, *A. centrale*, *A. phagocytophilum*, and *A. bovis*—are recognized as causative agents of bovine anaplasmosis, species-level differentiation requires molecular diagnostic methods. The characteristic dot-like structures of *Anaplasma* observed under microscopic examination appear as nuclear remnants and cannot be reliably distinguished to the species level. Nonetheless, the intracellular localization of *Anaplasma* varies among species: for example, *A. marginale*, the most prevalent and pathogenic species in cattle, is typically found near the erythrocyte membrane, whereas *A. centrale* is more frequently located centrally or near the center of erythrocytes (Inokuma, 2007). Despite these morphological differences, definitive species identification was not possible in this study; therefore, the reported prevalence pertains to *Anaplasma* spp. collectively.

In this study, *Anaplasma* spp. were detected in blood smears from 10 cattle, resulting in a prevalence of 1.73%. A review of bovine anaplasmosis prevalence in Türkiye reveals considerable variation. Birdane et al. (2006) reported *A. marginale* prevalence rates of 34.11% by microscopy and 55.35% by serology in 645 cattle blood samples. Another study analyzing 484 samples found 69 positive by microscopy and 287 by serological methods (IFAT and cELISA) (Ekici & Sevinc, 2011). Molecular studies have reported a prevalence of 9% in 389 samples, with species-specific rates of 2.8% for *A. marginale*, 1% for *A. centrale*, and 1% for *A. phagocytophilum* (Aktas et al., 2011). In Karaman, Aydin et al. (2019) found a 2.66% prevalence of *Anaplasma*-like organisms via microscopy, whereas Reverse Line Blot (RLB) analysis detected *A. centrale* at 5.33% and *A. marginale* at 6%. Aktas and Colak (2021) investigated bovine anaplasmosis epidemiology in 200 clinically healthy cattle using 16S rRNA PCR-RLB, RFLP, and DNA sequencing. They reported an overall *Anaplasma* spp. infection rate of 38.5%, with single and mixed infection prevalences of 31.5% and 7%, respectively. The predominant species was *A. marginale* (32.5%), followed by *A. centrale* (5.5%), an *Anaplasma*/*Ehrlichia* catch-all group (5.5%), and *Anaplasma* sp. Omatjenne (2.5%), whereas *A. phagocytophilum* and *A. bovis* were not detected. These studies predominantly involved samples from clinically healthy animals, suggesting random sampling of asymptomatic cattle. Similarly, this study collected blood and fecal samples randomly from apparently healthy cattle. It is well established that cattle recovering from clinical anaplasmosis often develop premunition, becoming lifelong reservoirs of the pathogen (Richey & Palmer, 1986). Consequently, while the 1.73% *Anaplasma* spp. prevalence observed here is relatively low, it provides valuable microscopy-based evidence of *Anaplasma* presence in this region. Moreover, these findings highlight the risk of uncontrolled movement of carrier animals between endemic and non-endemic areas, potentially facilitating the spread of anaplasmosis and triggering outbreaks.

In this study, *Eimeria* spp. oocysts were detected in 7.61% (44/578) of the examined cattle fecal samples, with no detections in samples from the Ağlasun and Kemer districts. The vast majority (97.57%) of the sampled animals were over one year of age, while only 14 calves under one year old were included. Notably, all cattle positive for *Eimeria* spp. oocysts were older than one year, with most being older than three years. Since these positive animals fall outside the typical age range for clinical coccidiosis and did not exhibit clinical symptoms, they are considered reservoir hosts (carriers). Although asymptomatic, these animals continuously shed oocysts into the environment via feces. Under favorable environmental conditions, these oocysts sporulate and become infective, thereby posing a significant risk to susceptible calves and young cattle under one year of age. Consequently, implementing preventive measures to reduce environmental contamination and interrupt transmission is critical. Recommended practices include daily cleaning of bedding materials, housing animals separately according to age groups, maintaining strict hygiene and sanitation protocols, and regulating animal movement to prevent the uncontrolled introduction of carrier animals into susceptible herds.

Another gastrointestinal protozoan identified in this study was *Cryptosporidium* spp., the etiological agent of cryptosporidiosis, a neonatal enteric disease. *Cryptosporidium* spp. is a well-established enteropathogen affecting calves, lambs, and kids, and it ranks among the leading causes of neonatal diarrhea in livestock globally, including in Türkiye (Paraud & Chartier, 2012; Noordeen et al., 2012). In the present study, *Cryptosporidium* spp. oocysts were detected in a single five-day-old calf, resulting in a prevalence of 0.17% (1/578). This sample was collected following a farmer's report of diarrhea in the calf, which subsequently tested positive for the parasite. Given the low detection rate observed, the current data on *Cryptosporidium* spp. prevalence is insufficient for definitive conclusions. Therefore, further extensive epidemiological investigations are warranted to better understand the parasite's prevalence, distribution, and impact within the region.

The helminth eggs identified in this study included nematodes Trichostrongylidae (6.4%), *Marshallagia* spp. (0.34%), and *Nematodirus* spp. (0.17%); cestodes *Moniezia* spp. (0.17%); and trematodes *Dicrocoelium* spp. (2.07%) and *Fasciola* spp. (0.17%). Due to morphological similarities among eggs of *Ostertagia*, *Teladorsagia*, *Haemonchus*, and *Trichostrongylus* species within the Trichostrongylidae family, these were collectively classified as Trichostrongylidae, whereas *Marshallagia* spp. eggs, which exhibit distinct morphological characteristics, were reported separately. Various studies conducted across different regions of Türkiye have reported differing prevalence rates of bovine helminths, largely influenced by the diagnostic methods utili-

zed.

Helminth infections predominantly affect the gastrointestinal and biliary systems of cattle. While these infections rarely cause acute clinical disease, they often result in subclinical conditions characterized by growth retardation, decreased feed efficiency, and economic losses due to reduced meat, milk, and reproductive performance. Acute and peracute infections, though less common, can cause severe pathological damage and mortality in extreme cases. Consequently, helminthiasis represents a significant economic burden, compromises animal welfare, and poses potential zoonotic risks.

Previous reports indicate that the prevalence of fasciolosis in cattle in Türkiye ranges from 0.9% to 25.3%, and dicrocoeliasis from 0% to 74.6% (Celep et al., 1990; Ozyer, 1990; Yildirim et al., 2000; Sevimli et al., 2005; Yavuz et al., 2007; Balkaya & Simsek, 2010; Kozan, 2014; Kaplan et al., 2014; Acioz, 2019; Saltan & Tasci, 2020; Pekagirbas et al, 2020). The prevalence of liver fluke infections is influenced by multiple factors, including the distribution of intermediate hosts, seasonality of sampling, host age and physiological condition, and diagnostic approach. The relatively low prevalence detected in this study may be attributed to seasonal sampling, effective regional control measures, and limited habitats for intermediate hosts. Notably, liver fluke prevalence tends to be higher in eastern Türkiye compared to western regions, possibly due to differences in livestock density and parasite control knowledge.

The prevalence of *Moniezia* spp. infections, which generally present subclinically, varies according to region, host age, intermediate host presence, and study methodology. Prevalence rates reported in Türkiye range from 1% to 17.73%, consistent with the low prevalence observed in this study (Yildirim et al., 2000; Kozan et al., 2014).

Parasites of the Trichostrongylidae family cause parasitic gastroenteritis in cattle, leading to economic losses by reducing productivity, although severe clinical infections are rare. Climatic and soil conditions in Türkiye favor the survival of free-living nematode stages. Furthermore, irresponsible farming practices and uncontrolled anthelmintic use contribute to widespread parasite prevalence. Studies in Türkiye have reported varying prevalence rates of trichostrongylosis. For example, Central Anatolia studies documented Trichostrongylidae prevalence ranging from 30.2% to 50.6% across seasons (Tigin et al., 1993). Research in Kayseri identified *Ostertagia* spp. (35%), *Cooperia* spp. (15%), and *Oesophagostomum* spp. (15%), while in Afyon, 26.39% of cattle harbored strongylid-type eggs with species distributions of *Haemonchus* spp. (25.25%) and *Trichostrongylus* spp. (23.71%) (Sevimli, 2007). The findings of the present study in Burdur align with these reports, underscoring the significance of trichostrongylosis as a parasitic threat to cattle production in the region.

Age-related differences revealed significantly higher rates of blood, gastrointestinal, and multiple infections in animals aged seven years and older compared to those aged 1–3 years. This may reflect cumulative parasite exposure over a longer lifespan and the development of premunition and concomitant immunity resulting in a carrier state. However, these factors do not entirely explain the observed prevalence patterns, particularly the lack of significant differences between the oldest and intermediate age groups. Other factors such as animal origin, husbandry, nutrition, and the frequency and accuracy of antiparasitic treatments likely contribute.

Similarly, differences between sexes showed a higher rate of multiple infections in males, despite females being expected to be more susceptible due to physiological immunosuppression during pregnancy and lactation. This discrepancy is likely influenced by the considerable imbalance in sample sizes between sexes and other confounding variables. Further epidemiological research is warranted to elucidate these findings.

Breed-related differences revealed significantly higher haemoparasite prevalence in Montofon cattle compared to Holstein and Simmental breeds. Potential explanations include sample size disparities, management practices, nutrition, and preventive measures. Additionally, genetic factors influencing tick infestation and protozoan susceptibility have been reported (Glass et al., 2005; Glass & Jensen, 2007; Dewangan et al., 2015; Valente et al., 2022). Nevertheless, current literature does not fully clarify the observed susceptibility in Montofon cattle. Further detailed research is essential to better understand breed-specific resistance mechanisms, which could ultimately guide breeding strategies for disease-resistant cattle.

CONCLUSION

This study comprehensively analyzed fecal and blood samples from randomly selected cattle across all 11 districts of Burdur using conventional parasitological techniques. The findings enhance the epidemiological understanding of parasitic infections in cattle, addressing a significant challenge in livestock production. Systematic and regionally targeted parasitological surveys are essential in the future to generate data that can effectively inform and improve animal health management and public health strategies. The responsibility to implement and apply these findings extends beyond researchers to relevant public authorities and institutions, which must ensure the translation of this knowledge into practical control and prevention measures.

DECLARATIONS

Ethics Approval

The present study was approved by the Burdur Mehmet Akif Ersoy University Animal Experiments Local Ethics Committee (18.12.2019/603). In addition, the owners of the animals from which feces and blood samples were taken were informed about the study and signed 'Informed Consent Forms' were obtained. Moreover, permission for the study was also obtained from the Burdur Provincial Directorate of Agriculture and Forestry (27.01.2020/69877819-325.04.02-E.302078).

Conflict of Interest

All authors declare that there is no conflict of interest.

Consent for Publication

Not applicable.

Author contribution

Idea, concept and design: OK, RA, BAY, MFP

Data collection and analysis: OK, MFP, RA, TT, AE

Drafting of the manuscript: OK, MFP, RA,

Critical review: OK, MFP, RA, BAY

Data Availability

All data are fully available without restriction.

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