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ORIGINAL ARTICLE

Protozoan and helminthes parasites endorsed by imported camels (*Camel dromedaries*) to Egypt

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Abstract The prevalence and species spectrum of some blood and intestinal parasites affecting imported camels was studied on a total of 120 clinically suspected camels (males) imported to Egypt from Sudan during the period from January till July 2016 in Abu-Simbel quarantine station, Aswan governorate. Blood and fecal samples were collected from all camels under the study. The fecal samples were collected and examined by sedimentation–floatation techniques for detection of parasitic eggs/oocysts. Coprological examination revealed that the prevalence rate of the parasitic infection was 60% (72 out of 120). Eighteen species of helminthes/protozoan parasites eggs/oocysts were encountered stongyles species were the hightest prevalent of nematodes 12.5%. Four genera of flat worms were identified in the present study including *Paramphistomum* sp. 0.8%, *Fasciola* sp. 3.3%, *Moniezia* sp. 7.5% and *Dicrocoelim* sp. 0.8%. Four species of *Eimeria* were identified (*E. cameli*, *E. dromedarii*, *E. rajasthani*and *E. pellerdyi*) in infected camels the commenst one is *E. cameli* 15.8%, *Cryptospridium* sp. and *Balatidium coli* were recorded with a prevalence rate about 15.8%, 8.3% and 6.7% respectively. Blood smears from jugular vein revealed that 2.5% of camels were infected with *Dipetalonema evansi.* Wide spectrum and high prevalence of internal parasites were observed in the present study which may be lead to severe economic losses, so the application of control measures and treatment of infected camels with specific and effective drugs during the quarantine period are most important to prevent spreading of parasitic infestation and/or introduction of parasites previously not exist in our country.

Keywords Camels · Parasites · Blood · Protozoan · Helminthes

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Introduction

The one humped camel (*Camelus dromedaries*) is the most common species in camel family. It has been a potential importance in transportation and production of milk, meat and wool (Kamani et al. 2008).

Parasitic diseases are one of the major problems of livestock production (Radfar and Gowhari 2013). As well as gastrointestinal and blood parasites badly affect the general health of animals causing anemia, wasting and death in heavy infection (Mahran 1989). Most of parasites infect camels are enteric which are specific to camels or common to other hosts as domestic animals (Wernery and Kadden 2002). As an instance of protozoan, *Eimeria* is major gastrointestinal protozoan reported in camels (Radfar and Gowhari 2013). According to previous studies, some of Eimeria species as *E. cameli* are pathogenic to young camel calves (Yakhchali and Cheraghi 2007). Coccidiosis infection may be seen in camel calves with symptoms as dirrhrea, dysentery, degeneration and anemia

(Parsani et al. 2008). As well as the occurrence of exotic diseases could be expected due to free movements of camels throughout the borders which lead to the transmission and spreading of diseases (Abdel-Aziz 1996). In Egypt, there is an increase in consumption of camel meat (Abou El-Naga and Barghash 2016).

The current study was undertaken to determine the prevalence of the main gastrointestinal and blood parasites among camels imported from Sudan which will be helpful in understanding and ultimately applying the suitable control programs against the recorded parasitic fauna to minimize the possible role played by such imported camels in contamination of the local environment with different parasites.

Materials and methods

Study area

This study was conducted in Abu-Simbel quarantine station (Aswan governorate) representing the southern border of Egypt and important entrance point of imported camels from Sudan.

Animals

Animals with different clinical signs suggesting their infection with different parasites were our target in this study. A total of One hundred and twenty imported male camels were used in the present study. The basic clinical criteria include poor body condition, rough coat, emaciation, alopecia, scrotal swelling, edematous swelling in lower parts of body and legs and diarrhea.

Samples

Blood and fecal samples were collected from each examined camels.

Fecal sample collection

The fecal samples were collected directly from the rectum using disposable gloves in clean fecal pots and kept cool until transport to the laboratory where they were examined immediately for parasites. Each fecal sample was examined by direct smear, simple flotation method using saturated salt solution. Each fecal sample were examined by direct smear, simple flotation method using saturated salt solution (Cebra et al. 2007) and the sedimentation technique described by Zajac and Conboy (Zajac and Conboy 2012) to detect the presence of gastro-intestinal eggs/oocysts. Fecal smears stained with modified Ziehl–Neelsen staining technique for detection of *Cryptosporidium* spp. oocysts were done according to Henriksen and Pohlenz (1981). Photos of the detected eggs/oocyst were captured directly by using digital camera.

The blood samples were collected from each animal through jugular vein puncture after disinfection with 70% ethyl alcohol using vacutainer tubes. Thin blood smears were prepared, air dried, fixed and stained with 10% Giemsa stain and examined microscopically (40X and oil immersion objectives) according to Soulsby (1982). Morphological identification of all parasite diagnostic stages was described by Soulsby (1982), Boid et al. (1985) and Max (2006).

Statistical analysis

Data analysis was performed using a Microsoft Excel worksheet for Windows 2010. Data were summarized by descriptive statistics for number of infected organisms and percentage. The Chi square test was used to analyze the prevalence of all examined groups with total parasitic infestation. Variables were significant at $P < 0.05$.

Results

Out of the 120 examined camels 72 (60%) were harboring one or more types of gastrointestinal and blood parasites at varying levels (Fig. 1). Eighteen different gastrointestinal parasitic species were identified in camels (Figs. 2, 3, 4). As shown in Table 1, the results of infected camels showed that a percentage of 29.2%, 23.3% and 8.33% were infected with single protozoa, single helminthes and mixed infection respectively (Fig. 1). The means of the prevalence of single protozoa is significantly higher than single helminthes and mixed infection at the value of Chi square 23.25 ($P < 0.05$).

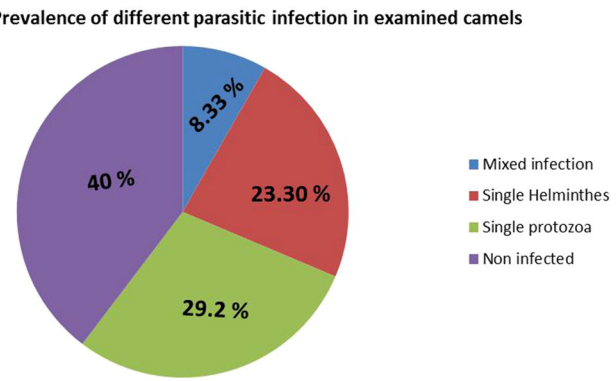

Fig. 1 Chart of prevalence percentages of different parasitic infection types affecting of *Camel dromedaries* in Egypt

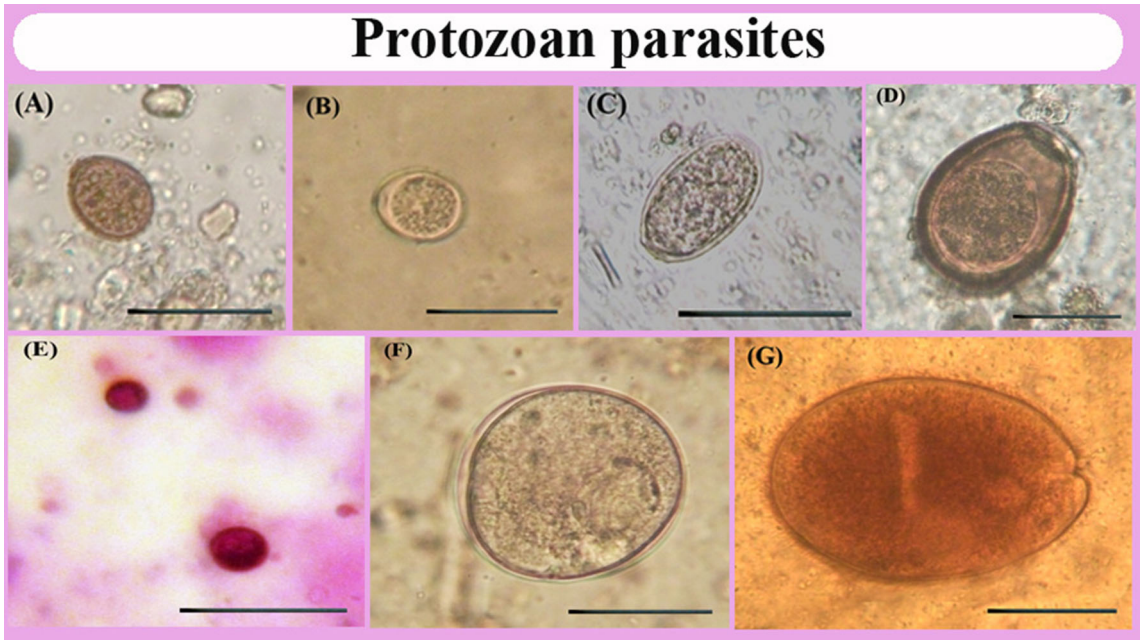

Fig. 2 Photomicrograph of feacal samples showing diagnostic stages of protozal parasitic species affecting of *Camel dromedaries* in Egypt; **a** oocyst of *Eimeria pellerdyi*; **b** *oocyst of Eimeria dromederi*; **c** *oocyst of Eimeria rajastha*ni; **d** oocyst of *Eimeria cameli*; **e** *Cryptosporidium* sp.; **f** *cyst of Balantidium coli*; **g** *trophozoite of Balantidium coli* (40×)

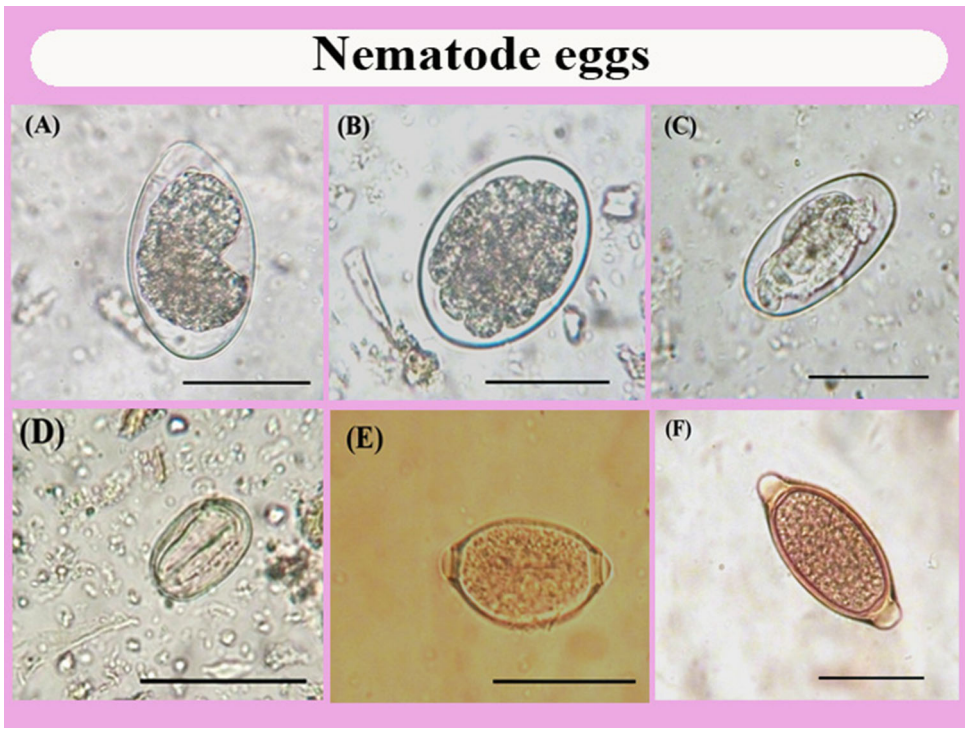

Fig. 3 Photomicrograph of feacal samples showing diagnostic eggs of different nematode species affecting of *Camel dromedaries* in Egypt; **a–c** different shapes of Strongyle eggs; **d** *Strogyloides papillosus*; **e** *Trichuris globulosa*; **f** *Trichuris ovis*. (40×)

Otherwise, examination of peripheral blood smears were detected one species (*Dipetalonema evansi*) with a percentage 2.5% of tested camels (Table 2).

Protozoan parasites

Out of 120 examined camels, 34 (28.33%) camels were infected with *Eimeria* species in the fecal samples. Four species of *Eimeria* were identified according

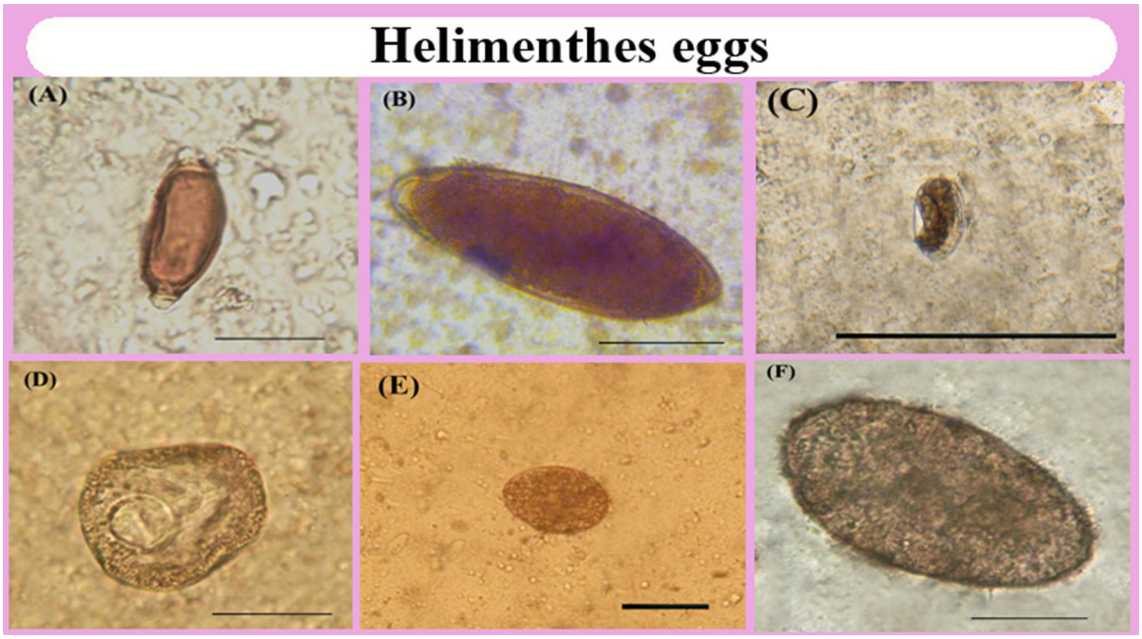

Fig. 4 Photomicrograph of feacal samples showing diagnostic eggs of different helminth species affecting of *Camel dromedaries* in Egypt; **a** *Lung worm egg*; **b** *Marshallgia* sp.; **c** *Capillaria* egg; **d** *Moniezia* egg; **e** *Paramphistomum* sp.; **f** *Fasciola* sp. (40×)

Table 1 Prevalence of different parasitic infection in examined camels

	Examined animals	Infected animals		Noninfected animals		Single protozoa		Single helminthes		Mixed infection		Total protozoa		Total helminthes	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total	120	72	60	48	40	35	29.2	28	23.3	10	8.33	45	37.5	38	31.7

morphological characters of oocysts (Table 2), as *E. cameli*, *E. dromederii*, *E. rajasthani and E. pellerdyi* with prevalence rate 15.8%, 6.7%, 5% and 0.8% respectively (Fig. 2a–d). *Eimeria cameli* was the most prevalent and predominant species (Fig. 2d) which significantly higher than other species at the value of Chi square ($P < 0.05$).

Follow that a protozoa of *Cryptosporidium* spp. was identified (Fig. 2e) in 10 samples of examined camels with prevalence rate about 8.3%. As well, *Balantidium coli* trophozoite (with visible cilia on the cell surface) and cyst of *Balantidium coli* (Fig. 2f, g) were recorded with visible cilia on the cell surface in 8 (6.7%) samples of examined camels.

Helminthes parasites

Ten species of helminthes eggs were recorded in the examined camels which including trematodes, cestodes and nematodes. Nematode eggs were dominant in the prevalence compared to other helminthes in the fecal samples (Figs. 3, 4). Seven different nematode eggs were identified according their morphological distinctive (Table 1 and Figs. 3, 4a–c). As presented in Table 2, the major percentage of infection to *strongyle* eggs (12.5%) which was significantly higher than identified nematode species at the value Chi square 14.98 ($P < 0.05$).

Three species of trematode eggs were identified (Fig. 4e, f) *Fasciola* sp. (3.3%,), *Dicrocoelim dendriticum* (0.8%) *and Paramphistomum* sp. (0.8%). The prevalence of *Fasciola* eggs (3.3%) was significantly higher than identified trematode eggs at value of Chi square 20.11 ($P < 0.05$). Only *Moniezia egg* (Fig. 4d) as cestode parasitic infection was recorded in 9 of examined camels with rate 7.5%.

Blood parasites

Only microfilaria species of *Dipetalonema evansi* was recorded as blood parasites in the examined camels. Stained microfilariae appeared slightly coiled (Fig. 5a). The microfilarial length varied from about 230–290 μm (mean = 260), while the diameter varied from about

Table 2 Morphological characters and prevalence of parasites detected in examined camels (n = 120)

Species	No. of infected	Prevalence (%)	Remarks
(*a*) *Protozoa*			
Eimeria cameli	19	15.8	Dark brown to black piriform oocysts
Eimeria dromederi	8	6.7	Circular structure has one central cluster
Eimeria rajasthani	6	5	Ovoid structures one central cluster
Eimeria pellerdyi	1	0.8	Medium size (21 × 30 µm) oocysts without residual body
Cryptosporidium spp.	10	8.3	Small rounded oocysts, red colour with modified acid-fast stain
Balantidium coli	8	6.7	Ovoid or elongated trophozoite with visible cilia on the cell surface
(*b*) *Nematodes*			
Strongyle sp.	15	12.5	Elliptical or oval has a thin, refractile wall
Trichuris ovis	2	1.7	Barrel shape eggs with plug at either pole
Trichuris globulosa	1	0.8	Thick walls has a pale cap-like structure
Capillaria	1	0.8	Dark red-brown (rugby-ball shaped)
Marshallgia sp.	2	1.7	Large eggs with thin shell and many cells
Strongyloides papillosus	1	0.8	Subspherical, thin shelled larvated egg
Lung worm egg	1	0.8	Elongated, thin walls, containing larva
(*c*) *Cestodes*			
Moniezia egg	9	7.5	Triangular to pyramidal, thick shell, embryonated with pyriform apparatus
(*d*) *Trematodes*			
Fasciola sp.	4	3.3	Large, oval, operculated yellow color
Dicrocoelim dendriticum	1	0.8	Thick-shelled dark brown in color
Schistosoma spindale	1	0.8	Elongated, spindle shape with a terminal spine
(*e*) *Blood parasite*			
Dipetalonema evansi	3	2.5	

3.5–4.5 µm (aver. 4 ± 0.24 µm). The anterior end of has parallel outlines and free from nuclei to a distance about 7–8 µm (aver. 7 ± 0.5 µm) (Fig. 5b). The nerve ring and excretory pore located at about 51–61 µm (aver. 55.3 µm) and 75–94 µm (aver. 82 µm) from the anterior end, respectively. The anal pore located at about 30–60 µm (aver. 45 µm) from the tail end which showed mostly a hooked appearance. The columns of body nuclei end with single row extend to the end of the tail region (Fig. 5c).

Discussion

The gastrointestinal parasites of camels have received the attention of many scientists in recent years as it considered one of the main problems in livestock animals worldwide. The present study was carried out to focus on the gastrointestinal and blood parasites in camels imported to Abu-Simbel quarantine station (Aswan governorate), Egypt from Sudan.

The overall prevalence of parasitic infection in this study was 60% with frequent infections with eighteen different species of helminthes and protozoan. Lower rate of infection was recorded (51.3%) of camels in Halaieb, Shalateen and Abo-Ramad triangle, Egypt (Mahmoud et al. 2008).

As well as variable rates were estimated as 34%, 73.8% in Algeria and Ethiopia, respectively (Duguma et al. 2014; Djerbouh et al. 2018). The present study recorded that the prevalence rate of 23.3% and 29.2% to single helminthes and single protozoan infection. Abdel-Rady (2014) recorded that the incidence of infection with helminthes was 26.9% which higher than estimated in this study. Mixed parasitism (8.33%) involving two or more parasitic genera was common in the present study and lower than that recorded by Abdel-Rady (2014) (35.5%). The distinction in the levels of infections between studies is probably associated the intensity of infection, number of adult parasites in the gastrointestinal tract, stage of parasite infection, level of host immunity or lack of improvement in the animal health management (Sharrif et al. 1996). As well as owners and nomads prefer to graze their animals in open fields where the animals become more associated with other carrier animals as cattle, sheep and goats (Abou El-Naga and Barghash 2016). On other hand, the present data cleared that body conditions of the animal did not associate

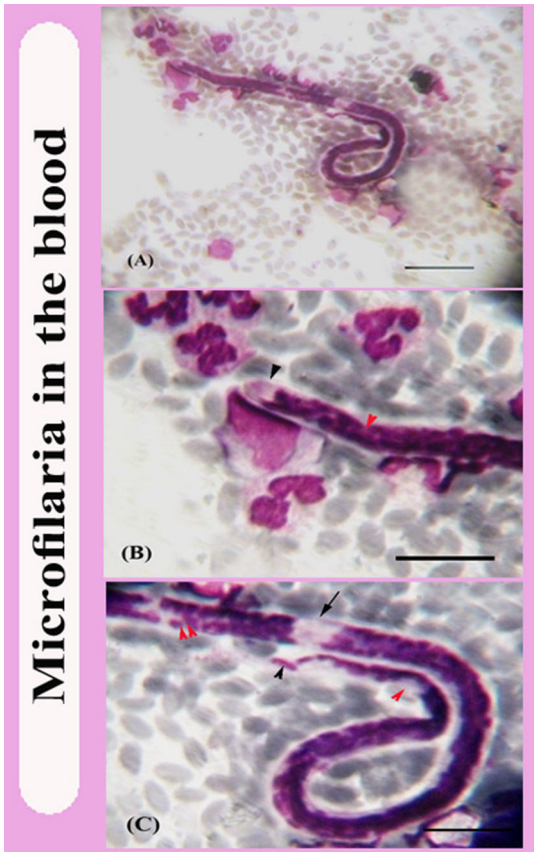

Fig. 5 Photomicrograph of thin blood smear stained with Giemsa stain showing *Dipetalonema evansi* microfilaria in *Camel dromedaries* in Egypt; **a** stained microfilariae appeared slightly coiled between blood cells (40×). **b** The anterior end free from nuclei showing body sheath (black arrowhead) and the nerve ring (red arrowhead). **c** The posterior end showing tail region (black arrowhead), the anal pore (red arrowhead), excretory pore (black arrow) and the body nuclei (double red arrowheads) (100×)

with the prevalence of the parasites where 40% of examined animals were negative by both feacal and blood examinations. This could be explained by the fact that the noticed clinical signs in the studied animals could be due to other infectious agents and/or non-infectious factors, such as poor husbandry, management system, climate, and suboptimal feeding of camels. The absence of association between body conditions of the animals and prevalence of parasetic infection is in agreement with that of Keyyu et al. (2003) and Regassa et al. (2006) as they concluded that no association was revealed between prevalence of infection and sex or body condition of the animals.

The results of collected data from different studies in Egypt pointed out the list of common heavy protozoan infection causes significant impact with high morbidity and mortality in young camels (El-Manyawe and Iskander 1994; El-badr et al. 2010; Abdel-Rady 2014; Osman et al. 2014; Abou El-Naga and Barghash 2016). Coccidiosis is the most important protozoan diseases of camels which concerning with the species coccidia and their life cycle in camels (Dubey et al. 2018). The morphological descriptions of *E. cameli*, *E. rajasthani*, *and E. dromedarii* were provided by Yagoub (1989). In the present study, four species of Eimeria were identified (*E. cameli*, *E. dromedarii*, *E. rajasthani* and *E. pellerdyi*) in infected camels with prevalence rate 15.8%, 6.7%, 5% and 0.8% respectively with total rate (34 camels) 28.3% and 8.3% as a mixed infection with helminth eggs. These results were near similar to that recorded by El-badr et al. (2010) who revealed that the total prevalence of *Eimeria* species in camels in Assiut Governate was 33.3% as single infection and 5.74% as a mixed infection with helminth eggs. This concurred with results of Monib and Arafa (2000) in the same area. High rates of *Eimeria* infection (40%) were recorded by Morsy (1997) in Egypt and the same percentage was recorded by Hussein et al. (1987) in Saudi Arabia. Otherwise, low infection rates were mentioned by El-Manyawe and Iskadar (1994) and Sakr (1988) in Egypt (19.7% and 8.23% respectively).

E. cameli is the most common pathogenic coccidia to camel which causes enteritis (Narnaware et al. 2017). The oocysts were characterized by a large size up to 108 µm compared to small size oocysts with a very thick oocyst wall up to 15 µm (Dubey et al. 2018). The present work revealed that *E. cameli* had the high prevalence rate (15.8%) compared to other *Eimeria* species. These results higher than recorded by Abdel-Rady (2014) 9.9% in Egypt 2012. At variance that El-Manyawe and Iskadar (1994) recorded that *E. dromedarii* and *E. noller* in infected camels with rates 9.2% and 5.5% in Egypt. Four *Eimeria* species (*E. rajasthani*, *E. bactriani*, *E. dromedarii*, and *E. cameli*) were reported in Egypt at the rate of 36.7%, 35.1%, 2.9% and 2.4% respectively (Morsy 1997). Only two species of *Eimeria* species, *E. dromedarii* (10.6%) and *E. cameli* (19.46%) were mentioned by Monib and Arafa (2000) in Egypt (Assiut governate). Counter that three species of *Eimeria* (*E. cameli*, *E. dromedarii*, and *E. rajasthani*) were reported at the rate of 18.3%, 16.1% and 6.9% in the same locality (El-badr et al. 2010). These variations in the prevalence rate of different species of *Eimeria* sp may be due overcrowding population, nutrition habits, stress factors and bad hygienic.

Coccidian of *Cryptosporidium* sp. was countered in 10 of examined camels with prevalence rate 8.3%. *Cryptosporidium* sp. are zoonotic enteric parasites which had a wide range among vertebrate hosts including humans (Ryan et al. 2014). It may be transmitted through contaminated water sources (Zahedi et al. 2016). Cryptosporidiosis in *C. dromedaries* was reported by (Nazifi et al. 2010; Sazmand et al. 2011; Yakhchali and Moradi 2012).

The least prevalence rate of protozoa in the present study was *Balantidium coli* which recorded in 8 camels with rate 6.7%. *B. coli* is most commonly reported worldwide wildlife which is zoonotic protozoa disease for humans (Schuster and Ramirez 2008) Little studies were reported camel balantidiasis and its prevalence in large animals. In recent reports are involved that the transmission of human balantidiasis in Muslim countries mainly by camels due to religious reasons and did not reared pigs which natural reservoir for *B. coli* (Javad et al. 2013). *Balantidium coli* were mentioned as case report in camels in Saudi Arabia (Altayib 2014).

The helminthes fauna in the gastrointestinal tract of camels are around 50 species (Dakkak and Ohelli 1987). The present study showed that helminthosis was an important health problem including weight loss, diarrhea, anemia, enteritis and gastritis in the study area. This finding is in agreement with the results of other researchers in Egypt (Mahmoud et al. 2008; Abdel-Rady 2014; Osman et al. 2014) and different countries in Africa (Radfar and Gowhari 2013; Demelash et al. 2014; Al-Megrin 2015; Abdalla et al. 2016).

The present work revealed that the overall prevalence rate for helminthes infection were 31.7% in 38 camels with 28 camel (23.3%) as single helminthes infection. The recorded prevalence rates were lower than reported by Tekle and Abebe (2001) 96.92% and Bekele (2002) 75% in Ethiopia, Borji et al. (2010) 75.1% in Iran, and Bamaiyi and Kalu (2011) 92.4% in Nigeria.

The total prevalence of helminthes eggs recorded in the present study were matched with that recorded in another studies in Africa countries with much or less variations in prevalence proportions. This variation may be results from nutritional status, climate variations, host immunity, farming systems and lack of health care of veterinary services or probably the laboratory protocols adopted in the studies (Abou El-Naga and Barghash 2016).

A total of 11 genera of worm eggs were identified in the fecal samples of examined camels including 7 species of nematodes, 3 species of trematodes and one species of cestoda.

Strongyle species are the most prevalence helminthes, nematodes in the current study with prevalence 12.5%. This prevalence was comparable to the prevalence of 8.3% to the same area in 2010 (Abdel-Rady 2014) and 36.84% in Halaieb, Shalateen and Abo-Ramad triangle in Egypt (Mahmoud et al. 2008). Otherwise, it is lower than the prevalence's of 15.4%, 59.67%, 75% and 89.2% in Saudi Arabia, Ethiopia, Tanzania and Sudan respectively (Abd El-Salam and Farah 1988; Demelash et al. 2014; Al-Megrin 2015; Djerbouh et al. 2018). Other nematodes species were recorded with lower rate, *Trichuris* species are common helminthes parasites of camelids which found in large intestine and causes diarrhea, weight loss and dehydration (Fowler 1996). Two species of Trichuris were reported in the present study *Trichuris ovis* and *Trichuris globulosa* with prevalence rate 1.7% and 0.8% respectively. *Marshallagia* sp. is very common in the Mediterranean area, and has been also reported in camels of Iran (Borji et al. 2010).

Lung worm infection (verminous pneumonia) is a chronic and prolonged infection caused by nematodes that affects the lungs of different animals. Coprological examination of faecal samples revealed that 0.8% of overall prevalence of lung worm infection in the study area. While *Dictyocaulus cameli* recorded in 24 camels at a prevalence of 29.3% in Uganda (Nakayima et al. 2017). Moreover, according to Bradford (2002), the occurrence of lungworms is associated with time of sampling, level of immunity of sampled animal's management practice of the animal and expansion of facilities like veterinary services.

Trematodes species of *Fasciola* sp. (3.3%), *Dicrocoelim dendriticum* (0.8%) and *Paraphistomum* (0.8%) were mentioned in the present study. *Fasciola* sp. was the predominant species of trematodes in the present study. These results were close to that reported by Ali (2003) 5.3% and Ghandour et al. (1989) 4.22%. On contrary high prevalence was reported in camels in Diwanyiah city, Iraq (31%) by Karawan (2017).

Paramphistomosis (or amphistomosis) is a disease caused by digenean trematodes of Paramphistomatidae family parasitising the rumen of ruminants worldwide. *Paraphistomum* sp. is one of parasitic disease of ruminants that adversely affects their health depending upon the number and developmental stages of the helminthes present. Immature forms of *P. cervi* cause severe damage to duodenal tissue, whereas adult forms injury rumen mild tissue (Singh et al. 1984). It was the common species harvested camels (34.0%) slaughtered in Maiduguri, Nigeria (Biu and Abbagana 2007). Also it was 4.2% in in Somali camels (Abdalla et al., 2016).

Concerning to cestode eggs, *Moniezia* eggs were found in 7.5% of examined camels. The present result is somewhat similar to (Monib and Arafa 2000) where the infection rate was 6.6% of camels in Assiut Governorate. Spreading of *Moniezia* infection in different animals depends on activity of oribatid mites (Soulsby 1982).

Only camel filariasis *Dipetalonema evansi* was reported as a blood parasite in the current study. *D. evansi* is haemoparasite present in the pulmonary arteries, lymph nodes, lymph vessels and hepatic arteries (Soulsby 1982). This parasite has been also reported in Egypt by Monib and Arafa (2000) and Ahmad et al. (2004). The identification of *D. evansi* microfilaria was based on their measurements and morphological characters which agree with description of Soulsby (1982).

In conclusion, it is clear that we face a considerable problem that need to re-evaluate and more attention to the modern animal health programs by camel owners and veterinary services. As well camels are usually imported from Sudan, which has a completely different climate, geographical and amanagmental conditions, bearing great epidemiological risk of introduction of different and/or new parasitic infections.

Authors' contribution Khaled A. Sayed El-Khabaz designed and coordinated the study, shared in sampling and revision the manuscript. Sara S. Abdel-Hakeem assisted in work, manuscript writing and data analysis, Mohsen I. Arfa helped in data analysis and reviewing the final manuscript. All authors discussed the results, commented on the manuscript and gave final approval of the final version to be submitted. All authors read and approved the final manuscript.

Data availability All the data regarding this study are demonstrated in the manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving animals were in accordance with the ethical standards of the Egyptian laws and University guidelines for the care of experimental animals. The protocols of the current experiment were approved by the Committee of the Faculty of Veterinary Medicine of Assiut University, Egypt.

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